TETRA TECH

Village of Haines Junction Aquifer and Wellhead Protection Plan

PRESENTED TO

Government of Yukon, Community Services

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LIMITATIONS OF REPORT

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1.0 INTRODUCTION

Tetra Tech EBA Inc. (Tetra Tech) was contracted by the Government of Yukon, Community Services (YG-CS) to prepare an Aquifer and Wellhead Protection Plan (AWHPP) for the Village of Haines Junction (VHJ) community water system. This work was authorized by Rick Kent, Senior Program Manager under Contract No. C000343288 signed on June 24, 2016.

The objective of the AWHPP is to provide practical protective measures to identify and manage activities and potential risks within inferred well capture zones and recharge areas for the VHJ potable water supply wells. This AWHPP is important to protect and reduce risks to the valuable groundwater resource, the health and safety of the community, and VHJ's and YG's investment in water supply infrastructure. The AWHPP should be considered a living document which should be updated based on activities near the community well that might result in additional risks, or when risks have been addressed and mitigated.

Some additional feedback was provided by the Village of Haines Junction after the release of our previous Issued For Use (IFU) report dated November 30, 2016. This report provides revisions and replaces the previous version.

2.0 SCOPE OF WORK

Tetra Tech's scope of work for the project included the following tasks:

- Background information review to refine the existing conceptual hydrogeological model;
- Field review of wellhead completion and water system infrastructure;
- Preparation of a technical memo detailing field observations and providing recommendations for wellhead upgrades or modifications for community wells Well No.3, Well No.4 and/or No.5 to ensure the ongoing security of the VHJ community water supply (this memo was provided to YG-CS and VHJ earlier in November 2016); and,
- Preparation of this AWHPP.

3.0 METHODOLOGY

There are no Yukon-specific guidance documents relating to aquifer and wellhead protection. This AWHPP was developed following guidance provided in the BC Ministry of Environment, *Well Protection Toolkit,* with the addition of risk-based consideration of potential threats to the security of the water source.

Risk-based AWPP's are established within a risk framework using risk assessment (hazard and risk identification and presentation) followed by risk management (mitigation, risk transfer, preventive action, monitoring, contingency planning and risk communication). Specific well threats (called risk scenarios) are identified, prioritized, and ranked to provide a management framework based on the actual risk posed by each identified hazard. This AWHPP is intended to provide a risk-based framework for decision making related to directing appropriate action in response to real or perceived threats to the VHJ water system, the level and type of that response, and appropriate risk communication throughout the process.

To complete this AWHPP, Tetra Tech collected and reviewed information from the following sources:

- Aerial photographs and satellite imagery, topographic and historical mapping;
- Interviews with VHJ Public Works representatives;

- Interviews with members of the public who resided in the Haines Junction area during the period when the US and Canadian Military were present in the Community;
- Review of the Yukon *Contaminated Sites and Spills Report* registers and a wide area spill search from Environment Canada;
- Review of available background reports;
- Review of historical industrial activities in the area (military etc.);
- Review of historical, current and proposed future land use in the area; and
- A visual survey of the wellhead infrastructure and surrounding areas to identify obvious potential sources of contamination.

4.0 SITE DESCRIPTION

4.1 Location and History

The Village of Haines Junction is located in west-central Yukon at the junction of the Haines Highway with the Alaska Highway. The community is located on the edge of Kluane National Park and Reserve and lies within the traditional territory of the Champagne and Aishihik First Nations. A site location map is included as Figure 1.

The Village of Haines Junction was established during the construction of the Alaska and Haines Highways as a US military base and military activity in the area started during the construction of the Alaska Highway in 1942 and was increased through the construction of the Haines Highway in 1943.

In 1946, the Canadian Military took over the Haines Junction Maintenance Camp, and maintained it until the early 1970s at which time it became the property of Yukon Government. Since the establishment of the highways, industrial activities in VHJ include shipping of materials to and from Alaska along the Alaska Highway, maintenance activities along the Alaska Highway, service garages for travellers on the Alaska Highway and the activities associated with the operation of the village.

4.2 Existing Water and Waste Water System

Water supply to the VHJ is currently provided by two wells (Well No.3 and Well No.5), both connected to a water treatment plant a piped water distribution system. Approximately half of the VHJ water supply is supplied by each Well No.3 and Well No.5 (Dave Hatherley 2017). Only one well is typically in use at a given time with Well No.3 pumped at a rate of about 9 L/s when in use and Well No.5 pumped at a rate of about 11 L/s. A third well, Well No.4, located adjacent to Willow Acres Road, near the water treatment plant (WTP) is currently capped and not in use.

Groundwater is treated by chlorine injection, pH adjustment via CO_2 injection and naturally elevated arsenic is removed using oxide arsenic filtration at the WTP. Water is then stored and distributed via the piped distribution system to the residences and businesses in VHJ.

The majority of residential and commercial building in the township of Haines Junction are serviced by a sanitary sewage system. Waste is collected in a piped sewage system and pumped to the VHJ sewage lagoon treatment system. Residences and businesses outside of the sanitary sewage system discharge waste to septic systems.

4.2.1 Existing VHJ Water Wells

VHJ owns three water wells, one of which (Well No.4) is currently not in operation. The construction and condition of the three water wells is summarized below.

Well No.3

Well No.3 is located adjacent to the Dezadeash River, just off the Haines Highway (Figure 3). Well No.3 was drilled in May 1980 by Midnight Sun Drilling Co. Ltd. The wellhead is completed in an enclosed, locked well house constructed upon a concrete slab foundation. The building consists of a metal wrapped insulated enclosure with surface casing extending to >1 m above ground surface. Well records do not show a surface sanitary seal for this well and based on this we assume for this AWHPP that no sanitary seal is present.

The well completion details for Well No.3 are presented in Table 4-1.

Table 4-1: Well Completion Details for Well No.3

Date of Completion:	May 1980
Drilling Contractor:	Midnight Sun Drilling Co. Ltd.
Completion Depth:	85.3 m bg
Static Water Level:	+3 m ag (1980)
Well Diameter:	203 mm (8”)
Screen Size:	Stainless Steel, 50-slot (0.010”)
Screen Interval:	79.3 to 82.3 m bg
Screen Length:	3 m
Sanitary Surface Seal:	No
Aquifer Description:	Fine to coarse sand and gravel
Recommended Sustainable Yield:	8.4 L/s (133 USgpm) (Tetra Tech 2011)
Other:	Aquifer overlain by thick sequences logged as clay, silt and till.

bg – below grade ag – above grade

Well No.4

Well No.4, located adjacent to Willow Acres Road (Figure 3), is capped and not currently in use, and Tetra Tech understands that VHJ intends to decommission the well.

Well No.4 was completed in September 1988 by Midnight Sun Drilling Inc. and was used to supply water to the VHJ from November 1991 to the fall of 2000 when it was taken out of use due to high turbidity levels (Water Use Application MN99-027, 2001). Well No.4 has not been in operation since it was taken offline in 2000 (HCL 1996, GLL 2002 and p.c. Dave Hatherley). Water produced from this well was noted as “hard but chemically acceptable” (DNA 1996), which suggests that it is relatively poor compared to that produced from Well No.3 and Well No.5. While data from Well No.4 has been used to establish the conceptual hydrogeological model, as this well has been withdrawn from the VHJ water system and there is no intention to re-incorporate it, the well is not included in this AWHPP. The well completion details for Well No.4 are presented in Table 4-2.

Table 4-2: Well Completion Details for Well No.4

Date of Completion:	September 1988
Drilling Contractor:	Midnight Sun Drilling Inc.
Completion Depth:	122.8 m bg
Static Water Level:	20 m bg (Tetra Tech 2003)
Well Diameter:	152 mm (6”)
Screen Size:	Stainless Steel, 50-slot (0.010”)
Screen Interval:	79.3 to 82.3 m bg
Screen Length:	3 m
Sanitary Surface Seal:	No
Aquifer Description:	Sand and gravel
Recommended Sustainable Yield:	4.7 L/s (75 USgpm) (1988) – Well was never pumped at this rate due to sediment issues
Other:	Aquifer overlain by thick sequences logged as clay, silt and till.

bg – below grade

Well No.5

Well No.5 is located in the western portion of the community, between the western corner of Quill Crescent and Source Motors on the Alaska Highway (Figure 4). The well is located in a fenced compound and in a locked, fully enclosed well house comprised of a metal wrapped insulated enclosure with surface casing extending to 0.95 m above ground surface.

Well No.5 was drilled in August and September 2002 by Midnight Sun Drilling Co. Ltd and completed in a sand and gravel aquifer approximately 365 m bg. When drilled, the well was flowing artesian at a rate of approximately 13 L/s (206 USgpm) and had an estimated hydraulic head of +59 m above ground surface (i.e., 84 psi). The well completion details for Well No.5 are presented in Table 4-3.

Table 4-3: Well Completion Details for Well No.5

Date of Completion:	September 2002	
Drilling Contractor:	Midnight Sun Drilling Co. Ltd.	
Completion Depth:	382.2 m bg	
Static Water Level:	+59 m ag (2002)	
Well Diameter:	0.0 – 141.06 m bg	244 mm (9.6”) O.D.
	139.08 – 145.30 m bg	101 mm (4”) I.D.
	141.06 – 361.9 m bg	178 mm (7”) O.D.
Screen Size:	Stainless Steel, 60-slot (0.060”)	
Screen Interval:	361.9 to 369.2 m bg	
Screen Length:	7.32 m	
Sanitary Surface Seal:	Yes (0 to 15.01 m bg)	
Aquifer Description:	Sand and gravel	
Recommended Sustainable Yield:	27 L/s (428 USgpm) (2002)	
Other:	Aquifer overlain by thick sequences logged as of clay and silt.	

bg – below grade ag – above grade O.D Outside Diameter I.D. Internal Diameter

4.2.2 Other Wells in the Haines Junction Area

Other known groundwater well location in the VHJ area are shown on Figure 3. Where available, well completion details and aquifer characteristics are summarized in Table 1, attached. Some wells that have been decommissioned and/or may no longer exist are included for reference. There are likely other private wells in the community that are not captured in this summary and multiple abandoned wells located in VHJ may or may not have been properly decommissioned. Records of well decommissioning were not available for the purposes of this report. Water wells included in the summary are taken from previous well records included in Tetra Tech's 2003, *Resource Assessment for Heat Potential Study,* as well as from wells reported by private property owners during the site visit. Other abandoned well locations in the community were taken from the UMA 1988, *Village of Haines Junction Water System Improvements* and from the Terrain Analysis and Mapping Services (TAMS 1980) report *Geologic and Hydrogeologic Interpretations of Haines Junction, Destruction Bay, Burwash Landing and Champagne, Yukon Territories.*

4.3 Existing Drinking Water Protection Measures and Management Activities

There are physical, operational and management measures in place to guard the VHJ groundwater supply and drinking water system against any contamination of the water supply. These measures include:

- Water treatment including chlorine disinfection, pH adjustment and arsenic removal;
- Water quality monitoring including monthly turbidity monitoring; continuous on-line residual chorine monitoring and microbiological and testing by water system operators; regular microbiological sampling and outside laboratory testing; and regular raw and treated water quality testing; and,
- Well construction measures including adequate stick up of wells, locked well enclosures to prevent tampering, heated well enclosures to prevent freezing at the wellheads.

4.4 Land Use Zoning

Land use zoning designations based on the VHJ Official Community Plan (OCP) from 2013 are included in Appendix B.

The area surrounding Well No.3 is zoned as parks, and mix of zoning surrounds this area:

- The area to the south is a mix of un-zoned land, parks and greenbelt;
- The area to the southwest is not zoned; and
- The area to the north and northeast is zoned commercial.

The area immediately surrounding Well No.5 is zoned as residential. Beyond this area, there are several different land use zoning areas in the vicinity of the well including:

- Industrial zoning in the Quill Crescent area to the northeast;
- Commercial zoning in the area to the south and southwest along the Alaska Highway;
- Self-government zoning in the area to the west;
- Community use in the area surrounding the sewage lagoon to the north; and

- Mix of parks, residential and commercial to the east and southeast.

4.5 Geological Setting

4.5.1 Topography, Terrain and Hydrology

The Village of Haines Junction is located on the northern bank of the Dezadeash River at an approximate elevation of 600 metres above sea level (m asl) in the Shakwak Valley and is nestled between three major mountain ranges including the Auriol Range of the Kluane Ranges, the Dezadeash Range and the Ruby Range. Figure 1 shows the topography in the Haines Junction region.

- The Auriol Range of the Kluane Ranges starts approximately 5.5 km southwest of the Village. From Haines Junction to the Auriol Range, the topography increases gently to the foothills, from the foothills, the Auriol Range rises steeply to a maximum elevation of approximately 2,310 m above mean sea level (asl).

- To the south and southeast of the Village, the Dezadeash and Ruby Range from the western portion of the Yukon Plateau with maximum elevations of 1,200 to 1,800 m asl. This region hosts an interconnecting network of valleys that drain into the major river systems such as the Dezadeash River.

- To the north of VHJ is southeast tip of the Ruby Range. Paint Mountain is located north of the community with a maximum elevation of approximately 1400 m.

The watershed of the Haines Junction area is defined by three major mountain ranges separated by two major tectonic zones known as the Tanana and Shakwak lineaments. Regional surface drainage surrounding Haines Junction consists of drainage ranging from ephemeral seasonal streams to creeks draining to the Dezadeash River. The Dezadeash River drains to the Alsek River and then south to the Pacific Ocean in Alaska. Recharge for these drainages mainly occurs in the mountain ranges from rainfall and glacial melt.

4.5.2 Surficial Geology and Glacial History

Regional scale mapping of surficial geology is presented in Figure 2. The most recent deposits in the Haines Junction region are Quaternary unconsolidated and consolidated deposits within river, mountain and glacial valleys, and depressions. According to Muller (1967), the Village of Haines Junction is situated within a lacustrine plain. Northeast of Haines Junction along the Dezadeash River Valley, and northwest and southeast of Haines Junction along the Shakwak Valley, these surficial deposits consist of glaviofluvial outwash gravels. Southwest of Haines Junction, towards the Auriol Range, the surficial deposits consist of diamicton ground moraine at the Auriol foothills, and a mixture of gravelly glacial kame deposits, till covered slopes, and gravelly glaciofluvial or fluvial fans on the slopes of the mountains.

Due to glaciation in the Shakwak Valley, several glacial lake events have submerged the Haines Junction area. During the glacial lake events, glaciolacustrine materials were deposited in the valley bottom resulting in an extensive blanket of fine-grained glaciolacustrine deposits. These deposition events include deposition of glaciolacustrine materials during several phases of Glacial Lake Champagne and Glacial Lake Alsek:

- At least three major glaciers have advanced through the Shakwak Valley and have covered the Village of Haines Junction (Muller 1967). These glaciers deposited clay-rich tills and upon retreating, created a large pro-glacial lake, known as Glacial Lake Champagne (Day 1962) that deposited thick sequences of clay and silt.

- During recent glacial surges of the late Holocene, the Lowell Glacier advanced across the Alsek Valley and blocked the south-flowing Alsek River. The resulting lake backed up into the Shakwak Valley in the vicinity of Haines Junction and created a lake known as Lake Alsek. Lake Alsek was at least 110 km long and 200 m

deep and submerged the area where VHJ is currently located. Radiocarbon dating has indicated that there have been several phases of Lake Alsek in the last 500 years as well as one, or more, older Neoglacial episodes of ponding. The last and least extensive expansion of the lake into Haines Junction area occurred during the 19th century around 1850 A.D. (Clague 1982).

The geological materials encountered beneath VHJ during the drilling of Well No.5 correlate to the expected deposits from the geological history described above. These deposits consist of an alternating sequence of clayey tills and fine-grained glaciolacustrine deposits consisting of silt and clay with occasional sand and gravel lenses. Drilling in the VHJ area has not encountered bedrock to date, and the thickness of sediment underlying Haines Junction is unknown.

4.5.3 Bedrock Geology

Due to sedimentary cover in excess of 370 m thick, detailed geology mapping for the area underlying Haines Junction has not been completed. However, good bedrock exposure has allowed for detailed mapping of bedrock geology in the surrounding mountainous terrain. The bedrock units identified in Haines Junction area include Yukon Group metamorphic rocks in the Yukon Plateau, Ruby and Dezadeash Ranges and volcanic and sedimentary rocks of the Mush Group, St. Clare Group and the Dezadeash Group in the Auriol Range.

4.6 Conceptual Hydrogeology

Well No.3 and Well No.5 are screened at depths of approximately 80 and 365 m, respectively and are inferred to target two separate aquifers. The following sections presents a discussion of the conceptual hydrogeology relating to each of these aquifers as well as other aquifers identified in the Haines Junction area.

4.6.1 Aquifers

Haines Junction is underlain by heterogeneous overburden materials, and multiple aquifers have been tapped by various wells over the course of development in the community. Major aquifer zones identified in previous hydrogeological investigations in the area are:

- A shallow, cold, sand and gravel aquifer is present at the southern end of the VHJ (in the vicinity of Well No.3 and the Dezadeash River) at depths of about 3.4 to 6.2 m bg (HCI 1978). This aquifer was the source water aquifer for the former VHJ Well No.1 and was intercepted during the drilling of Well No.2 and Well No.3 (HCI 1978, Stanley Associates 1980). VHJ Well No.1 was completed at 6.2 m bg and produced calcium-bicarbonate type water at a temperature of about 2°C (Tetra Tech 2003, HCI 1978). The extent of this aquifer is not known as shallow groundwater aquifers are not noted in the other well records. The aquifer is considered most likely to be related to modern fluvial deposits in the Dezadeash River and limited in its extent to areas close to the river.

- An intermediate groundwater aquifer was intersected by several wells in the VHJ area at depths between 30 and 60 m bg. This silty gravel aquifer produces sulphate type groundwater with the maximum temperature measured in the wells 4.2°C (Tetra Tech 2003).

- A second intermediate aquifer was intersected by Well No.3, former VHJ Well No. 2 (located near Well No.3) and potentially by several other wells in the VHJ area (see cross section in Appendix C). This sand and gravel groundwater aquifer produces sodium-bicarbonate water at temperatures of about 6.5 to 7°C (Tetra Tech 2003, Stanley Associates 1980).

- A deep groundwater aquifer is intersected by Well No. 5 at a depth of 329 to about 384 m bg. This gravel aquifer produces sodium bicarbonate type groundwater at temperatures of about 16°C with the maximum temperature measured in the well at 19.75°C at the well screen (GLL 2002, Tetra Tech 2003).

4.6.2 Hydrogeological Conceptual Model

Well No.5

Well No.5 is completed at a depth of 369 m bg and the static water level was approximately 57 m ag in July 2003. Groundwater flow direction and hydraulic gradient in the aquifer intersected by Well No.5 are not known. The artesian conditions in the well coupled with the depth of the aquifer zone indicate that the well recharge likely occurs in the mountains surrounding Haines Junction. The closest mountain range to the VHJ Well No.5 is the Auriol Range to the southwest, and it is likely that recharge to the aquifer occurs here.

Conceptual models for the recharge to Well No.5 have been completed by Gartner Lee Ltd. (GLL 2002) and by Tetra Tech (Tetra Tech 2003). Gartner Lee developed the original conceptual model and Tetra Tech furthered their conceptual model to produce two potential conceptual hydrogeology scenarios. Figures depicting both scenarios are included in Appendix C.

- The first conceptual model proposes that likely recharge to the deep warm aquifer intersected by Well No.5 occurs from meteoric water precipitation in alpine moraine glacial deposits on the foothills of the Auriol Range (Tetra Tech 2003). In this model, it is supposed that the water bearing units encountered in Well No.5 represent alluvial fans or deltas that formed off the slope of the Auriol Range wither through deposition of sand and gravel either directly as deltas into the Glacial Lake Champagne or as fans during periods of fluctuating lake levels. The sand and gravel deposits are confined above by glaciolacustrine silt and clay and below by clay rich till. The estimated travel time for groundwater to flow from the Auriol Range (approximately 5.5 km to the south west) to Well No.5 is between 12 and 240 years under this model depending on the inferred aquifer characteristics (porosity, hydraulic conductivity, hydraulic gradient). Based on the isotope chemistry analysis Tritium (^3H), for water from Well No.5, it is thought that the travel time is towards the middle of this estimate as tritium is present in modern meteoric waters at elevated concentrations due to atomic testing and this elevated concentration is not observed in the Well No.5 water indicating the recharge to the aquifer occurred prior to the beginning of atmospheric nuclear weapons testing in 1951 (Tetra Tech 2003).

- The second conceptual model proposes that recharge to the deep warm aquifer intersected by Well No.5 occurs through fractures or regional structural controls. Because structural control on flow through bedrock is inherently heterogeneous and complex, it is impossible to predict travel times for groundwater flow through fractures from the Auriol Range to Well No.5. It is expected that the travel time under a structurally controlled flow path model would be greater than the travel time under the alluvial fan/delta model (Tetra Tech 2003). Both the overburden and fracture flow conceptual models predict that the travel time for groundwater entering Well No.5 is greater than 10 years at minimum from the Auriol Range.

We note that there is insufficient information to confirm either of these conceptual models. The recharge zone(s) could potentially also be located to the north in the Ruby Ranges and/or to the east in the Dezadeash ranges.

There are no identified surficial features that are expected to be directly hydraulically connected to the deep aquifer to which discharge would occur. Given the strongly artesian conditions at Well No.5, groundwater in this deep aquifer is inferred to discharge to the overlying silts and clays and migrate vertically toward the surface. Close to surface, groundwater would discharge either directly to surface waterbodies (i.e., Dezadeash River) into shallow unconfined aquifers

Well No.3

Groundwater flow direction and hydraulic gradient in the aquifer intersected by Well No.3 are not known as there are not a sufficient number of wells completed in this aquifer to determine these hydrogeological parameters.

Based on the completion depth and artesian conditions in Well No.3, it is likely that the aquifer tapped by this well is recharged in a similar manner and from a similar area to Well No.5. Due to the lower static groundwater elevation and shallower well completion, it is inferred that recharge to Well No.3 occurs at lower elevations that the recharge to Well No.5 (Tetra Tech 2003).

Similarly to Well No.5, there are no identified surficial features that are expected to be directly hydraulically connected to the deep aquifer to which discharge would occur. Given the natural artesian conditions at Well No.3, groundwater in this deep aquifer is inferred to discharge to the overlying silts and clays and migrate vertically toward the surface. Close to surface, groundwater would discharge either directly to surface waterbodies (i.e., Dezadeash River) into shallow unconfined aquifers.

Shallow Water Table Aquifer

The shallow groundwater aquifer present in the south end of the VHJ is considered to be hydraulically connected the Dezadeash River. The hydraulic gradient in this aquifer has not been confirmed, but likely mimics topography in close proximity to the Dezadeash River, flowing towards and discharging directly to the river. Any contaminants entering the subsurface in the vicinity of Well No.3 could potentially migrate towards the river in this aquifer.

4.6.3 Aquifer Vulnerability

Aquifer vulnerability is assessed as a measure of the potential for a contaminant introduced at or near ground surface to reach the subject aquifer. Contaminant sources that might impact an aquifer include events such as spills or leaks at surface or from underground piping, tanks or septic fields. Aquifer vulnerability is taken into account when assessing the risk to the aquifer. Tetra Tech used the semi-quantitative Intrinsic Susceptibility Index (ISI) method to estimate the vulnerability of the aquifers tapped by each well (Ontario MOE 2001). ISI scores between 0 and 30 suggest high vulnerability; scores between 30 and 80 suggest medium vulnerability; and scores greater than 80 suggest low vulnerability to surface sources of contamination.

Tables 2-1 and 2-2, (attached) show the calculations of ISI for Well No.3 and Well No.5. The ISI for Well No.3 was calculated to be 381 and was 1,316 for Well No.5. These calculations indicate the wells have very low vulnerability to surface sources of contamination, primarily due to thick sequences of glaciolacustrine silts and clays overlying the separate aquifers.

5.0 STAGE 1: RISK FRAMEWORK

5.1 Risk Identification Approach

An appropriate risk identification approach must be chosen as the first step of developing a risk-based AWHPP. Risk identification can be approached from a qualitative perspective using descriptive assessment of the risk elements, hazards, exposure likelihood and receptors or a quantitative perspective using probabilistic mathematical analysis of the risk elements. Due to the limited aquifer and site information as well as resources available for the development of this AWHPP, a qualitative approach was judged to be appropriate.

5.2 Responsible Parties

Source water protection is a responsibility typically shared among various stakeholders. For risk-based AWHPP's the responsible parties are considered to be the well/water supply system owners responsible for managing the water system (i.e., VHJ representatives), and the fiduciary body responsible for funding the system (i.e., Government of Yukon and VHJ).

5.3 Risk Management Team

A risk management team is formed as one of the steps in developing and implementing an AWHPP and is comprised of representatives from the owner, technical advisors and key stakeholders such as domestic and community water users in the area. We suggest that at this time, the risk management team for this AWHPP consists of VHJ Village Council (the Owner), VHJ Public Works (the operator), and Tetra Tech (the technical advisor).

6.0 STAGE 2: RISK ASSESSMENT

6.1 Well Capture Zone Assessment

The first technical step in developing an AWHPP is to define the geographic area contributing groundwater to a well, known as the well capture zone, to Well No.3 and Well No.5. The capture zone is a key element in developing an AWHPP. The size and shape of the capture zone depends on the hydrogeological setting and the design and operation of the water well.

Horizontal Well Capture Zones

There is insufficient information to predict actual well capture zone shapes by analytical or numerical modelling methods. To assess the extent of the horizontal well capture zones, Tetra Tech assumed that recharge occurs in the foothills of the Auriol Mountains about 6 km to the southwest of the wells. Though the recharge could possibly occur in any of the surrounding mountain ranges, recharge in the Auriol Range would result in the greatest hydraulic gradient and all other factors being equal, the fastest groundwater travel times. Tetra Tech conservatively assumed the gradient of the groundwater flow is similar to topography from this mountain range to the wellhead location for both wells, resulting in an inferred groundwater gradient of 0.05 m/m, which is within the general range of typical groundwater gradients. Based on this assumption, and the aquifer characteristics, Tetra Tech calculated the distance to the edge of the horizontal well capture zone for 90 days, one year, five years and ten years using the following equation, as presented in the BC Well Toolkit:

$$d_{TOT} = \frac{t \times K \times i}{n}$$

Where:

d_{TOT} = the distance representing the 90 day, on, five or ten year time of travel (m)

t = specified time of travel (90 days, one, five or ten years)

K = hydraulic conductivity of the aquifer (m/year) from the transmissivity estimated from pumping test results divided by the aquifer thickness encountered during well drilling;

i = slope of the water table or hydraulic gradient assumed from topographic slope from the Auriol foothills to the static water elevation at well locations

n = porosity of the aquifer assumed to be 0.25 for sand and gravel aquifers in both wells

Use of this equation assumes radial flow towards the well, which is an appropriate assumption given the uncertainty of the hydrogeological conceptual mode. The inferred capture zone dimensions for Well No.3 and Well No.5 are summarized in Table 6-1 below.

Table 6-1: Inferred Capture Zone Dimensions

Parameter	Units	Value	Reference/Source
Well No.3			
K	m/year	4.73E+03	Tetra Tech 2011
n		0.25	Assumption based on sand and gravel aquifers (BC Toolkit)
i	m/m	0.05	Assuming recharge in Auriol foothills
90 day travel time	m	**237**	calculated
1 year travel time	m	**946**	calculated
5 year travel time	m	**4730**	calculated
10 year travel time	m	**9461**	calculated
Well No.5			
K	m/year	3.15E+02	Tetra Tech 2003
n		0.25	Assumption based on sand and gravel aquifers (BC Toolkit)
i	m/m	0.05	Assuming recharge in Auriol uplands
90 day travel time	m	**16**	calculated
1 year travel time	m	**63**	calculated
5 year travel time	m	**315**	calculated
10 year travel time	m	**631**	calculated

Vertical Travel Time

It is important to note that the inferred capture zones only account for horizontal travel time within the aquifer, which is overly simplistic and likely too conservative, particularly in the geological setting of Haines Junction. From the surficial geology mapping completed in the Haines Junction Area and information from well logs, there is a very extensive and thick blanket of fine-grained glaciolacustrine material covering the valley floor and any potential contaminant originating at surface would also have to travel vertically through these sequences to reach the pumped aquifers at Well No.3 and Well No.5. Figure 2 shows the regional extent of this surficial material.

To evaluate the potential for surficial sources of contamination to migrate to the depth of the aquifers targeted by Well No.3 and Well No.5 through the overlying fine-grained sediments, Tetra Tech made a very conservative estimate of vertical travel time at each well based on the following assumptions:

- Hydraulic conductivity value (*K)* = 4×10^{-8} m/s for silt and clay - upper limits of published hydraulic conductivities (Fetter 1994, Freeze & Cherry 1979);
- Hydraulic gradient (*i)* = 1 - this is very conservative as the actual observed gradient is upwards except when the well is pumping;

- Effective porosity of (*n)* = 0.20; and
- Vertical thickness of the glaciolacustrine silt and clay unit between surface and aquifer (*m)* = 65 m for Well No.3 and 331 m for Well No.5.

The average linear flow velocity *v* and travel time *t* can then be calculated using Darcy's Law as follows:

$$v = \frac{K \cdot i}{n}$$

$$t = m/v$$

Table 6-2 summarizes the vertical travel time calculations for Well No.3 and Well No.5.

Table 6-2: Summary of Vertical Travel Time Calculations

Well No.3			
Thickness of glaciolacustrine silt	m	65	Well log (Tetra Tech 2014a)
Pumping gradient	m/m	1	Assumed (Tetra Tech 2014a)
Effective porosity		0.2	Assumed (Tetra Tech 2014a)
Hydraulic conductivity of silt + clay		4.00E-08	Assumed Freeze + Cherry 1979
v=Ki/n	m/s	2.00E-07	calculated
t=m/v	**years**	**10**	calculated
Well No.5			
Thickness of glaciolacustrine silt	m	331	Well log
Pumping gradient	m/m	1	Assumed (Tetra Tech 2014a)
Effective porosity		0.2	Assumed (Tetra Tech 2014a)
Hydraulic conductivity of silt + clay		4.00E-08	Assumed Freeze + Cherry 1979
v=Ki/n	m/s	2.00E-07	calculated
t=m/v	**years**	**52**	calculated

Based on the above assumptions, the estimated travel time through the glaciolacustrine silt and clay is about 10 years at Well No.3 and approximately 50 years at Well No.5. In reality, based on the artesian conditions encountered in deep aquifers underlying the Haines Junction region, there is expected to be an upwards hydraulic gradient in the vicinity of Well No.3 and Well No.5, restricting the potential for surficial contaminants to migrate to depth.

6.2 Potential Receptors

Potential receptors are users of the VHJ public water supply system, which includes the majority of residents of VHJ, local businesses and community centres. There are approximately 900 regular users of the VHJ municipal water supply (Yukon Bureau of Statistics, 2016).

6.3 Identification of Risk Scenarios

Risk is generally defined as the likelihood that a receptor will be exposed to a particular hazard multiplied by the consequence of that exposure. Hazard and receptor must meet to result in exposure, so exposure risk can be defined as occurring where hazard and receptor meet due to an exposure pathway. Eliminating or blocking the

pathways for exposure can remove or reduce the chance that an exposure will occur and reduce or eliminate risk. Figure 6-1 illustrates this concept.

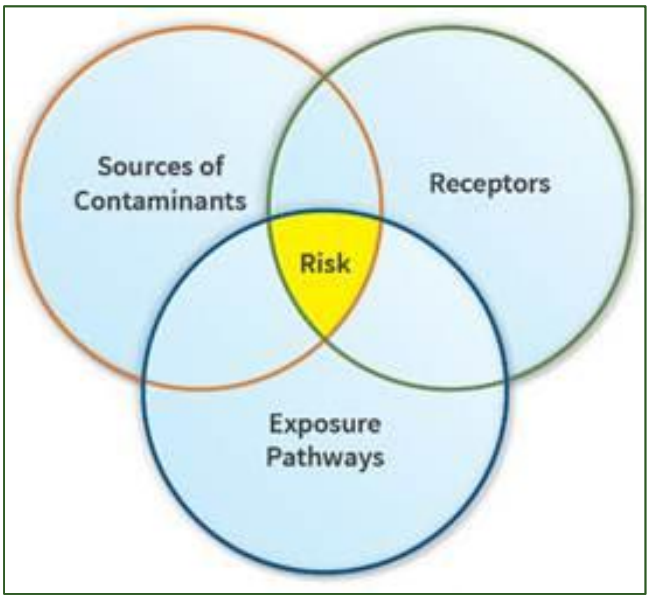


Figure 6-1: Fundamental Concepts of Risk and Risk Management

For the purposes of this AWPP, risk is defined as the potential for exposure of a receptor (e.g., users of the VHJ water system and ultimately the system users) to a hazard (e.g., contamination in the water) multiplied by the anticipated severity of the consequence of exposure. Hazards are categorized in terms of severity (contaminant toxicity). Risk assessment is the process of evaluating the likelihood of exposure and the hazard severity and evaluating and ranking the potential consequences of the identified risk scenarios.

Tetra Tech catalogued and assessed potential sources of contamination to Well No.3 and Well No.5 in order to evaluate the risk these sources pose to the community water users. Tetra Tech identified APECs in the vicinity of the VHJ wells using several methods:

- Reconnaissance of the VHJ area with VHJ personnel, Sarah Sternbergh, P.Eng. on June 29, 2016;
- Meeting with VHJ representatives to discuss current and former land uses, known hazards and anecdotal information;
- Reviewing current and historical air photos and maps of the area for land use;
- Completing a search of properties adjacent to the community water wells for spills records within Environment Canada, Environmental Protection Branch Spills;
- Completing a large area search (10 km radius of VHJ) for contaminated sites and spills within the Government of Yukon, Department of Environment;
- Reviewing available previous reports pertaining to the site and the immediate vicinity; and

- Reviewing water quality sampling results.

6.3.1 Current Surrounding Land Uses

6.3.1.1 Current Land Uses

Identified current land uses in the area surrounding Well No.3 are:

- To the south is the Dezadeash River and an undeveloped recreational area.
- To the west is an area that has been developed for recreation trail use.
- The majority of development and residences in VHJ are located north of Well No.3.
  - The area to the immediate north of the well is occupied by the VHJ weigh station, VHJ nursing station, Conservation Office service building, VHJ RMCP station, RCMP and nursing residences and a motel.
  - To the immediate northeast of Well No. 3 is the VHJ Highways maintenance camp, VHJ government administration building which houses the Yukon College, liquor store and government offices and YG Property Management Division (PMD) building which has some fuel and oil storage onsite.

Identified current land uses in the area surrounding Well No.5 are:

- The VHJ sewage lagoon is located approximately 750 m north of Well No.5. The area between the sewage lagoon and Well No.5 is undeveloped.
- The area to the west of Well No.5 is relatively undeveloped except for the Alaska Highway corridor.
- To the south and southwest of Well No.5 is the Stardust Motel, Source Motors service station, several residences with water wells and the VHJ cemetery.
- To the northeast of the well, along Quill Crescent is the VHJ industrial area with multiple equipment storage and fuel decanting sites recorded during the June 2016 site visit as well as the Fas Gas Service Station located along the Alaska Highway.
- To the southeast of Well No.5, there are several commercial properties including the Village Bakery and Raven Hotel intermingled with residential properties.

6.3.1.2 Historical Surrounding Land Uses

Over the past 75 years, there have been various industrial activities in Haines Junction with the potential to contaminate soil and groundwater including:

- The Haines-Fairbanks pipeline was constructed in 1954/1955 and operated from 1955 to 1971. During the period of operation, a pumping station was built just north of Haines Junction at Mile 1026 on the Alaska Highway (K. Bisset & Associates 1995). The pipeline was dismantled in 1991 with some sections left in place to minimize the impacts of the cleanup. Various spills were recorded through the lifetime of the pipeline; however, none were reported within the Well No.3 or Well No.5 capture zones,
- At one point a tar refining facility was started on the Marshall Creek Road (the old Alaska Highway alignment) just to the east of the main VHJ (p.c. Dave Hatherley, K. Bisset & Associates 1995). This facility is observed in air photos from 1964 and is still in place today, though it appears to be abandoned.

- Bisset et.al. (1995) reported that in 1995 a “radioactive test truck” was dug up from a site along the Marshall Creek Road outside of Haines Junction during the 1995 remediation efforts addressing military sites throughout the Yukon.

Identified former land uses in the area surrounding Well No.3 are:

- Review of air photos of this area from 1948, through 1980 indicate the area immediately surrounding Well No.3 was the location of the US Military camp from the initial occupation to the construction of the Alaska and Haines Highways and through the ongoing maintenance to the early 1970s when the Yukon government took over the site. The military camp expanded from the Well No.3 area to the current highways yard area during the course of the road building and maintenance.

- Anecdotal reports (p.c. Dave Hatherley -VHJ Public Works Foreman, June 2016) coupled with air photo review and review of military activities summarised in the Research of Former Military Sites & Activities in the Yukon (K. Bisset & Associates 1995) indicate that there has been significant industrial and military activity in the vicinity of Well No.3 since the construction of the Alaska Highway in 1944. Reports indicate there was likely a former waste oil pit approximately 100 m from the wellhead (p.c. Dave Hatherley June 2016, AES 1995) which may have resulted in hydrocarbon contamination to the subsurface. Additionally, anecdotal information (p.c. Dave Hatherley) indicates that there may have been dumping of military waste somewhere in the vicinity of the well.

- Review of old mapping and air photos as well as current sewer line maps show that a former sewage lagoon was located about 270 m northwest of Well No.3, and, from communication with Dave Hatherley, Tetra Tech understands that the former sewage lagoon is still used as an emergency overflow from the sewage lift station located here.

Identified former land uses in the area surrounding Well No.5 are:

- Air photo review of the area surrounding Well No.5 from the period 1948 to 1980 as well as current satellite imagery indicates that the former land use was much the same as the current with the industrial area in Quill Crescent, as well as Source Motors and the Stardust Motel on the Alaska Highway built in their current locations over the years.

- One feature noted is that the current location of Fas Gas on the Alaska Highway in the Quill Crescent area was a former location of large fuel storage tanks in 1948 and 1964, and ongoing contamination at this site is present.

6.3.2 Contaminated Sites and Spills Search, Environment Canada

A contaminated sites search of all properties in the 300 m radius of Well No.3 and Well No.5 water wells was conducted by Environment Canada on September 13, 2016. This search returned no records of contaminated sites within the search area (Appendix D).

6.3.3 Contaminated Sites and Spills Search, Government of Yukon

Tetra Tech requested a search for spills and contaminated sites from the Government of Yukon for the area within 10 km of VHJ for the purposes of this AWHPP. Government of Yukon provided the appended report on August 30, 2016 (Appendix D). A total of 14 spill sites and 10 contaminated sites were identified within the 10 km search radius. Of these 24 sites, nine were identified as remediated, three were identified as having minor contamination, three were identified as having unknown status, and nine were identified as contaminated sites. Two of the locations were located at a significant distance outside VHJ – at the landfill and at Mendenhall Road and have not been included

in this study. Note that this report retains the Environment Yukon site identification nomenclature for the identification of registered contaminated sites

The location of the sites identified with status indicated as: as minor contamination, unknown or contaminated in the Village of Haines Junction are identified on Figure 3 and Figure 4. These sites are summarized below:

- Hydrocarbon contamination is present from a leaking UST and a recorded fuel spill at the YG Highways Maintenance Yard, additionally, a Phase II assessment of the site indicates there may be some soil contamination from road salts. The YG Highways Maintenance Yard site status is indicated as “contaminated”. Hydrocarbon contaminated soils are present at the Conservation Office Services Building (site status indicated as “contaminated”) and the RCMP Detachment (site status indicated as “minor or unlikely contamination”). These sites are within 300 m of Well No.3.

- Contaminated Site No. 08-013 is located at Source Motors on the Alaska Highway. Approximately 2,300 L of diesel fuel was spilled under the fuel storage tanks, and this site status is indicated as “contaminated”. Source Motors is within 300 m of Well No.5.

- Hydrocarbon contaminated due to heating fuel spills at the St. Elias Community School (“site status indicated as “contaminated”) and on St. Elias Street at Site No. 10-066 (site status indicated as “contaminated”) are all greater than 300 m from Well No.3 and Well No.5.

- Hydrocarbon contaminated soil due to spills of heating fuel may be present at Sites No. 05-050 (site status indicated as “minor contamination”), 05-090 (site status indicated as “minor contamination”), 06-10 (site status indicated as “unknown”), 14-015 (site status indicated as “contaminated”), and 16-082 (site status indicated as “contaminated”) as well as, the Fas Gas Station (site status listed as “contaminated”) on the Alaska Highway and the VHJ Public Works Yard (site status not indicated). All of these sites are greater than 300 m from any of the wellheads.

6.4 Potential Contaminant Sources in Vicinity of Well No.3 and Well No.5

A list of APECs identified within VHJ and near the wellhead protection areas as of (June 2016) with the potential contaminants of concern is summarized in Table 3 (attached). Both potential biological pathogens and chemical contaminants have been considered in this inventory. Figures 4 and 5 show the spatial distribution of the identified APECs, in relation Well No.3 and Well No.5.

APECs identified and listed in this AWPP are those identified within the 300 m radius of each well by field reconnaissance in June 2016, by interviews with VHJ Public Works representatives, by interviews with residents of Haines Junction and by review of available records including spill searches. Tetra Tech notes that there may be other APECs in VHJ that have not been included as they are not located within the 300 m radius of the VHJ water wells and are not recorded in available documentation.

The main types of APECs identified in the community are listed below:

Above-ground Storage Tanks: Tetra Tech compiled an inventory of properties with above-ground storage tanks (ASTs) during our June 2016 site visit. Fuel storage in the vicinity of the community water wells in VHJ includes residential heating fuel at the majority of residences with the 300 m radius of both the wells, commercial fuel storage and fuel sales at Source Motors (south of Well No.5) and heating fuel storage at government buildings north of Well No.3 including the nursing station and at nursing and RCMP residences.

Septic Systems, Sanitary Sewage System, Outhouses: Septic fields were identified within 300 m of the community wells. Though other septic fields are likely present, septic fields identified during the site reconnaissance

include the Stardust Motel septic field and three residential septic fields within 300 m of Well No.5. None of these septic fields are located within the 60 m regulatory setback.

Former Sewage Lagoon: The former VHJ sewage lagoon was located about 270 m north of Well No.3 until around 1987. While a new sewage lagoon was constructed in 1987, the former lagoon is still in use for overflows from the nearby lift station.

Contaminated Sites: Environment Yukon records identified a number of sites with status recorded as: *minor contamination*, *unknown* or *contaminated* within capture zones of Well No.3 and Well No.5. These sites potentially contain residual contamination that would classify them as APEC.

YG Highways Camp and Grader Station: The highways camp and grader station, approximately 100 m from Well No.3 has the potential to be the source of fuels, salts and glycol spills and leaks.

Former Military Site: Anecdotal information suggests that "military waste" may have been dumped in the vicinity of Well No.3. The location, volume or type of waste dumped is not known. The nature of the waste could vary from relatively benign and inert materials such as wood or metal to putrescible garbage (i.e., food scraps) or organic chemicals such as oils, fuels and degreasers. Dense non-aqueous phase liquids (such as some solvents/degreasers) have the potential to migrate against the hydraulic gradient, however the low permeability materials underlying the site would be expected to limit vertical migration of these substances if present. Dependent upon the type and volume of material dumped, there may be residual contamination in the subsurface.

Waste Oil Dump: Anecdotal information indicates there was likely a former waste oil pit located approximately 100 m from Well No.3 (p.c. Dave Hatherley June 2016, AES 1995) which may have resulted in hydrocarbon contamination to the subsurface. Dependent upon the type and volume of material dumped, there may be residual contamination in the subsurface.

6.4.1 Water Quality Sampling Results

Tetra Tech reviewed available water quality sampling results for samples collected from Well No.3 and Well No.5 between the period of 2004 and 2016. Samples collected from the wells have been analyzed for general chemical and physical parameters as well as total metals as required for yearly reporting under the Yukon *Public Health and Safety Act*. In addition to the water chemistry results, Tetra Tech reviewed bacteriological sampling results as part of the Large Public Drinking Water Systems review in 2012, and the results of this review are included herein.

Analytical results from the two wells are summarized in Table 4, attached. Laboratory analytical reports from sampling conducted in 2015 and 2016 are provided in Appendix E. A summary of laboratory analytical results and bacteriological testing results is provided below:

- Over the period of April 4, 2005 to April 19, 2011 there were three positive Total Coliform results from raw water samples and no positive *E. coli* results reported. Raw water samples were taken from Well No.3 and Well No.5 as well as a mixed water line at Pump House 1, and positive total coliform results included one sample at Well No.5 and two samples from the mixed water line (0.7% of all tests). Positive Total Coliform results were observed in August and April 2005 and October 2008.
- Arsenic in raw water has been consistently elevated at both Well No.3 and Well No.5 above the *Guidelines for Canadian Drinking Water Quality* (GCDWQ) maximum acceptable concentration (MAC) of 0.01 mg/L.
- In 2009, the cadmium concentration in a raw water sample taken from Well No.5 was more than 20 times higher than the GCDWQ MAC of 0.005 mg/L. Results prior and subsequent to 2009 were below the GCDWQ MAC.

- In 2006 the copper concentration in a sample taken from Well No.5 exceeded the GCDWQ AO of 1 mg/L. Subsequent samples taken from this well have reported copper concentrations below the GCDWQ.

Each of the above exceedances are considered to be naturally occurring, and not an indication of contamination from anthropogenic sources.

6.4.2 Identification of Risk in Well Capture Zones

Well No.3

For the purposes of this AWHPP, the capture zone of Well No.3 has been broken down into zones with different levels of control recommended to safeguard the water supply. These zones are defined based on applicable regulations and a conservative estimate of the travel time it will take for a contaminant to reach the well. The well capture zones are defined as follows (the extent of these zones are detailed in Figure 3):

- **Zone 1:** Regulatory Setback Area within a radius of 300 m of the wellhead. The Yukon Public Drinking Water Regulations state that potential surface sources of contamination such as sewage pits or lagoons should be located outside of the 300 m setback distance. This setback area encompasses required setback distances from *"potential sources of contamination"* (60 m) and *"dumps and cemeteries"* (120 m). Zone 1 also corresponds approximately with the 90 day horizontal groundwater travel time zone.

- **Zone 2:** Horizontal travel time in the source aquifer within this area is estimated to be up to 1 year from the zones outer perimeter to the well; however due to the presence of thick fine-grained sediment, vertical travel time from surface to the groundwater aquifer in this zone is estimated to be a minimum of 10 years under conservative assumptions. For the purpose of this risk assessment, we have assumed that a 10 year travel time is sufficient to reduce contaminant concentrations to below guideline concentrations through natural attenuation processes along the travel path.

- **Zone 3:** Horizontal travel time within this zone is greater than 1 year; however due to the presence of thick fine-grained sediment, vertical travel time from surface to the groundwater aquifer in this zone is estimated to be a minimum of 10 years under conservative assumptions. Based on surficial geology mapping, this zone is expected to extend to aquifer recharge areas inferred to be at least 4 km to the north, west and east and 2 km to the south. This area has been identified as an individual zone due to the relatively high groundwater travel times in the aquifer Well No. 3 is completed in and for the potential for groundwater wells drilled to a similar depth as Well No.3 to provide a conduit for rapid contaminant migration to the aquifer.

Well No.5

For the purposes of this AWHPP, the capture zone of Well No.5 has been assigned to a single zone, identified as Zone 1, which is defined by a Regulatory Setback Area within a radius of 300 m of the wellhead. The Yukon *Public Drinking Water Regulations* state that potential surface sources of contamination such as sewage pits or lagoons should be located outside of the 300 m setback distance. This setback area encompasses required setback distances from *"potential sources of contamination"* (60 m) and dumps and cemeteries (120 m). The extent of this zone is detailed in Figure 4.

A zone has not been defined beyond of the 300 m Regulatory Setback Area. This is due the presence of an extremely thick fine-grained sediments and a vertical travel time from surface to the groundwater estimated to be a minimum of 50 years (for the purpose of this risk assessment, we have assumed that the 50 year travel time is sufficient to reduce contaminant concentrations to below guideline concentrations through the natural attenuation process along the travel path). As there are no groundwater wells completed to the same depth as Well No.5 and given the strong artesian pressure at Well No.5, we consider there is negligible possibility that contamination can

migrate from anthropogenic surface sources to the aquifer in which Well No.5 is completed; therefore, additional zones outside of the Regulatory Setback Area are not considered necessary.

6.5 Identification of Risks in Well Capture Zones

6.5.1 Well No.3

Hazards with the potential to release contaminants that may impact Well No. 3 that have been identified in the well protection zones are summarized below:

- Historical and current spills/leaks from ASTs, USTs, vehicles, fuel stations;
- Releases from industrial activity at the VHJ Weigh Station, at the YG Maintenance Yard, at the YG PMD storage building,
- Migration of contaminants from historical waste oil pit near Well No.3.
- Contaminants sourced from buried military waste.
- Existing and emergency sewage lagoons, existing sanitary sewage system.
- Faecal contamination from animals burrowing under the Well No.3 well house.

In addition to the APEC's identified above, there are understood to be a number of groundwater wells (some active, some abandoned) in the VHJ area. These wells, if not properly constructed, maintained, or if improperly decommissioned could provide a conduit from surface to the aquifers in which the wells are completed and allow for the migration of contamination to depth along the well annulus, through broken or corroded casing or directly down wells. Contamination that reaches the aquifer that Well No.3 is completed in this manner could rapidly migrate to Well No.3 and potentially impact water quality.

6.5.2 Well No.5

Potential groundwater contamination sources identified within 300 m of Well No.5 include:

- Spills/leaks from ASTs, USTs, vehicles, fuel stations;
- Releases from industrial activity in the Quill Crescent industrial area; and,
- Migration of contaminants from historical spills at various locations in VHJ.

We note that there is potentially one abandoned/unused well within the Well No.5, Zone 1 area and a number of potentially abandoned/unused wells in the surrounding area. As discussed above, due to hydrogeological conditions there is a negligible chance that contamination can migrate to Well No.5 via leakage or deliberate disposal to existing wells.

6.6 Risk Evaluation and Mapping

Risk to the well users was evaluated for each of the hazards identified using the Risk Matrix shown in Figure 6-2. The following factors were used to define the categories of exposure likelihood and hazard consequence:

- Size and magnitude of the hazard (point source or non-point source);
- Location (distance from wells);

- Groundwater travel times to the wells;
- Likelihood of each contaminant directly affecting water well; and
- The consequence of the exposure to the hazard for users of the VHJ community water supply.

The risk matrix provides the potential risk posed by each of the hazards identified within the well capture zones. An overall risk of “Very Low”, “Low”, “Medium” and “High” was assigned to each potential contaminant of concern (hazard) identified within the well capture zones. The risk levels were based on the combined exposure likelihood and consequence for the potential contaminant source. Colour coding the identified risks provides a straight forward and intuitive basis for managing risks identified on a colour coded Risk Map.

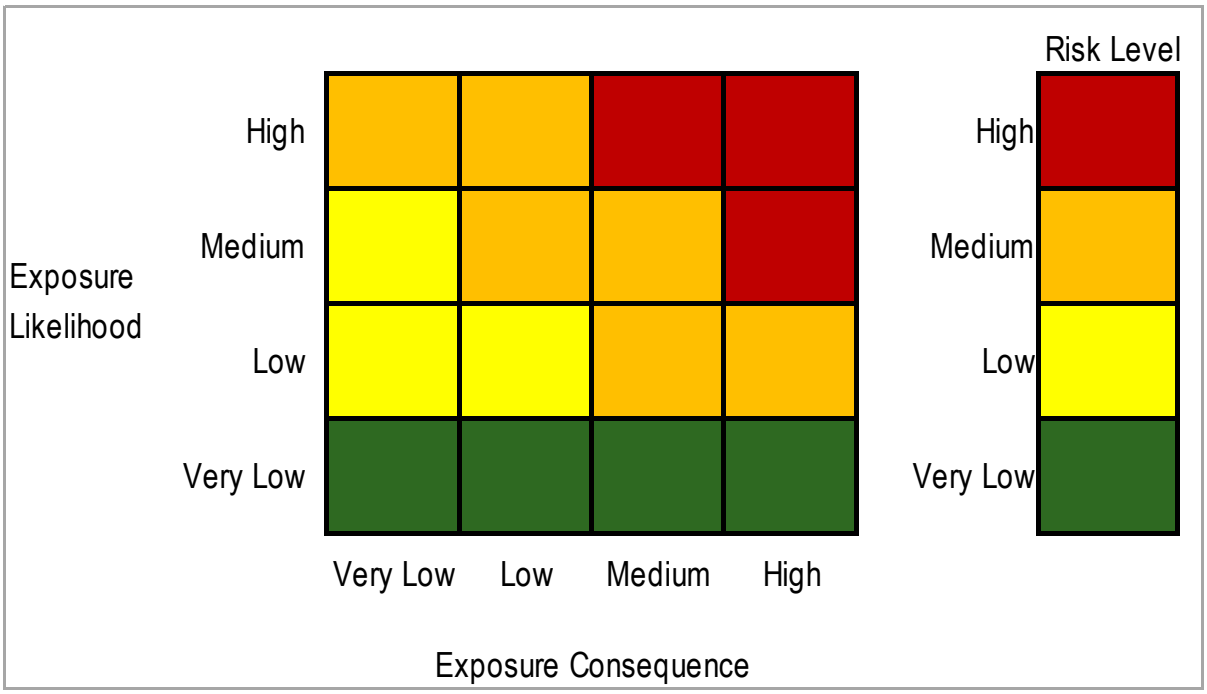


Figure 6-2: Risk Assessment Matrix

Table 6-3 summarizes the rational used for assigning “Very Low”, “Low”, “Medium” and “High” risk values to each identified exposure likelihood and exposure consequence within the well capture zones.

Table 6-3: Hazard Exposure Likelihood and Consequence Categories

Likelihood of Exposure to Hazard	Criteria	
	Bacterial Pathogen	**Chemical Contaminant**
Very Low	Travel time > 1 year	Travel time > 10 years
Low	Travel time > 1 year	Travel time 5 to 10 years
Medium	Travel time < 1 year	Travel time 1 to 5 years
High	Travel time <90 days	Travel time < 1 years
Consequence of Exposure to Hazard	**Criteria**	
Very Low	Exceeds aesthetic objectives in drinking water guidelines	
Low	Short-term health effects (lost time - days)	
Medium	Chronic health hazard (lost time - weeks to months)	
High	Acute health hazard (permanent disabilities or fatalities)	

The resulting risk ranking for each hazard is shown in the risk matrix corresponding to the community well that would be impacted (Figure 6-3 and Figure 6-4), and are colour coded to represent the estimated level of risk the hazard presents to the community water users.

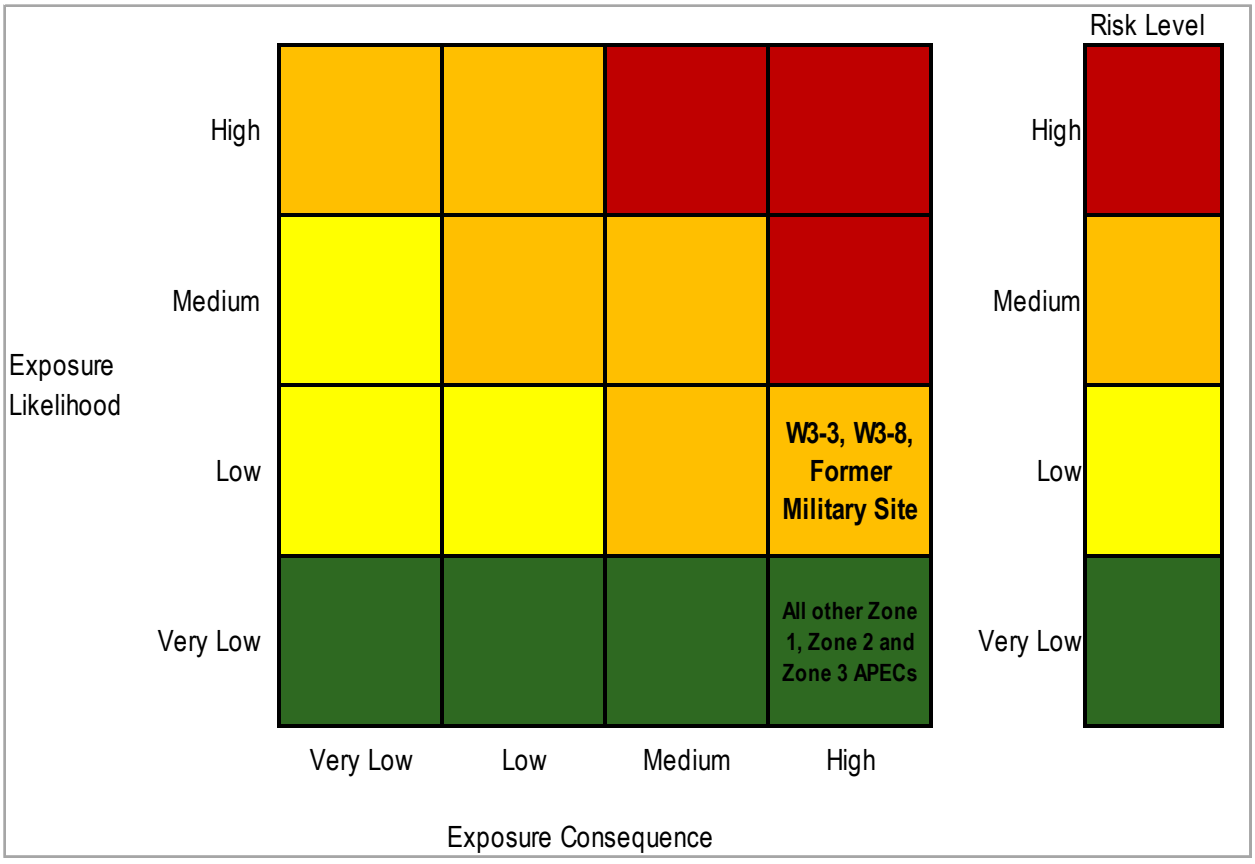


Figure 6-3: Risk Ranking for Potential Contaminant Sources identified in the vicinity of Well No.3

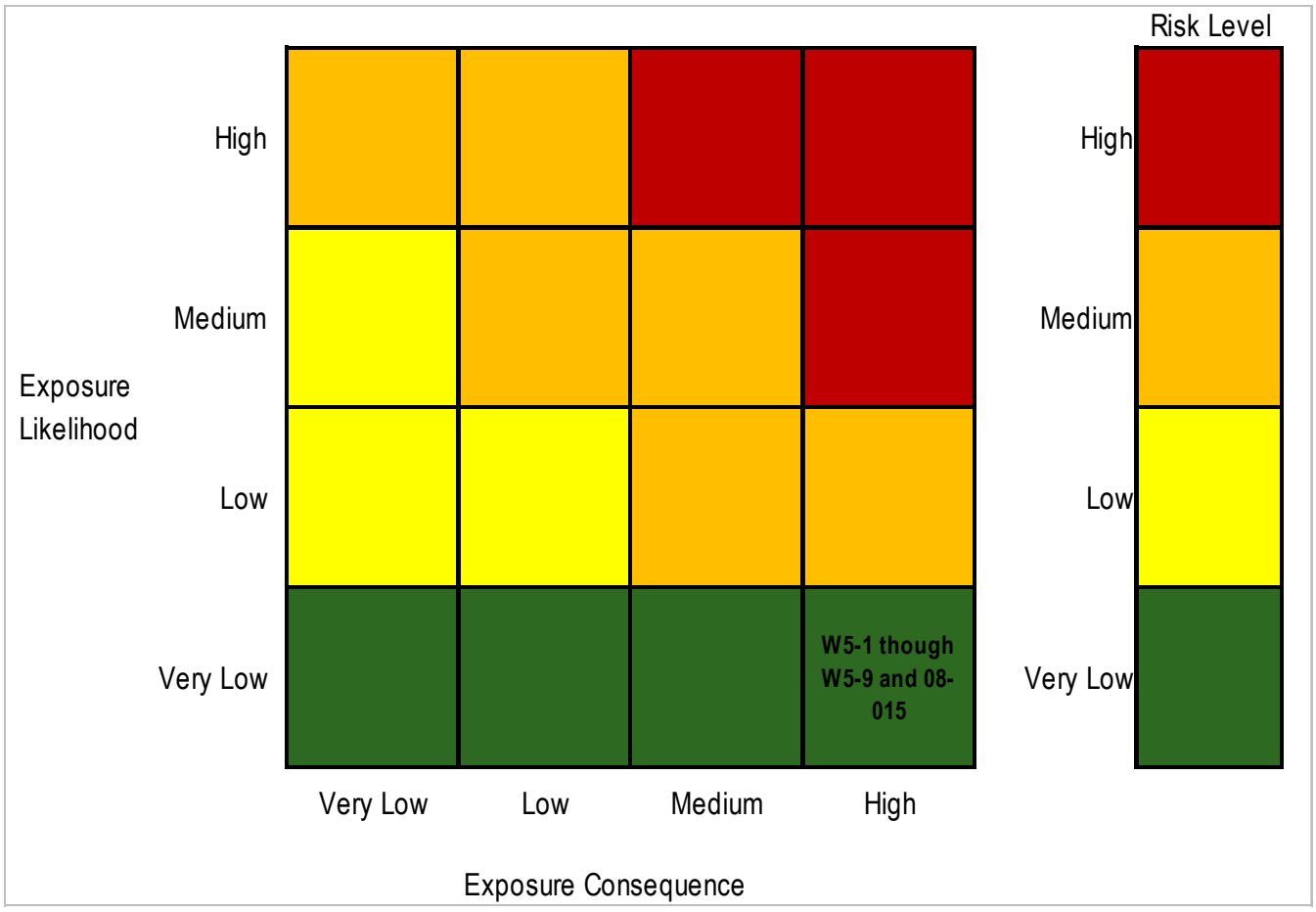


Figure 6-4: Risk Ranking for Potential Contaminant Sources identified in the vicinity of Well No.5

Table 5-1 and Table 5-2, attached, present a summary of risk scenarios within the capture zones as identified in Table 3 and evaluated using the Risk Matrix. The risk rank results are presented on the Risk Maps compiled for both Well No.3 and Well No.5 and presented as Figure 3 and Figure 4 respectively.

Several APECs (W3-3 and the Former Military Site) were defined a higher risk category due to the unconfirmed type of waste deposited/disposed, the long period since deposition may have occurred (60+ years) and the potential for a contaminant plume from these APECS to have migrated to Well No.3. W3-8 was also assigned a higher risk based on the proximity of the potential contaminant source to the wellhead. However, while the horizontal travel time to Well No.3 in the shallow sand and gravel aquifer inferred to exist close to the river may be less than 90 days, the actual potential for contaminants to impact the well is considered low as the only mechanism for impact is through migration along the borehole annulus to depth (considered unlikely due to the thick clay and silt sequence which would likely have formed a tight seal in the months after drilling) or through a corroded/broken well casing (considered unlikely given the well is still within its estimated life expectancy).

7.0 STAGE 3: RISK MANAGEMENT

7.1 Risk Management Strategy

Risk management strategies integrate information collected during the capture zone delineation and hazard identification steps and provides workable strategies for preventing, detecting, and responding to wellhead protection risks. The following includes examples of such strategies:

- Endorsing and promoting Best Management Practices (BMPs) in handling, treating, distributing and protecting the water resource;
- Providing public and landowner information sessions and training;
- Periodic inspections and/or reviews of the AWHPP and wellhead areas; and
- Implementing Action and Management Strategies (provided in Table 6-1 and Table 6-2).

The hazard scenarios identified in this AWPP are potential rather than existing threats to the VHJ community wells, with the thick silt/clay layer providing a strong barrier to contaminants reaching the well intake. Based on the AWPP assessment, the most appropriate risk management for the VHJ water supply system will be preventative action and contingency planning in the event that one of the potential risk scenarios occurs.

In terms of risk communication, the Risk Maps provided with this report and the Risk Information Posters provided as an adjunct to this report can form a concise and convenient basis for communicating information regarding the status of potential threats to all stakeholders including the risk management team, water system operators, community organizations, or municipal councils. Frequent reporting is important to document progress, improve public perception, reduce potential legal issues and possibly reduce insurance costs.

Based on the findings of this AWHPP, we have defined 300 m Wellhead Protection Areas (WPA) around Well No.3 and Well No.5 based on the maximum Yukon *Public Drinking Water Regulations* maximum setback requirements. All future development within this zone should be undertaken in compliance with these regulations and all proposed development within this zone that has the potential to contaminate groundwater should be assessed in the context of this AWHPP.

7.2 Risk Reduction Plan

A Risk Reduction Plan involves pre-planning actions to respond to acute risks situated within the capture zone. For example, this would include emergency response actions and communication should a contaminant release occur within a well capture zone. A list of risk reduction and elimination strategies is provided in Table 6-1 and Table 6-2.

7.3 Risk Monitoring

A Risk Monitoring Plan involves periodic reviewing, auditing and updating of the Risk Maps and Risk Database. Once an AWPP is in place, continued implementation of the program is essential for it to be worthwhile. The Risk Monitoring Plan entails periodically inspecting the community wells and well sites; periodically inspecting the capture zones for new AWPP hazards; working together with the residents and other stakeholders in VHJ to identify and create zoning by-laws for the VHJ area; and updating the status for each identified risk as risk management actions are implemented. The outcome of this would be revised Risk Maps for display or reporting purposes.

Tetra Tech has identified the key areas where risk monitoring will be effective for reducing the risk to the VHJ source water. These are included in the summary Table 6-1 and Table 6-2. The key monitoring measure recommended is

the inclusion of hydrocarbon testing in the annual monitoring of water quality at Well No.3; at least until such time as further investigations and if necessary remediation is completed in the area of former military activities.

At minimum, yearly inspections by a VHJ Water Systems Operator qualified and inspections by a suitably experienced engineer/hydrogeologist should be conducted every 5 years within each WPA to review and identify APEC's that may place Well No.3 or Well No.5 wells or aquifers at risk.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

Based on the review of existing data and the site visit conduced on June 29, 2016 as well as interviews with VHJ residents and municipal works staff, Tetra Tech identified existing hazards to the VHJ source water aquifers and wells. Based on this review, Tetra Tech assessed the risk presented to the VHJ source water supply by these hazards. Tetra Tech emphasises the following conclusions of this study:

- Both Well No.3 and Well No.5 are completed in highly protected, artesian aquifers with likely recharge zones located in the Auriol Range within Kluane National Park. As such, the chance of anthropogenically sourced contamination entering either aquifer is considered medium to extremely remote,
- To Tetra Tech's knowledge, targeted groundwater quality analysis (i.e., hydrocarbon suite) has not been conducted at Well No.3 to determine if there have been any impacts from the potential former waste oil pit or buried military waste.
- Water quality from Well No.3 and Well No.5 is generally good based on raw water quality testing, though exceedances of the GCDWQ for arsenic are common, and cadmium and copper concentrations have also exceeded the GCDWQ in Well No.5 on separate occasions. Water quality results have not shown any signs of contamination of the aquifers at either well. While hydrocarbon testing has not been included in previous monitoring events, we understand that there have been no comments or complaints made to VHJ in relation to odours or tastes potentially relating to hydrocarbon impact.
- The highest risks presented to the source water quality in VHJ are related to potential contaminant sources in the vicinity of Well No.3. These risks have been identified as:
  - Ground squirrels living under the Well No.3 well house cement slab (**Medium Risk**);
  - Potential former waste oil dump site approximately 200 m north of Well No.3 (**Medium Risk**); and
  - Potential military waste burial in the area surrounding Well No.3 (**Medium Risk**).

Risks from each of these APECs can be mitigated through eliminating rodent access under the Well No.3 slab and through assessment and assessment and remediation (if required) of the potential waste oil dump site and military waste (see recommendations below):

- Based on the findings of this AWHPP we have defined 300 m Wellhead Protection Areas (WPA) around Well No.3 and Well No.5 based on the Yukon Public Drinking Water Regulations setback requirements. All future development within this zone must be undertaken in compliance with these regulations and all proposed development within this zone that has the potential to contaminate groundwater should be assessed in the context of this AWHPP. At minimum, yearly inspections by a VHJ representative should be conducted within each WPA to review and identify APEC's that may place Well No.3 or Well No.5 source aquifers at risk.

Assessments every 5 years by qualified engineer or hydrogeologist in conjunction with the AWPP update is also recommended.

- In addition to the defined wellhead protection area around Well No.3, Tetra Tech considers it prudent that all proposed development within the 1 year horizontal capture zone (Zone 2) that has the potential to contaminate the deep aquifer that Well No.3 is completed in is assessed in the context of this AWHPP and mitigation measures implemented if required.

8.2 Recommendations for Work Addressing Wellhead Conditions

Tetra Tech's November 2016 memo titled, *Wellhead Inspections and Recommended Improvements – Wells No.3, No.4 and No.5 Village of Haines Junction, YT*, made a number of recommendations for assessment and improvements to be completed at Well. No.3 and Well No.4 to further protect the wells and reduce risk of impact from contamination. In addition to the recommendations identified in the 2016 wellhead review, Tetra Tech identified some problems with piping to Well No. 3 in a field review memo completed December 2014 titled *Water Well Decommissioning Well 1 and Well 2.* These recommendations to address the medium risks identified above and presented in the aforementioned memos are summarized below.

8.2.1 Well No.3: Recommendations

- Based on the observations made by Cathway Water Resources Ltd. and the electrician on site during the decommissioning of Well No.1 and Well No.2, the water main leading to the pumphouse at Well No. 3 is configured such that Wells No. 1, No. 2, and No. 3 are in series. Heat trace was found to be present only along the water main between Well No. 1 and Well No. 2. Based on this observation, Tetra Tech recommends that the entire water main be equipped with an approved heat trace or a new water main be constructed leading directly from Well No. 3 to the pump house to reduce risk of freeze damage (Tetra Tech 2014b).

- The cracks in the concrete slab should be sealed with an appropriate, non-toxic sealant, the ground squirrels should be driven out from under the slab using non-fatal means and the holes under the slab should be filled with grout pumped from surface. Tetra Tech recommends the installation of an insulated cut-off wall around the perimeter of the building to a depth of approximately 1 m to deter rodents from burrowing under the building again.

- To assess potential impact to drinking water from waste oil disposal and buried military waste potential in the nearby area, Tetra Tech recommends including hydrocarbon monitoring during the annual water quality sampling until such time as a potential hydrocarbon contamination source is determined to not exist or has been removed. Routine parameters should include LEPH, HEPH and PAHs.

- To determine if there is any contamination present in the soils within the vicinity of (60 m) of the wellhead and any buried waste within 120 m, Tetra Tech recommends completing a Phase II Environmental Site Assessment including geophysical investigation and test pitting as required to determine the level of contamination, if present, from former military activities. Should contamination be found, a plan of restoration should be developed to remediate the soils and remove any potential sources of contamination.

8.2.2 Well No.4: Recommendations

- Should VHJ choose to decommission Well No.4, this work should be completed in compliance with applicable regulatory guidelines and best management practices. Removing the well will ensure that the aquifer in this location is protected from surface sources of contamination.

8.3 Recommendations for Long-Term Risk Management for the VHJ System

In addition to the recommended risk reduction measures presented in Table 6-1 and Table 6-2 for consideration, and the assessment and physical well improvement recommended above, Tetra Tech recommends that VHJ complete the following:

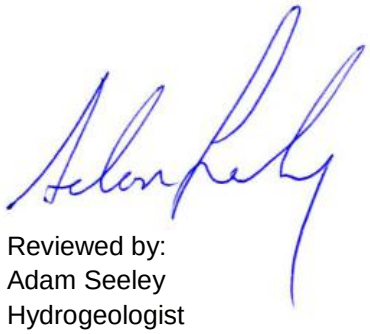
- Form a Risk Management Team to review and update this AWHPP and direct recommended work to ensure this AWHPP is current, relevant and protects the VHJ water source adequately.
- Endorse and promote waste minimization and collection programs to ensure that new sources of contamination are not introduced in the vicinity of the wellheads;
- Ensure that regulatory setback requirements are followed within 300 m of the wellhead as detailed in the Yukon *Public Health and Safety Act*, *Drinking Water Regulation*, Part 1 Section 9.
- All groundwater wells (in-use, unused and abandoned) within a 5 km radius of Well No.3 should be identified and assessed to determine if they should be upgraded to comply with the most current relevant *Guidelines for Water Well Construction* and secured to prevent unauthorised access; or they should be decommissioned in accordance to the applicable Guidelines. *Note: At this current time, new Yukon Guidelines are being developed but are not yet in effect.*
- Implement contingency planning including emergency response actions and communication. VHJ should have an emergency spill response plan in place that emphasizes the actions to take in the event that a spill occurs in the vicinity of the community wellheads;
- Complete regular tracking and monitoring of risks identified within the vicinity of the wellheads (recommended annually at minimum);
- Tetra Tech recommend that VHJ consider their role in long term planning for development of infrastructure and access in the Kluane National Park to protect groundwater recharge areas .
- Educate well owners in the VHJ area on measures they can take to ensure the groundwater aquifers are adequately protected.
- Review and update the AWPP on a regular basis. Every five years may be sufficient or as required due to changes affecting the well system or risk management around the well;
- Incorporate this AWPP into the VHJ community development planning and future zoning planning. This Groundwater Protection Program should include at minimum:
  - Formal recognition and protection status for identified well protection zones such as those identified in this report;
  - Enforcement of well protection measures;
  - Restrictions on land use activities that have the potential to contaminate groundwater within regulatory well protection zones;
  - Require Hydrogeological assessment as a requirement of development for land use activities considered as higher risk such as the development of private water wells in the capture zone of Well No.3, and including groundwater monitoring on and adjacent to specified sites as a condition of development;

– Develop a response action plan and remedial action plans as a condition of development for some specified higher risk land uses.

9.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech EBA Inc.



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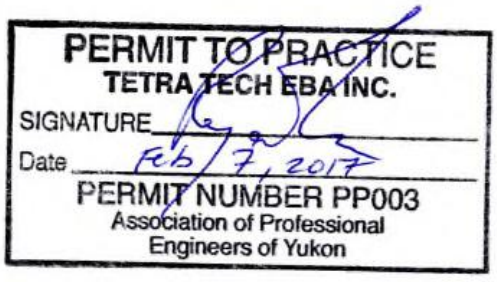

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TABLES

Table 1: Summary of Groundwater Wells in the VHJ Area

Well Name	Wellhead Elevation[A] (a asl)	Drilling and Completion Details[B] (m bgl)	Static water level and Pumping Rates[B] (m^3/day)	Water Chemistry and Characteristics[B]	Comments
Well No.1	582.5	▪ Dug to 7.6 m bg ▪ Not screened ▪ Aquifer 7.0 - 7.6	▪ Static water level unknown ▪ Flow rate 3.4 to 3.8 L/s	Calcium Bicarbonate (1973, 1974, 1988)	Also known as Testhole #2-74 - decommisioned
Well No.2	583	▪ Drileld to 134 m bg ▪ Screen 76.5 - 78.3 ▪ Aquifer uncertain	▪ Artesian upon completion ▪ 7.6 L/s during development, 3.4 L/s in 1980 due to siltation (SAEL, 1980)	Sodium Bicarbonate, 3.3°C (1974)	Also known as Warm Water Well #1 - decommisioned
Well No.3	582.5	▪ Drilled to 82.3 m bg ▪ Screen 79.3 - 82.3 ▪ Aquifer 78.4 - 83.2	▪ Artesian (3 m ags) ▪ 8 L/s during development, 3.4 L/s (UMA, 1988)	Sodium Bicarbonate (1978, 1980, 1988)	Also known as: Warm Water Well #2
Well No.4	618	▪ Drilled to 249.9 m bg ▪ Screen 119.8 – 122.8 ▪ Aquifer 120.4 - 121.9	▪ Static 20 m bgs ▪ 4.7 L/s but never reached due to sediment in water (UMA, 1988)	Sulphate	Also known as: TW3-89
Well No.5	608.5	▪ Drilled to 384.6 m bg ▪ Screen 361.9 - 369.2 ▪ Aquifer 329 - 369.2	▪ Static at 56.95 m ag on July 2, 2002 ▪ 27 L/s (GLL, 2002)	Sodium Bicarbonate (2002)	Aquifer interval from 329 mbgl to mbgl.
Fas Gas Station Well	613	▪ Drilled to approx. 60 m bg	▪ Static 24 m bg ▪ Flow rate approx.. 0.38 L/s	Sulphate (1988)	Formerly Esso Station
RCMP Shallow Well		▪ Drilled to approx. 30 m bg	▪ Static 9.3 m bg ▪ Flow rate approx unknown		Location estimated
St. Elias School	612.5	▪ Drilled to approx. 34 m bg	▪ Static 26 m bg ▪ Flow rate approx.. 0.6 L/s	Sulphate (1988)	abandoned
Brewster's Well	602	▪ Drilled to approx. 156 m bg	▪ Artesian flowing ▪ Flow rate not available	Sodium Carbonate (1974, 1988)	Insufficient yield for community well
Willow Acres Subdivision	619	▪ Drilled to approx. 71.6 m bg	▪ Static 45.7 m bg ▪ Flow rate not available	High Sulphate	Located at Lot 13
Stardust Motel	605	▪ Drilled to approx. 79 m bg	▪ Static 20 m bg ▪ Flow rate not available	Sodium Carbonate (1997)	Well depth indicated by owner Transmissivity = 4.8 m^2/day
Ranger's Well	607	▪ Drilled to 165 m bg ▪ Screen unknown ▪ Aquifer interval 12.2 - 15.8	▪ Static 8.5 m bg ▪ Flow rate not available	Not available	Located at Park's Canada Kluane Visitor Center
Parks Canada Deep Well		▪ Drilled to 158 m bg ▪ Screen unknown ▪ Aquifer interval unknown	▪ Static unknown ▪ Flow rate not available	Not available	Located at Park's Canada Kluane Visitor Center
Private Well	610	▪ Drilled to approx 45 m bg ▪ Screen unknown	▪ Static not known ▪ Flow rate not available	Not available	Location estimated
Sue Burton Well		▪ Drilled to approx. 26 m bg	▪ Static unknown ▪ Flow rate not available	Magnesium Bicarbonate (1988)	Location not known
Experimental Farm Well	634	▪ Drilled to approx. 26 m bg	▪ Flowing artesian ▪ Flow rate not available	Sodium Bicarbonate (1988)	Location estimated
Refinery Well	590	▪ Dug to approx. 6-9 m bg	▪ Static unknown ▪ Flow rate not available	Calcium Bicarbonate	obstruction in well water was hauled from well to supply the town
Stardust Motel Well 1		▪Approx 60 m bg	▪ Static unknown ▪ Flow rate not available	▪ Unknown	Location Estimated
Stardust Motel Well 2		▪Approx 23 m bg	▪ Static unknown ▪ Flow rate not available	▪ Unknown	Location Estimated
Stardust Motel Well 2		▪ Unknown	▪ Static unknown ▪ Flow rate not available	▪ Unknown	Location Estimated
Mile 1018 Well	605	▪ Completion details unknown	▪ Static unknown ▪ Flow rate not available	Sulphate type, elevated iron, manganese, 2.2°C	Location Estimated Very poor water quality similar water quality to Pine Creek

Notes:
A) Elevations based on published reports, 2 m contour mapping or Google Earth elevations
B) Well depths, static water levels, and water chemistry are based on published reports or field measurement data

Table 2-1: Intrinsic Susceptibility Index for Haines Junction Well No.3

Well 3	Aquifer assumed to be confined at this location		Aquifer encountered at 78.4 m bgs (5/1980)		
Interval (m)		Effective Thickness (a) (m)	Description	K-Factor (b)	(a*b)
from	to				
0.0	0.3	0.3	GRAVEL	1	0
0.3	2.5	2.2	CLAY	3	7
2.5	6.0	3.5	GRAVEL	1	4
6.0	7.3	1.3	CLAY	8	10
7.3	15.0	7.7	TILL, gravelly, grey, some cobbles	5	39
15.0	38.5	23.5	TILL, pebbly, grey	5	118
38.5	53.6	15.1	CLAY, grey	8	121
53.6	60.0	6.4	CLAY AND SILT, interbedded, grey	4	26
60.0	63.0	3.0	SILT, compat, grey	4	12
63.0	66.5	3.5	SILT, compact, gravelly	4	14
66.5	71.5	5.0	TILL, grey, increaseing gravel content with depth	5	25
71.5	78.4	6.9	GRAVEL, coarse, angular, silty containing colluvial grey till and hard clay	1	7
78.4	82.5	4.1	GRAVEL (aquifer)	0	0
			Intrinsic Susceptibility Index:		**381**

Notes:

1. Intrinsic Susceptibility Index Method from Ontario Ministry of the Environment (Groundwater Studies 2001/2002 Technical Terms of References, November, 2001)
2. Aquifer vulnerability is low if the value is greater than 80, the vulnerability is medium if the value is between 30 and 80 and the aquifer vulnerability is high if the value is less than 30
3. The vulnerability of the confined aquifer encountered by Well #3 is very low

Table 2-2: Intrinsic Susceptibility Index for Haines Junction Well #5

Interval (m)		Effective Thickness (a) (m)	Description	K-Factor (b)	(a*b)
from	to				
0.0	329.0	329.0	SILT and CLAY with occaisional fine sand lenses and pebbles	4	1316
329.0	343.0	14.0	SILT, SAND and GRAVEL	0	0
343.0	369.2	26.2	SAND and GRAVEL (Aquifer)	0	0
			Intrinsic Susceptibility Index:		**1316**

Notes:

1. Intrinsic Susceptibility Index Method from Ontario Ministry of the Environment (Groundwater Studies 2001/2002 Technical Terms of References, November, 2001)
2. Aquifer vulnerability is low if the value is greater than 80, the vulnerability is medium if the value is between 30 and 80 and the aquifer vulnerability is high if the value is less than 30
3. The vulnerability of the confined aquifer encountered by Well #5 is very low
4. This value is a conservative estimate, as compact till may be present in some of the clay/silt interbedded layers

Table 3: Areas of Potential Environmental Concern - VHJ Well No.3 and Well No.5

ID	APECs	Location (Zone 8/ Nad83)		Time Period	Approximate Distance From Well (m)	Notes	PCOC
		Easting	Northing				
	Well No. 3						
W3-1	Outhouses equipped with below grade septic tanks	363207	6737406	Current	104		Microbiological - coliforms, *E.coli*, viruses
W3-2	Fuel tank at weigh scales	363267	6737405	Current	83		Hydrocarbons
W3-3	Former waste oil dump	363247	6737521	40s to 90s?	200	Was reportedly used until the construction of the Haines Junction Landfill	Hydrocarbons
W3-4	Fuel storage at Nursing Station	363213	6737549	Current	234	Area is bermed and lined, but liner appears degraded from UV exposure	Hydrocarbons
W3-5	UST at Yukon Government Building	363350	6737621	Current	311		Hydrocarbons
W3-6	Barrels and tanks at YG Property Management building	363382	6737579	Current	282		Hydrocarbons
W3-7 / CS5	Highways yard with existing soil contamination, potential source of fuel spills, salt contamination	363373	6737461	Current	175	Highways yard, note that this was a former military site	Hydrocarbons, glycol, salts
10-066	Fuel spill	363266	6738263	Current	950	200 L diesel spilt, some remediation undertaken, contamination remains	Hydrocarbons
14-015	Fuel spill at private residence	363637	6738078	Current	850	Unknown volume of home heating oil, contamination believed to remain	Hydrocarbons
16-082	Fuel spill at private residence	362985	6737934	Current	650	200L of home heating oil, contamination believed to remain	Hydrocarbons
06-10	Fuel spill at Parks Canada building	362828	6737895	Current	700	Diesel spill, status of site is unknown	Hydrocarbons
05-050	Fuel spill at RV park	362570	6737807	Current	850	10 L spilt, minor contamination	Hydrocarbons
05-090	AST leak at VHJ Health Centre	363104	6737736	Current	400	2 gallons spilt, minor contamination	Hydrocarbons
	Well No. 5						
CS1	Contamination at FasGas gas station	362818	6738725	Current	1500	Tank removal project in 2012, contamination not fully delineated	Hydrocarbons
CS2	Soil contamination at St Elias School	363279	6738267	Current	1000	Former UST removed in 1998, residual soil contamination likely below school foundations	Hydrocarbons
CS3	VHJ Public Works Yard	363019	6738072	Current	800	10 m3 of petroleum hydrocarbon soil	Hydrocarbons

Table 3: Areas of Potential Environmental Concern - VHJ Well No.3 and Well No.5

ID	APECs	Location (Zone 8/ Nad83)		Time Period	Approximate Distance From Well (m)	Notes	PCOC
		Easting	Northing				
CS4	Fuel leak at RCMP Detachment	363167	3737784	Current	450	Contaminated soil excavated and removed from site, contamination minor or unlikely	Hydrocarbons
CS6	Soil contamination under Conservation Officer building	363140	6737769	Current	450	Hydrocarbon contaminated soil remaining under building	Hydrocarbons
CS7	Abandoned service station	363205	6737919	Current	350		Hydrocarbons
W5-1	Discharge trench for artesian flow during well maintenance	362195	6738405	Current	10	Intermittently used during well repair work	Microbiological - coliforms, *E.coli*, viruses
W5-2	Equipment storage on Quill Road	362442	6738640	Current	339		Hydrocarbons, glycol
W5-3	Septic system	362420	6738573	Current	279		Microbiological - coliforms, *E.coli*, viruses, nitrate
W5-4	Source Motors gas station & garage, contaminated site	362115	6738216	Current	207		Hydrocarbons, glycol
W5-5	Residential fuel storage	362053	6738201	Current	250		Hydrocarbons
W5-6	Former gas station, fuel storage and septic field	362021	6738205	40s-current	267	Stardust gas station has been removed.	Hydrocarbons, microbiological, nitrate
W5-7	Cemetery	361963	6738151	Current	346		Microbiological - coliforms, E.coli, viruses; embalming chemicals
W5-8	Fuel storage, septic field, livestock	362263	6738178	Current	238	Very likely a dead horse was buried on this property in the past. There is a well on this property.	Hydrocarbons, microbiological, nitrate
W5-9	Future septic field location	362349	6738110	Future	333	Resident plans to put in the septic field this summer	Microbiological - coliforms, *E.coli*, viruses, nitrate
08-013	Fuel spill at Source Motors	362059	6738194	Current	1500	2300 L of diesel spilt in 2008. Remediated however contamination remains below AST foundations	Hydrocarbons
Former Tar Refinery	Oil/hydrocarbons from former tar refining activities	364409	6738205	not known	1400	Well located on site understood to be completed to approx. 6 to 9 m below grade	Hydrocarbons
Former Sewage Lagoon	Sewage beds at former and emergency sewage lagoon	362994	6737609	Current	400		Microbiological - coliforms, *E.coli*, viruses, nitrate
Current Sewage Lagoon	Sewage beds at current sewage lagoon	362034	6739391	Current	2400		Microbiological - coliforms, *E.coli*, viruses, nitrate
Former Military Site	Unknown use of land, waste deposition, disposal	363338	6737490	1940's to 1970's	-	Unknown if land used for deposition/disposal of waste and chemicals, potential for spills/leaks of organic and inorganic chemicals	Range of organic and inorganic chemicals.
Sanitary Sewage System	Leaks in system that services the majority of the VHJ	-	-	Current	-		Microbiological - coliforms, *E.coli*, viruses, nitrate

Table 4: Village of Haines Junction Groundwater Chemistry Summary

Sample ID	Units	Detection	Guidelines for		Well No.3: Raw Groundwater											
Date Sampled		Limits[4]	AO[3]	MAC[2]	5/1/2004	4/1/2005	4/1/2006	4/25/2007	5/9/2008	6/15/2009	7/13/2010	11/2/2015	6/8/2015	4/1/2015	4/1/2015	6/1/2016
Physical Tests																
Colour, True	CU	5	15	-	5	-	-	-	-	<5	<5	<5.0	<5	<5.0	<5	<5
Conductivity	uS/cm	2	-	-	215	226	206	208	215	224	217	215	215	208	214	212
Hardness (as CaCO3)	mg/L	0.7	-	-	44.5	45	41	43	41	44.9	46.8	48.7	50	46.8	45	50.7
pH	pH	0.01	-	-	8.41	8.36	8.97	8.45	8.29	8.36	8.35	8.44	8.03	8.42	8.17	7.65
Total Dissolved Solids	mg/L	10	-	500	167	140	128	148	172	176	130	125	118	125	120	186
Turbidity	NTU	0	-	-	<0.1	0.10	0.10	<0.1	0.00	<0.1	0.06	0.11	0.02	0.44	<0.02	0.18
Anions and Nutrients																
Alkalinity, Total (as	mg/L	2	-	-	87	100	90	95	92	-	95	94	89	98	89	91
Chloride (Cl)	mg/L	0.5	250	-	1.3	0.20	0.08	0.20	0.16	0.16	0.33	<0.50	0.18	<0.5	0.21	0.15
Fluoride (F)	mg/L	0.02	1.5	-	0.19	0.20	0.19	0.15	0.18	0.15	0.16	0.16	0.21	0.158	0.18	0.15
Nitrate (as N)	mg/L	0.02	-	45	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.0050	0.03	<0.0050	0.05	<0.01
Nitrite (as N)	mg/L	0.005	-	3.2	0.00	0.00	0.000	0.00	0.05	<0.01	<0.005	<0.0010	0.08	<0.0010	0.07	<0.01
Sulfate (SO4)	mg/L	0.5	500	-	19.6	18.0	19.0	18.6	19.1	19.3	17.7	19.9	19.4	19.7	19.1	20.1
Total Metals																
Aluminum (Al)	mg/L	0.01	0.1	-	0.009	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.010	<0.005	<0.010	<0.0050	0.002
Antimony (Sb)	mg/L	0.0005	-	0.01	<0.0002	<0.0002	<0.0002	<0.0004	<0.0002	<0.0002	<0.0002	<0.00050	<0.0001	<0.00050	<0.0001	<0.00002
Arsenic (As)	mg/L	0.0001	-	0.01	0.0117	0.0120	0.0111	0.0110	0.0107	0.0119	0.0110	0.0118	0.0127	0.0125	0.0131	0.0123
Barium (Ba)	mg/L	0.02	-	1.00	0.023	0.024	0.023	0.022	0.020	0.025	0.022	0.025	0.025	0.024	0.0243	0.023
Boron (B)	mg/L	0.01	-	5.00	0.071	0.058	0.066	0.073	0.056	0.086	0.069	<0.1	0.067	<0.10	0.064	0.065
Cadmium (Cd)	mg/L	0.00001	-	0.01	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00020	<0.00001	<0.00020	<0.00001	<0.00001
Calcium (Ca)	mg/L	0.1	-	-	12.6	12	11.4	12	11.3	12.4	12.8	13.3	13.9	13.0	13.8	13.9
Chromium (Cr)	mg/L	0.0004	-	0.05	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	0.00	<0.0020	<0.0005	<0.0020	<0.0005	<0.00005
Copper (Cu)	mg/L	0.001	1	-	<0.001	<0.001	<0.001	0.002	<0.001	0.003	<0.001	<0.0010	<0.0001	<0.0010	0.0006	<0.0002
Iron (Fe)	mg/L	0.03	0.3	-	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.030	0.008	<0.030	0.014	0.010
Lead (Pb)	mg/L	0.0005	-	0.01	0.0002	0.0007	0.0002	0.0005	0.0002	0.0005	0.0001	<0.00050	<0.0001	<0.00050	0.0005	<0.00001
Magnesium (Mg)	mg/L	0.1	-	-	3.30	3.40	3.00	3.30	3.06	3.40	3.60	3.74	3.64	3.49	3.69	3.90
Manganese (Mn)	mg/L	0.005	0.05	-	0.0140	0.0100	0.0120	0.0200	0.0128	0.0147	0.0143	0.0152	0.0159	0.0154	0.0162	0.0150
Mercury (Hg)	mg/L	0.0002	-	0.0010	<0.0002	<0.0002	-	-	-	-	-	<0.00020	<0.00001	<0.00020	<0.00001	<0.00001
Potassium (K)	mg/L	0.1	-		2.80	3.00	2.70	2.60	2.62	2.80	3.10	2.64	2.90	2.80	2.90	3.00
Selenium (Se)	mg/L	0.0001	-	0.01	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0010	<0.0001	<0.0010	<0.0001	<0.0002
Sodium (Na)	mg/L	2	200	-	29.2	29.0	29.1	29.6	27.5	30.0	27.9	29.1	29.1	27.6	28.9	29.7
Uranium (U)	mg/L	0.0001	-	0.02	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.00010	0.00002	<0.00010	0.00002	0.00002
Zinc (Zn)	mg/L	0.001	-	5	0.006	0.007	0.002	0.004	0.009	0.006	0.005	<0.050	0.0015	<0.050	<0.0005	0.0011

Table 4: Village of Haines Junction Groundwater Chemi

Sample ID	Units	Detection Limits[4]	Guidelines for		Well No.5: Raw Groundwater										
Date Sampled			AO[3]	MAC[2]	4/1/2005	4/1/2006	4/25/2007	5/9/2008	6/15/2009	7/13/2010	11/2/2015	6/8/2015	4/1/2015	4/1/2015	6/1/2016
Physical Tests															
Colour, True	CU	5	15	-	-	-	-	-	9.00	<5	5.10	<5	<5.0	<5	<5
Conductivity	uS/cm	2	-	-	257	234	235	242	250	242	257	373	235	250	252
Hardness (as CaCO3)	mg/L	0.7	-	-	13	14	10	9	33.4	14.5	11.4	12	10.5	10	11.6
pH	pH	0.01	-	-	8.85	8.36	8.94	8.91	8.84	8.88	9.00	8.61	8.78	8.75	8.43
Total Dissolved Solids	mg/L	10	-	500	166	148	174	188	194	146	156	210	148	142	234
Turbidity	NTU	0	-	-	0.10	0.20	<0.1	0.10	<0.1	0.09	0.10	0.43	0.21	<0.02	0.21
Anions and Nutrients															
Alkalinity, Total (as	mg/L	2	-	-	119	109	110	109	-	113	122	129	120	110	122
Chloride (Cl)	mg/L	0.5	250	-	0.40	0.37	0.50	0.50	0.53	0.67	0.64	28.5	<0.5	0.61	0.56
Fluoride (F)	mg/L	0.02	1.5	-	0.20	0.23	0.21	0.22	0.24	0.20	0.23	0.18	0.215	0.23	0.19
Nitrate (as N)	mg/L	0.02	-	45	<0.03	<0.03	<0.1	<0.02	<0.01	0.01	<0.0050	0.07	<0.0050	<0.01	<0.01
Nitrite (as N)	mg/L	0.005	-	3.2	<0.03	<0.03	<0.05	0.040	0.04	<0.005	<0.0010	<0.01	<0.0010	0.08	<0.01
Sulfate (SO4)	mg/L	0.5	500	-	14.0	15.4	14.8	15.7	15.0	14.3	17.1	16.5	16.2	16.3	16.6
Total Metals															
Aluminum (Al)	mg/L	0.01	0.1	-	0.008	0.010	0.075	<0.01	0.097	0.019	<0.010	<0.005	<0.010	0.012	0.026
Antimony (Sb)	mg/L	0.0005	-	0.01	<0.0002	<0.0002	<0.0004	<0.0002	<0.0002	<0.0002	<0.00050	<0.0001	<0.00050	<0.0001	0.00002
Arsenic (As)	mg/L	0.0001	-	0.01	0.0180	0.0176	0.0180	0.0155	0.0207	0.0198	0.0181	0.0201	0.0174	0.0195	0.0186
Barium (Ba)	mg/L	0.02	-	1.00	0.013	0.013	0.010	0.014	0.084	0.027	<0.02	0.013	<0.020	0.0128	0.0094
Boron (B)	mg/L	0.01	-	5.00	0.097	0.107	0.120	0.089	0.118	0.112	0.110	0.110	0.120	0.108	0.110
Cadmium (Cd)	mg/L	0.00001	-	0.01	<0.00001	<0.00001	<0.00001	<0.00007	0.13400	0.00124	<0.00020	<0.00001	<0.00020	<0.00001	<0.00001
Calcium (Ca)	mg/L	0.1	-	-	4.4	4.8	6.1	3.06	12.3	4.97	3.8	4.0	3.5	3.82	3.9
Chromium (Cr)	mg/L	0.0004	-	0.05	<0.0005	<0.0005	<0.001	<0.0005	0.0008	0.0012	<0.0020	0.0012	<0.0020	<0.0005	<0.00005
Copper (Cu)	mg/L	0.001	1	-	<0.001	**1.91**	<0.002	<0.001	0.0030	0.0100	<0.0010	<0.0001	<0.0010	0.0005	<0.0002
Iron (Fe)	mg/L	0.03	0.3	-	<0.1	<0.1	<0.2	0.010	0.020	0.020	<0.030	0.124	<0.030	0.005	0.002
Lead (Pb)	mg/L	0.0005	-	0.01	<0.0001	0.0009	0.0008	<0.0001	0.0056	0.0003	<0.00050	<0.0001	<0.00050	0.0008	<0.00001
Magnesium (Mg)	mg/L	0.1	-	-	0.40	0.40	0.40	0.36	0.66	0.50	0.48	0.47	0.42	0.46	0.47
Manganese (Mn)	mg/L	0.005	0.05	-	<0.005	<0.005	0.0100	0.0008	0.0048	0.0014	<0.0020	0.0029	<0.0020	0.0011	0.0010
Mercury (Hg)	mg/L	0.0002	-	0.0010	<0.0002	-	-	-	-	-	<0.00020	<0.00001	<0.00020	<0.00001	<0.00001
Potassium (K)	mg/L	0.1	-		<0.4	<0.4	<0.8	0.27	0.30	0.70	0.29	0.30	0.29	0.30	0.30
Selenium (Se)	mg/L	0.0001	-	0.01	<0.0002	<0.0002	<0.0004	<0.0006	<0.0006	<0.0006	<0.0010	<0.0001	<0.0010	<0.0001	<0.0002
Sodium (Na)	mg/L	2	200	-	54.3	52.2	51.9	49.0	56.6	52.0	60.3	84.8	55.0	58.2	61.5
Uranium (U)	mg/L	0.0001	-	0.02	<0.0005	<0.0005	<0.001	<0.0005	<0.0004	<0.0004	<0.0010	0.00001	<0.00010	0.00001	0.00001
Zinc (Zn)	mg/L	0.001	-	5	0.0060	0.0020	0.0420	0.0080	0.0370	0.0120	<0.050	0.0018	<0.050	<0.0005	0.0006

Table 5-1: Risk Scenarios and Risk Assessment - Well No.3

Map ID	Travel Time	Hazard Description	Hazard Risk Factors		Risk Rank
			Exposure Likelihood	Exposure Consequence	
Zone 1					
W3-1	>10 years	Outhouses equipped with below grade septic tanks. Leaks could result in untreated septic waste entering the soil.	Very Low	High	**Very Low**
W3-2	>10 years	AST located at weigh scales appears to be single walled and is not contained in a bermed enclosure. A spill from this tank could introduce hydrocarbons to the soil that could potentially migrate into the Well No.3 source aquifer.	Very Low	High	**Very Low**
W3-3	<90 days	Former waste oil dump since the 1940's. Migration of hydrocarbons from this site could potentially introduce hydrocarbons to the Well No.3 source aquifer. This APEC has been defined a higher risk category due to the unconfirmed type of waste deposited and the long period since deposition may have occurred (60+ years). While the horizontal travel time to Well No.3 in the shallow sand and gravel aquifer inferred to exist close to the river may be less than 90 days, the actual potential for contaminants to impact the well is considered low as the only mechanism for impact is through migration along the borehole annulus to depth (considered unlikely due to the thick clay and silt sequence which would likely have formed a tight seal in the months after drilling) or through corroded/broken well casing (considered unlikely given the well is still within its estimated life expectancy).	Low	High	**Medium**
W3-4	>10 years	Fuel storage at Nursing Station. This tank is located in a bermed lined enclosure, but significant UV degradation of the liner was noted. A spill here could introduce hydrocarbons into the soil that could potentially migrate into the Well No.3 source aquifer.	Very Low	High	**Very Low**
W3-5	>10 years	UST at Yukon Government Building. A spill at this location could introduce hydrocarbons to the soil that could potentially migrate into the Well No.3 source aquifer.	Very Low	High	**Very Low**
W3-6	>10 years	Barrels and tanks at PMD building. A chemical spill here could introduce contaminants to the soil that could potentially migrate into the Well No.3 source aquifer.	Very Low	High	**Very Low**
W3-7 and CS5	>10 years	YG maintenance yard. Fuel and oil spills here could introduce hydrocarbons to the soil that could potentially migrate into the Well No.3 source aquifer. Existing Fuel spills at the highways yard could potentially migrate to the Well No.3 source aquifer	Very Low	High	**Very Low**
W3-8	<90 days	Ground squirrels living under cement slab at Well No.3 have the potential to introduce fecal matter into the well infrastructure should corrosion of casing or breakage of welds occur. This APEC has been defined a higher risk category due to vicinity of the contamination source to the well. While the horizontal travel time to Well No.3 in the shallow sand and gravel aquifer inferred to exist close to the river may be less than 90 days, the actual potential for contaminants to impact the well is considered low as the only mechanism for impact is through migration along the borehole annulus to depth (considered unlikely due to the thick clay and silt sequence which would likely have formed a seal in the months after drilling) or through corroded/broken well casing (considered unlikely given the well is still within its estimated life expectancy).	Low	High	**Medium**
Former Military Site	<90 days	Former military site from the 1940's to the 1970's. Potential for migration of chemicals from this site to impact the Well No.3 source aquifer. This APEC has been defined a higher risk category due to the potential deposition/disposal of unknown wastes and the long period since deposition may have occurred (60+ years). While the horizontal travel time to Well No.3 in the shallow sand and gravel aquifer inferred to exist close to the river may be less than 90 days, the actual potential for contaminants to impact the well is considered low as the only mechanism for impact is through migration along the borehole annulus to depth (considered unlikely due to the thick clay and silt sequence which would likely have formed a very tight seal in the months after drilling) or through corroded/broken well casing (considered unlikely given the well is still within its estimated life expectancy).	Low	High	**Medium**
Sanitary Sewage System	>10 years	Leaks to ground could introduce microbiological contaminants (coliforms, E.coli, viruses) and nitrate to subsurface.	Very Low	High	**Very Low**

Table 5-1: Risk Scenarios and Risk Assessment - Well No.3

Map ID	Travel Time	Hazard Description	Hazard Risk Factors		Risk Rank
			Exposure Likelihood	Exposure Consequence	
Zone 2					
10-066	>10 years	Migration of contaminants from this site could potentially introduce hydrocarbons to the Well No.3 source aquifer.	Very Low	High	**Very Low**
14-015	>10 years	Migration of contaminants from this site could potentially introduce hydrocarbons to the Well No.3 source aquifer.	Very Low	High	**Very Low**
16-082	>10 years	Migration of contaminants from this site could potentially introduce hydrocarbons to the Well No.3 source aquifer.	Very Low	High	**Very Low**
06-10	>10 years	Migration of contaminants from this site could potentially introduce hydrocarbons to the Well No.3 source aquifer.	Very Low	High	**Very Low**
05-050	>10 years	Migration of contaminants from this site could potentially introduce hydrocarbons to the Well No.3 source aquifer.	Very Low	High	**Very Low**
05-090	>10 years	Migration of contaminants from this site could potentially introduce hydrocarbons to the Well No.3 source aquifer.	Very Low	High	**Very Low**
CS-2	>10 years	Migration of contaminants from this site could potentially introduce hydrocarbons to the Well No.3 source aquifer.	Very Low	High	**Very Low**
CS-3	>10 years	Migration of contaminants from this site could potentially introduce hydrocarbons to the Well No.3 source aquifer.	Very Low	High	**Very Low**
CS-4	>10 years	Migration of contaminants from this site could potentially introduce hydrocarbons to the Well No.3 source aquifer.	Very Low	High	**Very Low**
CS-6	>10 years	Migration of contaminants from this site could potentially introduce hydrocarbons to the Well No.3 source aquifer.	Very Low	High	**Very Low**
CS-7	>10 years	Migration of contaminants from this site could potentially introduce hydrocarbons to the Well No.3 source aquifer.	Very Low	High	**Very Low**
Former Sewage Lagoon	>10 years	Infiltration to ground during emergency use periods could introduce microbiological contaminants (coliforms, E.coli, viruses) and nitrate to subsurface.	Very Low	High	**Very Low**
Sanitary Sewage System	>10 years	Leaks to ground could introduce microbiological contaminants (coliforms, E.coli, viruses) and nitrate to subsurface.	Very Low	High	**Very Low**

Table 5-1: Risk Scenarios and Risk Assessment - Well No.3

Map ID	Travel Time	Hazard Description	Hazard Risk Factors		Risk Rank
			Exposure Likelihood	Exposure Consequence	
Zone 3					
W5-1	>10 years	Discharge trench for artesian flow during well maintenance. Surface water ponding may provide a haven for bacteria, protozoa and viruses.	Very Low	High	**Very Low**
W5-2	>10 years	Equipment storage on Quill Road. A fuel spill or leak in this area could introduce hydrocarbons to the soil that could potentially migrate into the Well No.5 source aquifer	Very Low	High	**Very Low**
W5-3	>10 years	Septic system here provides the potential to introduce improperly renovated septic wastes into the shallow groundwater.	Very Low	High	**Very Low**
W5-4 and 08-015	>10 years	Source Motors gas station & garage. A fuel spill or leak in this area could introduce hydrocarbons to the soil that could potentially migrate into the Well No.5 source aquifer. Migration of existing contamination resulting in contamination of the deep groundwater aquifer.	Very Low	High	**Very Low**
W5-5	>10 years	Residential fuel storage. A fuel spill or leak in this area could introduce hydrocarbons to the soil that could potentially migrate into the Well No.5 source aquifer	Very Low	High	**Very Low**
W5-6	>10 years	Former gas station, fuel storage and septic field. A fuel spill or leak in this area could introduce hydrocarbons to the soil that could potentially migrate into the Well No.5 source aquifer. Improperly renovated septic waste has the potential to introduce bacteria and viruses to the shallow groundwater.	Very Low	High	**Very Low**
W5-7	>10 years	Cemeteries are potential sources of chemicals from embalming fluids as well as biological hazards such as bacteria and viruses.	Very Low	High	**Very Low**
W5-8	>10 years	Fuel storage, septic field, livestock. A fuel spill or leak in this area could introduce hydrocarbons to the soil that could potentially migrate into the Well No.5 source aquifer. Improperly renovated septic waste has the potential to introduce bacteria and viruses to the shallow groundwater.	Very Low	High	**Very Low**
W5-9	>10 years	Future septic field location. Improperly renovated septic waste has the potential to introduce bacteria and viruses to the shallow groundwater.	Very Low	High	**Very Low**
CS1	>10 years	Migration of contaminants from this site could potentially introduce hydrocarbons to the Well No.3 source aquifer.	Very Low	High	**Very Low**
Sanitary Sewage System	>10 years	Leaks to ground could introduce microbiological contaminants (coliforms, E.coli, viruses) and nitrate to subsurface.	Very Low	High	**Very Low**
Current Sewage Lagoon	>10 years	Infiltration to ground could introduce microbiological contaminants (coliforms, E.coli, viruses) and nitrate to subsurface.	Very Low	High	**Very Low**
Former Refinery	>10 years	Migration of contaminants from this site could potentially introduce hydrocarbons to the Well No.3 source aquifer.	Very Low	High	**Very Low**

Table 5-2: Risk Scenarios and Risk Assessment - Well No.5

Map ID	Travel Time	Hazard Description	Hazard Risk Factors		Risk Rank
			Exposure Likelihood	Exposure Consequence	
Well No.5					
W5-1	>10 years	Discharge trench for artesian flow during well maintenance. Surface water ponding may provide a haven for bacteria, protozoa and viruses.	Very Low	High	**Very Low**
W5-2	>10 years	Equipment storage on Quill Road. A fuel spill or leak in this area could introduce hydrocarbons to the soil that could potentially migrate into the Well No.5 source aquifer	Very Low	High	**Very Low**
W5-3	>10 years	Septic system here provides the potential to introduce improperly renovated septic wastes into the shallow groundwater.	Very Low	High	**Very Low**
W5-4 and 08-015	>10 years	Source Motors gas station & garage. A fuel spill or leak in this area could introduce hydrocarbons to the soil that could potentially migrate into the Well No.5 source aquifer. Migration of existing contamination resulting in contamination of the deep groundwater aquifer.	Very Low	High	**Very Low**
W5-5	>10 years	Residential fuel storage. A fuel spill or leak in this area could introduce hydrocarbons to the soil that could potentially migrate into the Well No.5 source aquifer	Very Low	High	**Very Low**
W5-6	>10 years	Former gas station, fuel storage and septic field. A fuel spill or leak in this area could introduce hydrocarbons to the soil that could potentially migrate into the Well No.5 source aquifer. Improperly renovated septic waste has the potential to introduce bacteria and viruses to the shallow groundwater.	Very Low	High	**Very Low**
W5-7	>10 years	Cemeteries are potential sources of chemicals from embalming fluids as well as biological hazards such as bacteria and viruses.	Very Low	High	**Very Low**
W5-8	>10 years	Fuel storage, septic field, livestock. A fuel spill or leak in this area could introduce hydrocarbons to the soil that could potentially migrate into the Well No.5 source aquifer. Improperly renovated septic waste has the potential to introduce bacteria and viruses to the shallow groundwater.	Very Low	High	**Very Low**
W5-9	>10 years	Future septic field location. Improperly renovated septic waste has the potential to introduce bacteria and viruses to the shallow groundwater.	Very Low	High	**Very Low**

*WHPA - wellhead protection area

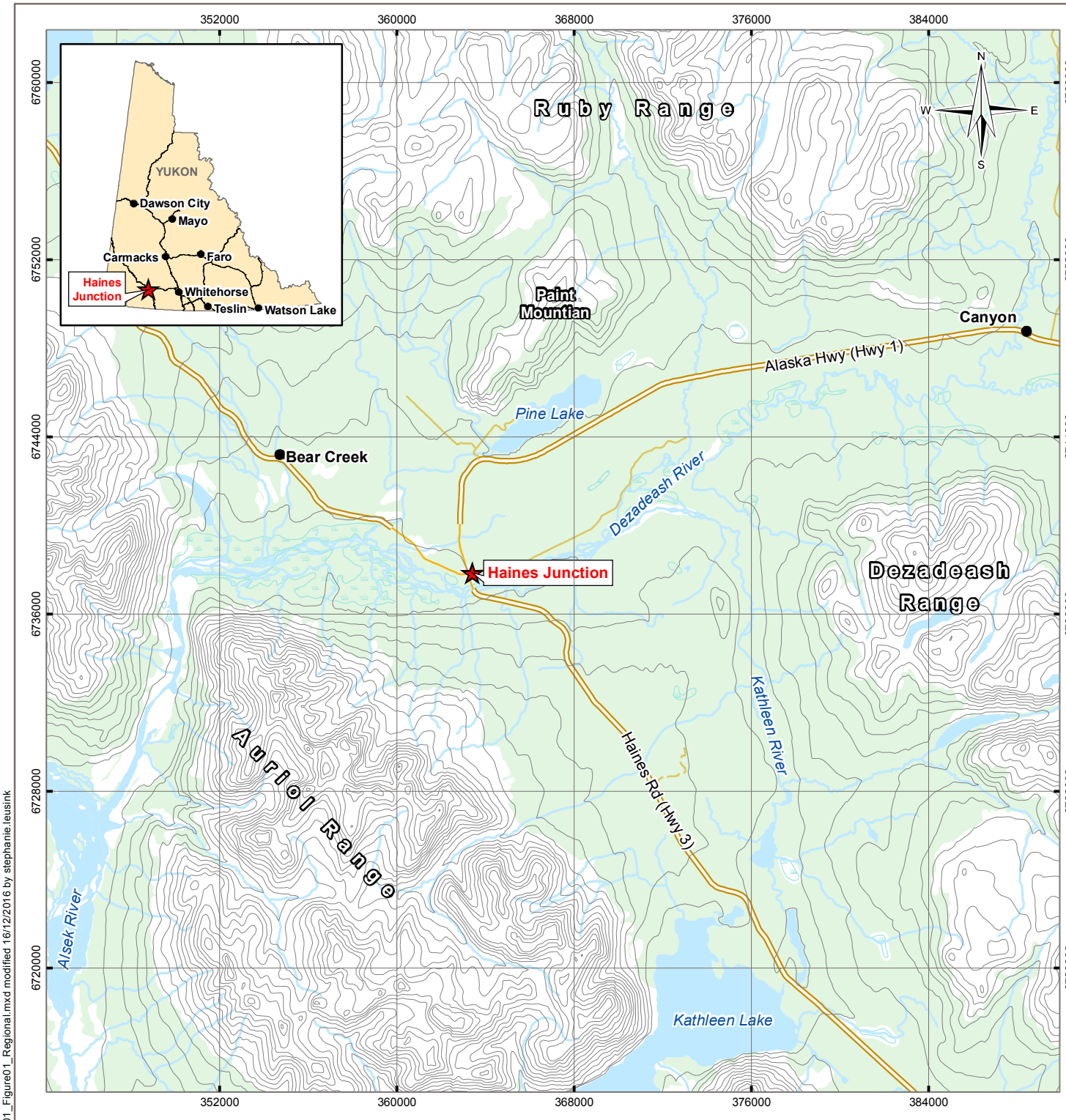
Table 6-1: Risk Mitigation Strategies - Well No.3

Map ID	Hazard Description	Current Risk Level	Risk Reduction Options to Consider	Risk Elimination Options to Consider
Zone 1				
W3-1	Potential leaks from outhouse septic storage tanks	**Very Low**	-	Remove outhouse
W3-2	Potential release of fuel from the AST at the VHJ nursing station	**Very Low**	Repair secondary containment with a liner properly buried under soil to protect it from UV degradation	Replace with Propane
W3-3	Potential migration of contaminants from former waste oil dump.	**Medium**	Include monitoring for hydrocarbons in the annual water quality monitoring at Well No.3	Determine the existence, extent and amount of contamination by conducting a test pitting and drilling program. If necessary, remediate the site by removing contaminant sources and/or removing/remediating contaminated soils onsite.
W3-4, W3-5, W3-6, W3-7 and CS6	Fuel release from fuel stored at YG nursing station, liquor store, highways yard, migration of contaminants from highways contaminated site, RCMP residences, nursing station, and/or weigh station	**Very Low**	Store fuel with secondary containment (e.g.. bermed lined storage area or cement containment). Remove UST and replace with AST equipped with secondary containment.	Replace with Propane, Assess and remediate any contamination.
W3-8	Ground squirrels living under cement slab at Well No.3 have the potential to introduce fecal matter into the well infrastructure should corrosion of casing or breakage of welds occur.	**Medium**	-	Repair cement slab under the wellhouse to prevent ground squirrels from burrowing under the building, install insulated cutoff wall around slab perimeter to deter burrowing rodents.
Former Military Site	Former military site from the 1940's to the 1970's. Migration of hydrocarbons from this site could potentially introduce hydrocarbons to the Well No.3 source aquifer. This APEC has been defined a higher risk category due to the unconfirmed type of waste deposited and the long period since deposition may have occurred (60+ years).	**Medium**	Include monitoring for hydrocarbons in the annual water quality monitoring at Well No.3	Determine the existence, extent and amount of contamination by conducting a geophysics, test pitting and drilling program. Remediate the site by removing contaminant sources and/or removing/remediating contaminated soils onsite.
Zone 2				
10-066, 14-015, 16-082, 06-10, 05-050, 05-090, CS2, CS3, CS4, CS6, CS7	Migration of potential contaminants from these sites could introduce hydrocarbons to the Well No.3 source aquifer.	**Very Low**	Assess actual risk based on spill volume and remediated volume	Remediate existing contaminated sites if significant residual contamination still remains
Former Sewage Lagoon	Infiltration to ground during emergency use periods could introduce microbiological contaminants (coliforms, E.coli, viruses) and nitrate to subsurface.	**Very Low**	Minimize discharge during emergency situations	Upgrade system or find alternative discharge location so not needed for emergency use
Sanitary Sewage System	Leaks to ground could introduce microbiological contaminants (coliforms, E.coli, viruses) and nitrate to subsurface.	**Very Low**	-	Assess system for leaks and repair as necessary
Zone 3				
W5-1	Surface water ponding in the discharge trench may provide a habitat for bacteria, protozoa and viruses.	**Very Low**	Fence and monitor trench to ensure that sources of fecal matter such as migratory birds and animals are not present.	-
W5-2, W5-4, W5-5, W5-6, W5-8	Release of fuel from one of these sites resulting in hydrocarbon contamination of soils and shallow groundwater with the potential to migrate.	**Very Low**	Community education for areas within the wellhead protection area to ensure any spills are reported and properly remediated.	-
W5-4 and 08-015	Migration of contamination from existing hydrocarbon contamination.	**Very Low**	Remediate contaminated soils located under the fuel storage tanks.	Remediate contaminated soils located under the fuel storage tanks.
W5-3, W5-6, W5-8, W5-9	Septic systems have the potential to produce improperly renovated septic wastes into the shallow groundwater.	**Very Low**	Community education to educate residents and business owners on the proper maintenance and monitoring of septic fields.	
W5-7	Cemeteries are potential sources of chemicals from embalming fluids as well as biological hazards such as bacteria and viruses.	**Very Low**	-	-
CS1	Migration of contaminants from this site could introduce hydrocarbons to the Well No.3 source aquifer.	**Very Low**	remediate existing contamination	Remediate existing contamination
Sanitary Sewage System	Leaks to ground could introduce microbiological contaminants (coliforms, E.coli, viruses) and nitrate to subsurface.	**Very Low**	-	Assess system for leaks and repair as necessary
Current Sewage Lagoon	Infiltration to ground could introduce microbiological contaminants (coliforms, E.coli, viruses) and nitrate to subsurface.	**Very Low**	-	-
Former Refinery	Migration of contaminants from this site could introduce hydrocarbons to the Well No.3 source aquifer.	**Very Low**	Asses site for residual contamination	-

Table 6-2: Risk Mitigation Strategies - Well No. 5

Map ID	Hazard Description	Current Risk Level	Risk Reduction Options to Consider	Risk Elimination Options to Consider
Well No.5				
W5-1	Surface water ponding in the discharge trench may provide a habitat for bacteria, protozoa and viruses.	**Very Low**	Fence and monitor trench to ensure that sources of fecal matter such as migratory birds and animals are not present.	-
W5-2, W5-4, W5-5, W5-6, W5-8	Potential release of fuel from one of these sites resulting in hydrocarbon contamination of soils and shallow groundwater with the potential to migrate.	**Very Low**	Community education for areas within the wellhead protection area to ensure any spills are reported and properly remediated.	-
W5-4 and 08-015	Potential migration of contamination from existing hydrocarbon contamination.	**Very Low**	-	Remediate contaminated soils located under the fuel storage tanks.
W5-3, W5-6, W5-8, W5-9	Septic systems have the potential to produce improperly renovated septic wastes into the shallow groundwater.	**Very Low**	Community education to educate residents and business owners on the proper maintenance and monitoring of septic fields.	
W5-7	Cemeteries are potential sources of chemicals from embalming fluids as well as biological hazards such as bacteria and viruses.	**Very Low**	-	-

FIGURES



LEGEND

- Haines Junction
- Other Community
- Highway
- Main Road
- Local Road
- Resource/Recreational Road
- Contour (100 m)
- Watercourse
- Waterbody
- Wetland
- Wooded Area

NOTES
Base data source: CanVec 1:250,000.

STATUS
ISSUED FOR USE

HAINES JUNCTION AQUIFER AND WELLHEAD PROTECTION PLAN

Site Location and Regional Topography

PROJECTION UTM Zone 8			**DATUM** NAD83	**CLIENT** Government of Yukon Community Services
Scale: 1:250,000 4 2 0 4 Kilometres				TETRA TECH
FILE NO. GWTR03067-01_Figure01_Regional.mxd				
OFFICE Tt-VANC	**DWN** SL	**CKD** MEZ	**APVD** SS	**REV** 0
DATE November 30, 2016	**PROJECT NO.** WTR.GWTR03067-01			**Figure 1**

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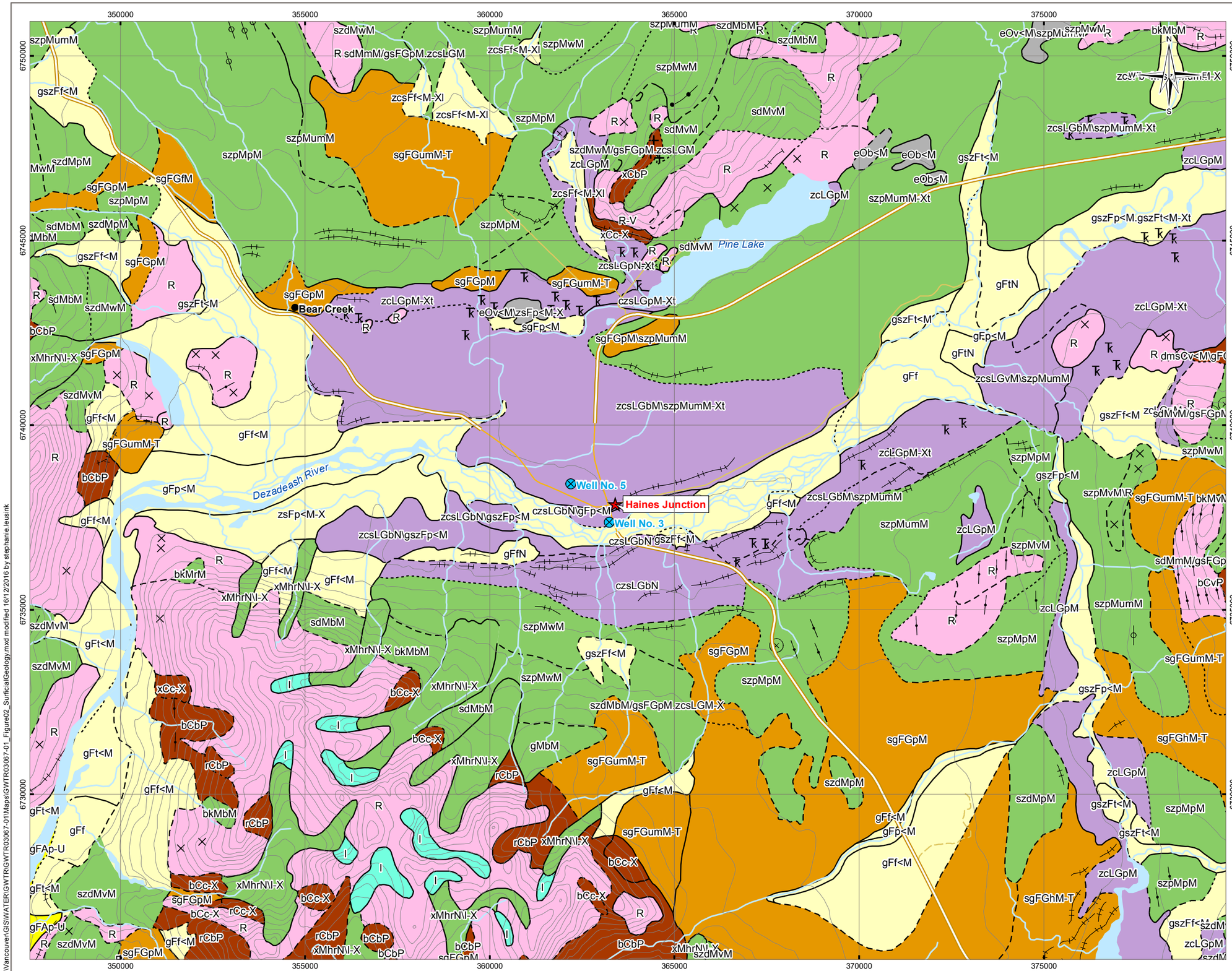


LEGEND

- Haines Junction
- Community Water Well

Surficial Geology

- Glacially Scoured Bedrock (unclassified)
- Kame (unclassified)
- Streamlined Landform (ice-flow direction unknown, drumlin or drumlinoid)
- Streamlined Landform (ice-flow direction unknown, undifferentiated lineations and flutings)
- Thermokarst Collapse (unclassified)
- Tor (unclassified)
- Geological Boundary (defined)
- Geological Boundary (approximate)
- Geological Boundary (assumed)
- Glacial Lake Shoreline (unclassified)
- Moraine Ridge (unclassified)

Surficial Material

- Colluvium
- Fluvial
- Active Fluvial
- Glaciofluvial
- Ice (Glacier)
- Glaciolacustrine
- Morainal (till)
- Organic
- Bedrock

- Highway
- Main Road
- Local Road
- Resource/Recreational Road
- Contour (100 m)
- Watercourse
- Waterbody

NOTES
Base data source: CanVec 1:250,000.
Surficial Geology from the Yukon Digital Surficial Geology Compilation (April 2014).

STATUS
ISSUED FOR USE

HAINES JUNCTION AQUIFER AND WELLHEAD PROTECTION PLAN

Surficial Geology

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD83	Government of Yukon Community Services

Scale: 1:100,000
2 1 0 2
Kilometres

TETRA TECH

FILE NO. GWTR03067-01_Figure02_SurficialGeology.mxd

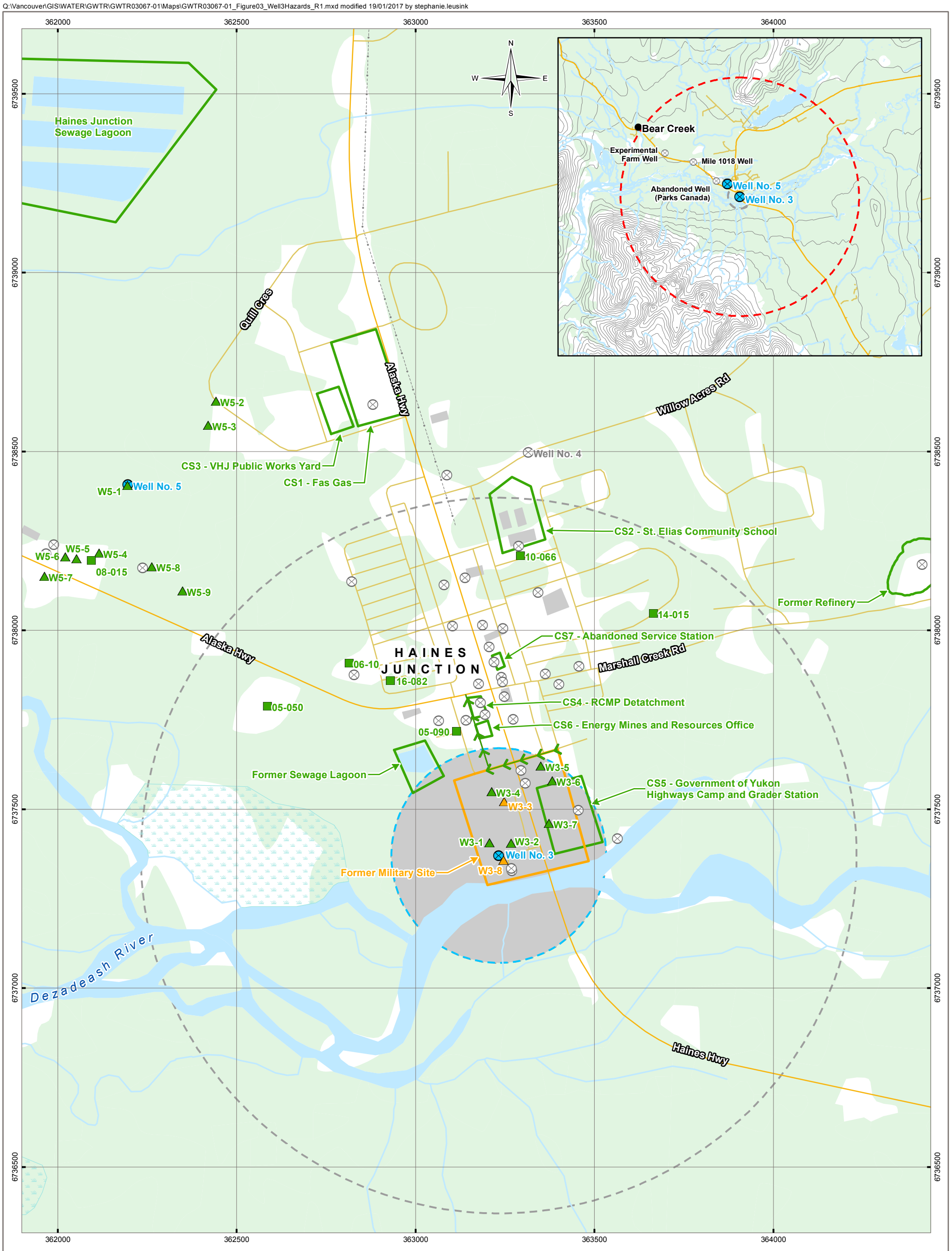
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	MEZ	SS	0

DATE November 30, 2016
PROJECT NO. WTR.GWTR03067-01

Figure 2

Q:\Vancouver\GIS\WATER\GWTR\GWTR03067-01\Maps\GWTR03067-01_Figure02_SurficialGeology.mxd modified 16/12/2016 by stephanie.leusink

Q:\Vancouver\GIS\WATER\GWTR\GWTR03067-01\Maps\GWTR03067-01_Figure03_Well3Hazards_R1.mxd modified 19/01/2017 by stephanie.leusink



LEGEND

- Community Water Well
- Domestic Water Well
- Contamined Site with ID Number
- Potential Source of Contamination
- Sewer
- Other Site Feature

Risk Ranking

- High Risk
- Moderate Risk
- Low Risk
- Very Low to No Risk

Well No. 3 Protection Zones

- Zone 1 / Regulatory Protection Area (300 m)
- Zone 2 (1 km)
- 10-Year Horizontal Travel Time (10 km)

- Main Road
- Local Road
- Building
- Power Line
- Watercourse
- Waterbody
- Wetland
- Wooded Area

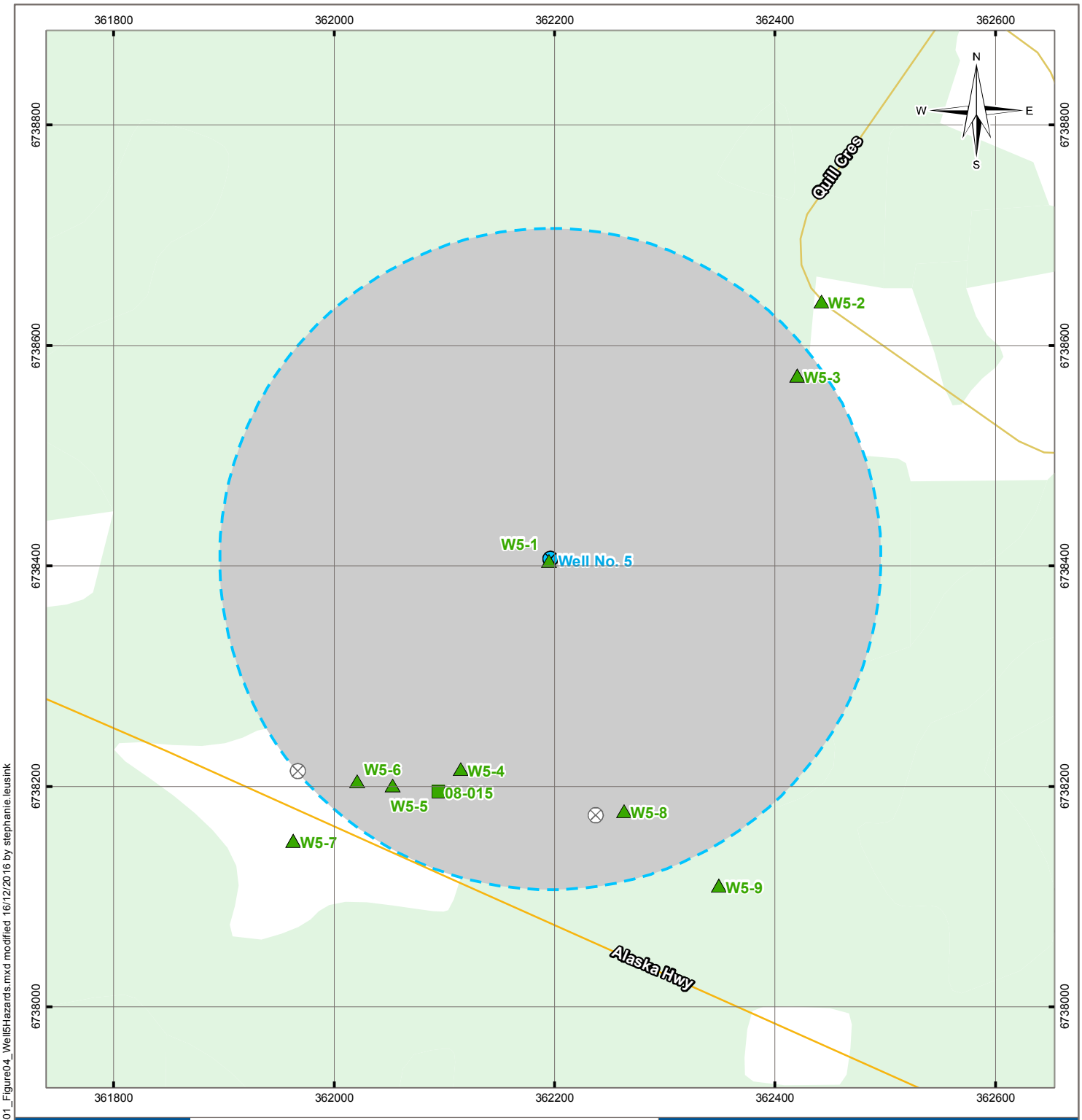
NOTES
Base data source: CanVec 1:50,000.

STATUS
ISSUED FOR USE

HAINES JUNCTION AQUIFER AND WELLHEAD PROTECTION PLAN

Wellhead Protection Zones and Risk Map for Well No. 3

PROJECTION: UTM Zone 8	DATUM: NAD83			CLIENT: Government of Yukon Community Services
Scale: 1:10,000 (200 100 0 200 Metres)				TETRA TECH
FILE NO.: GWTR03067-01_Figure03_Well3Hazards_R1.mxd				
OFFICE: Tt-VANC	DWN: SL	CKD: MEZ	APVD: SS	REV: 1
DATE: January 19, 2017	PROJECT NO.: WTR.GWTR03067-01			Figure 3



LEGEND

- Community Water Well
- Domestic Water Well
- Contamined Site with ID Number
- Potential Source of Contamination
- Main Road
- Local Road
- Wooded Area

Risk Ranking

- High Risk
- Moderate Risk
- Low Risk
- Very Low to No Risk

Well No. 5 Protection Zone

- Zone 1 / Regulatory Protection Area (300 m)

NOTES
Base data source: CanVec 1:250,000.

STATUS
ISSUED FOR USE

HAINES JUNCTION AQUIFER AND WELLHEAD PROTECTION PLAN

Wellhead Protection Zones and Risk Map for Well No. 5

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD83	Government of Yukon Community Services

Scale: 1:5,000
100 50 0 100
Metres

FILE NO.
GWTR03067-01_Figure04_Well5Hazards.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	MEZ	SS	0

DATE
November 30, 2016

PROJECT NO.
WTR.GWTR03067-01

TETRA TECH

Figure 4

Q:\Vancouver\GIS\WATER\GWTR\GWTR03067-01\Maps\GWTR03067-01_Figure04_Well5Hazards.mxd modified 16/12/2016 by stephanie.leusink

APPENDIX A
TETRA TECH'S GENERAL CONDITIONS

GENERAL CONDITIONS

GEOENVIRONMENTAL REPORT – GOVERNMENT OF YUKON

This report incorporates and is subject to these "General Conditions".

1.1 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of TETRA TECH's client. TETRA TECH does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than TETRA TECH's Client unless otherwise authorized in writing by TETRA TECH. Any unauthorized use of the report is at the sole risk of the user.

1.2 ALTERNATE REPORT FORMAT

Where TETRA TECH submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed TETRA TECH's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by TETRA TECH shall be deemed to be the original for the Project.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by TETRA TECH in its reasonably exercised discretion.

1.4 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of the report, TETRA TECH may rely on information provided by persons other than the Client. While TETRA TECH endeavours to verify the accuracy of such information when instructed to do so by the Client, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

APPENDIX B
VILLAGE OF HAINES JUNCTION ZONING

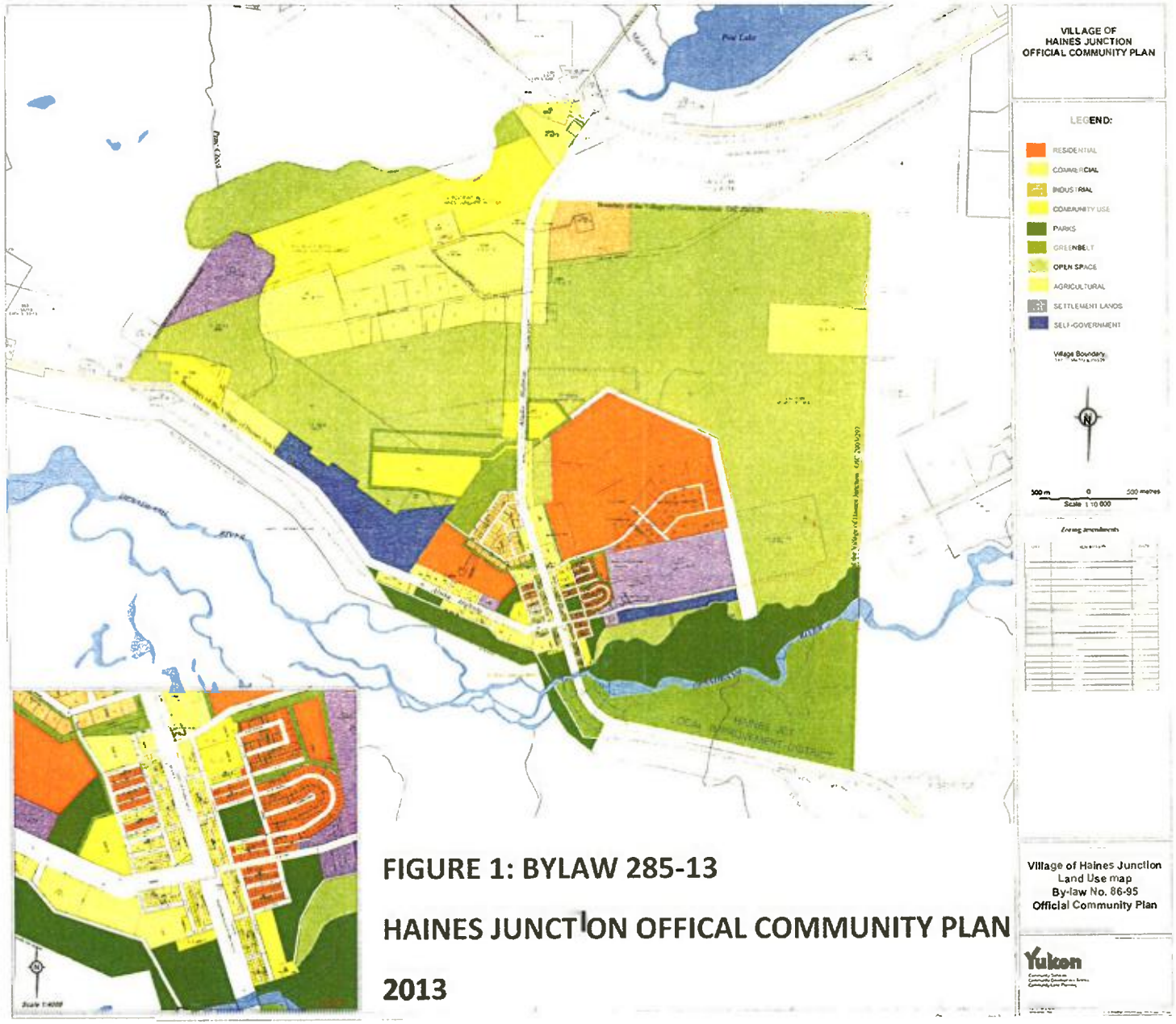


FIGURE 1: BYLAW 285-13

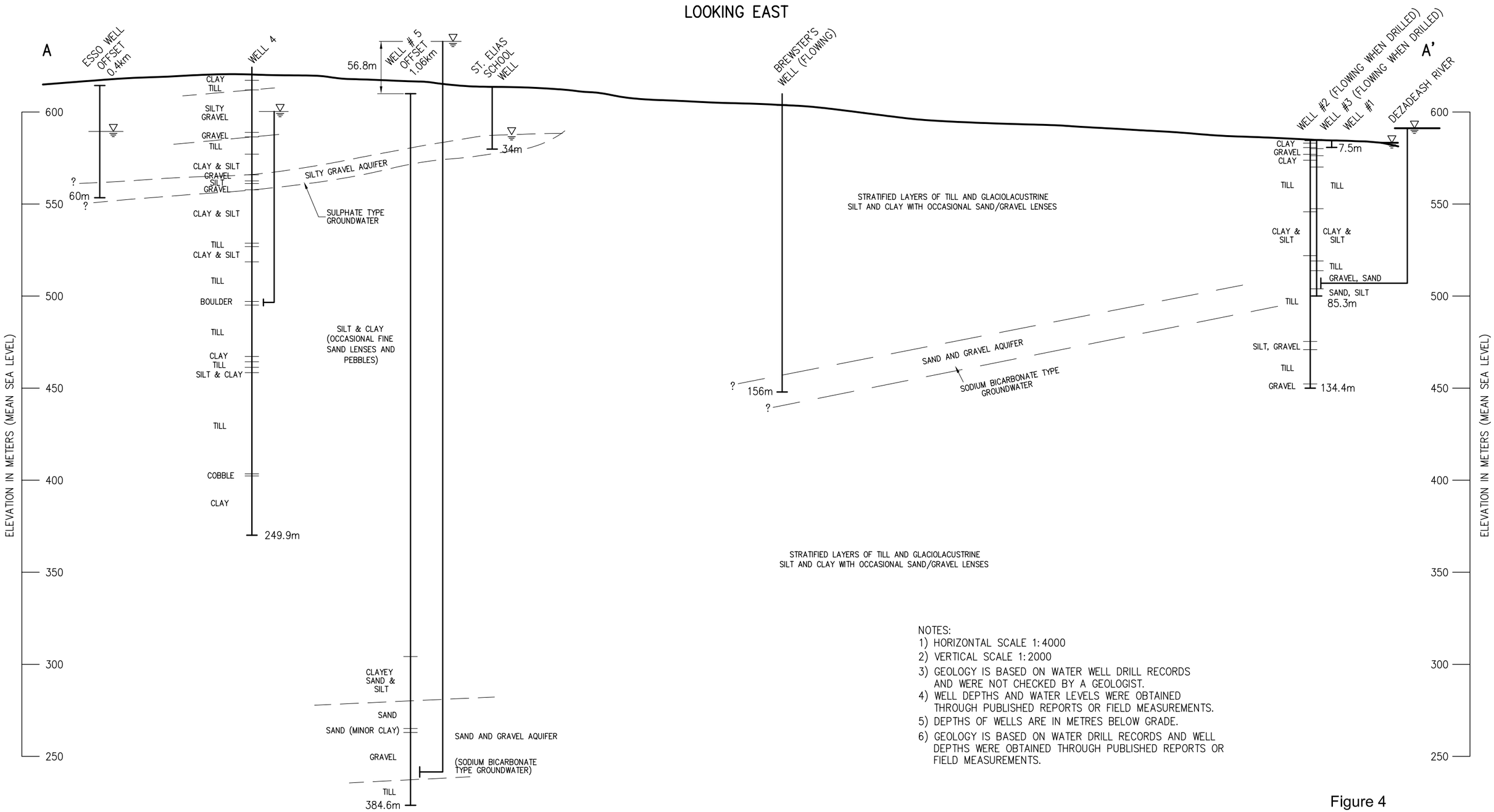
HAINES JUNCTION OFFICAL COMMUNITY PLAN

2013

APPENDIX C

SELECT PAGES FROM TETRA TECH'S RESOURCE ASSESSMENT FOR HEAT POTENTIAL STUDY (2003)

LOOKING EAST

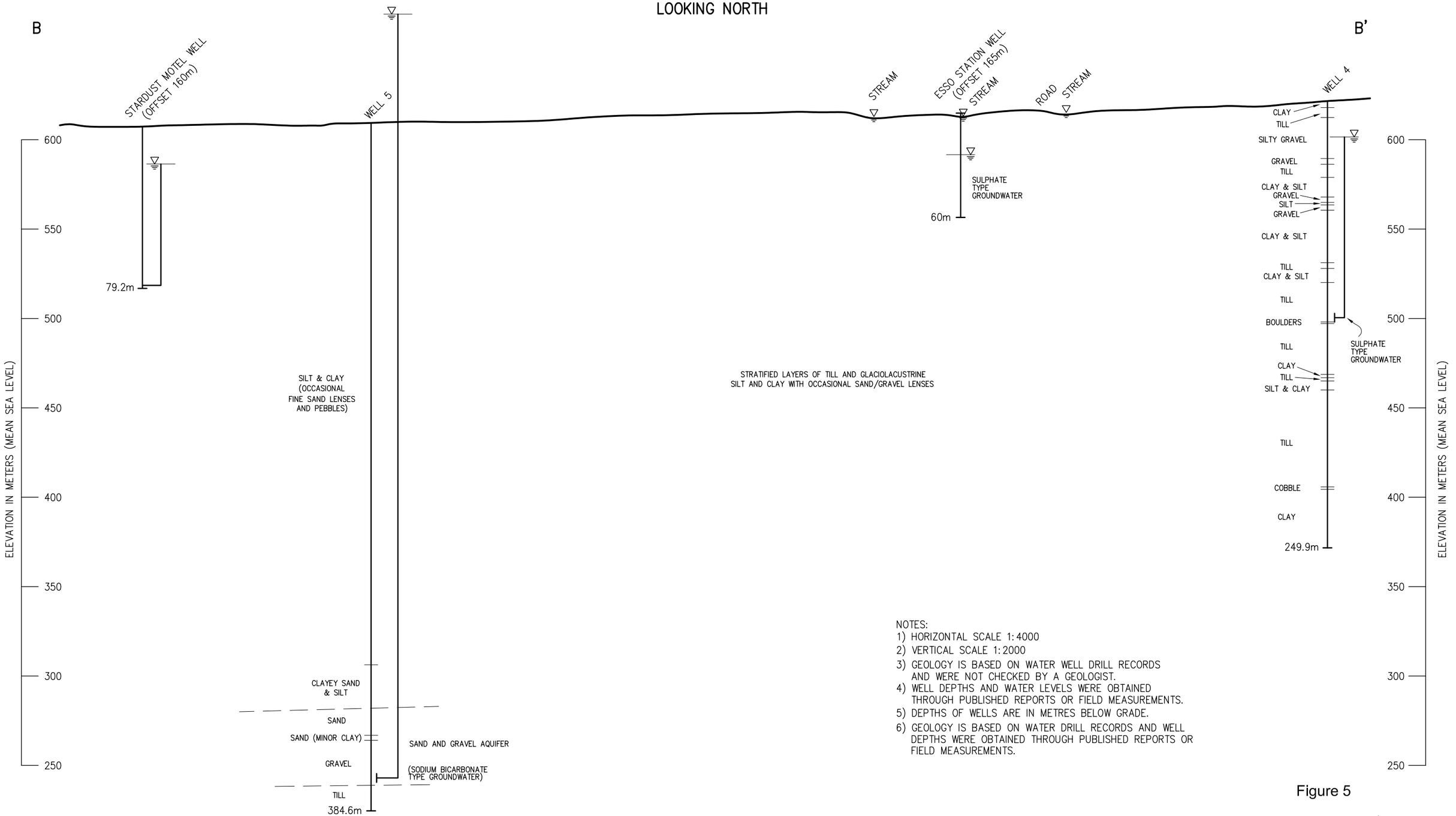


NOTES:
1) HORIZONTAL SCALE 1:4000
2) VERTICAL SCALE 1:2000
3) GEOLOGY IS BASED ON WATER WELL DRILL RECORDS AND WERE NOT CHECKED BY A GEOLOGIST.
4) WELL DEPTHS AND WATER LEVELS WERE OBTAINED THROUGH PUBLISHED REPORTS OR FIELD MEASUREMENTS.
5) DEPTHS OF WELLS ARE IN METRES BELOW GRADE.
6) GEOLOGY IS BASED ON WATER DRILL RECORDS AND WELL DEPTHS WERE OBTAINED THROUGH PUBLISHED REPORTS OR FIELD MEASUREMENTS.

Figure 4

Cross-Section A-A'

LOOKING NORTH



NOTES:
1) HORIZONTAL SCALE 1:4000
2) VERTICAL SCALE 1:2000
3) GEOLOGY IS BASED ON WATER WELL DRILL RECORDS AND WERE NOT CHECKED BY A GEOLOGIST.
4) WELL DEPTHS AND WATER LEVELS WERE OBTAINED THROUGH PUBLISHED REPORTS OR FIELD MEASUREMENTS.
5) DEPTHS OF WELLS ARE IN METRES BELOW GRADE.
6) GEOLOGY IS BASED ON WATER DRILL RECORDS AND WELL DEPTHS WERE OBTAINED THROUGH PUBLISHED REPORTS OR FIELD MEASUREMENTS.

Figure 5

Cross-Section B-B'

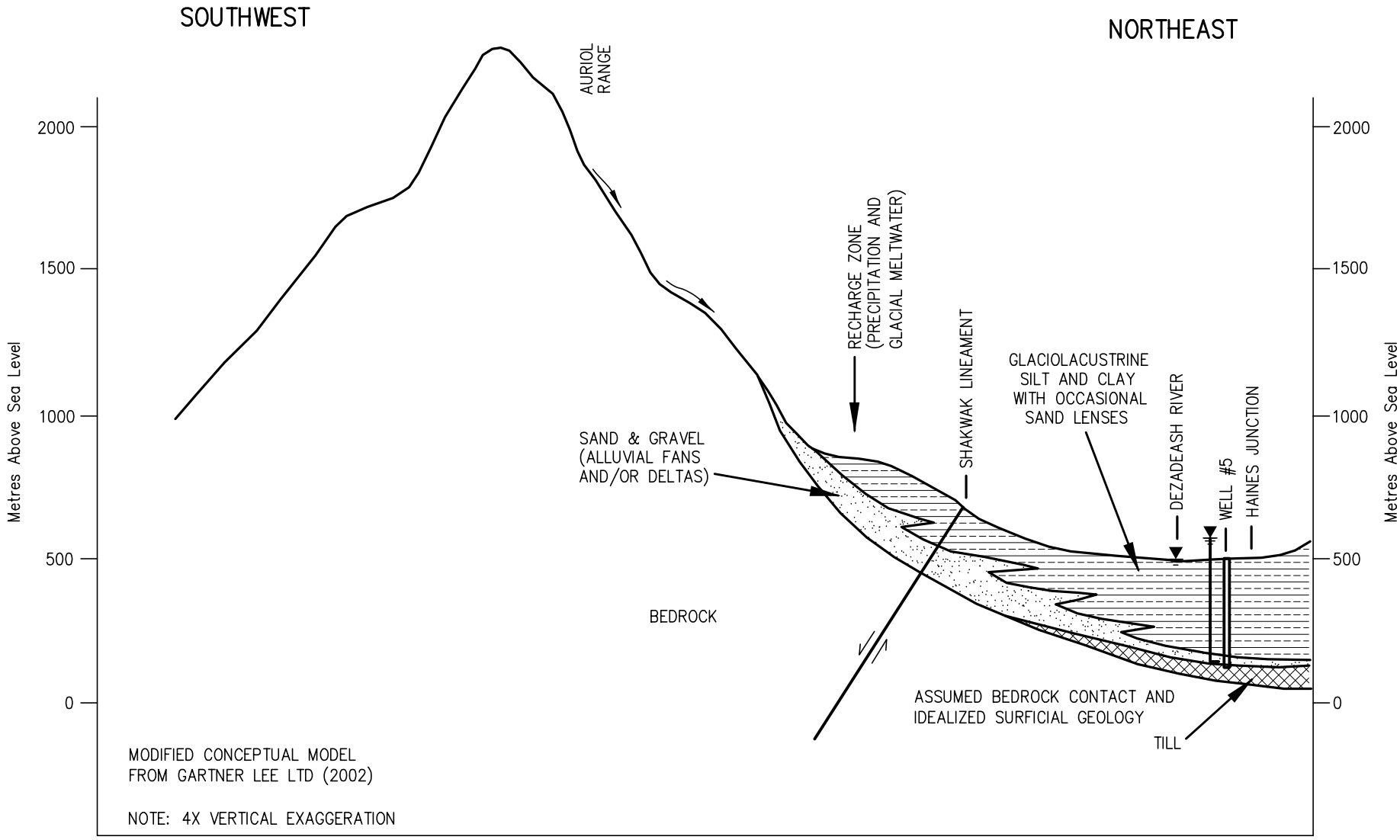


Figure 13, Pg. 60
Conceptual Hydrogeological Model of Well #5
Alluvial Fans/Deltas Control

1240049D03A.dwg

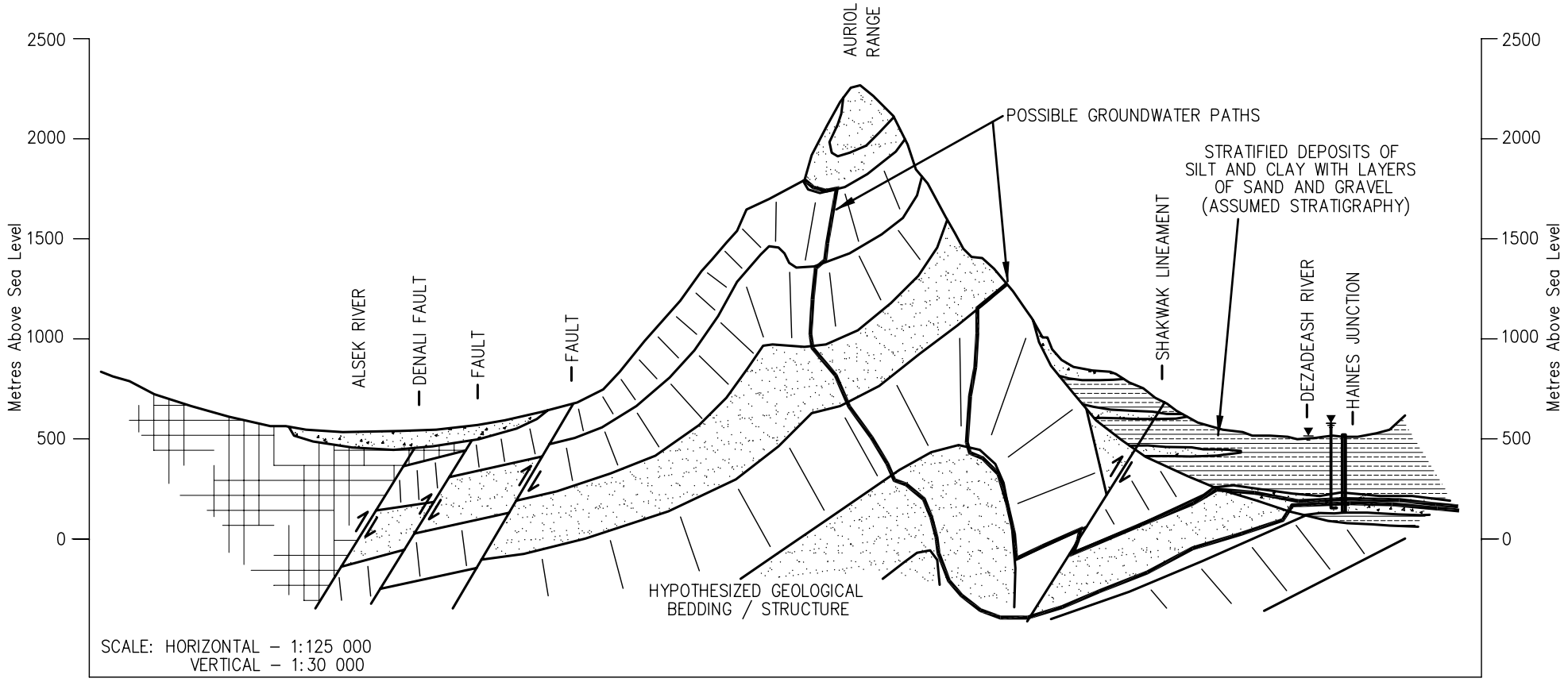


Figure 14, Pg. 62
Conceptual Hydrogeological Model of Well #5
Bedrock Structural Control

1240049D04A.dwg

APPENDIX D
CONTAMINATED SITES SEARCHES

Yukon
Environment
Box 2703, Whitehorse, Yukon Y1A 2C6

August 30, 2016

Sarah Sternbergh, M Sc.E., P.Eng
Tetra Tech EBA

Dear Ms. Sternbergh

Re: Contaminated Sites Information Request for Haines Junction City Centre and 10km Radius

Thank you for your request dated June 23, 2016. The Environmental Programs Branch does have file listings in the areas indicated on the map you provided (properties in Haines Junction, Yukon Territory). Please see below for the spills and contaminated sites that we have on file for this area.

SPILLS

Occurrence #	
05-090	An AST leak was reported in May 2005 at the Haines Junction Health Centre. Approximately 2 gallons of fuel spilled out of a tank due to fuel expansion. Water Resources was given the initial lead. The spill occurrence was closed, however there is no description of the final status ***(Minor Contamination)***
05-050	While an AST was being filled at Kluane RV Park approximately 10 L of fuel was reported to have exited the over-flow pipe and had spilled into surrounding containment berm. The spill was considered minor, and after the completion of a site visit the file was closed ***(Minor Contamination)***
08-013	In February 2008, an AST was overfilled at Source Motors Ltd (Mile 1017 Alaska Highway) in Haines Junction, resulting in a spill of 2300 L of diesel fuel. A consultant was hired to assess and remediate the site. The report states that site restoration and remediation was conducted in accordance with regulatory requirements. However, it also concludes that contamination remains below the concrete foundations supporting the above ground fuel storage tanks, and is inaccessible without first removing the fuel tanks. Report further indicates that fuel did not migrate outside of containment area. Area will be considered a contaminated site until proven otherwise. Additionally, in February 2014 a relocation permit application was provided for the relocation of 1m3 of PHC-contaminated material from Source Motors to a license facility. The results appear to have been received, however we do not have any record beyond that. ***(Contaminated)***
00-011	In May 2000, approximately 450L of diesel fuel was disposed of at a landfill (Haines Junction Dump, metal and wood area). Water was spread over the fuel, and the mixture was spread over a large area; our files indicate that the soil was to be moved to the soil treatment area of the landfill. This file has been closed. ***(Current Status Unknown)***

06-10	A diesel fuel spill was reported in January 2006 at the Parks Canada building in Haines Junction. Environment Canada is indicated as the lead agency. No additional details are present in our files. ***(Current Status Unknown)***
10-066	A diesel fuel spill was reported in June 2010 at 107 Saint Elias Street, Haines Junction. Approximately 200L were spilled, caused by a leaking AST. Though some remedial activities were undertaken for the site, contamination is still present. ***(Contaminated)***
09-050	An unknown quantity of diesel fuel was released due to several leaking ASTs (locations at 105 and 111 Rainbow Road, 106 and 131 Alsek Road). Remedial excavations were completed, and the remaining soil was below CSR standards. No further action was required and this file was closed. ***(Remediated)***
13-003	A spill of 100L of home heating fuel was reported in February 2013 at 37 Mendenhall. A plan of restoration was submitted and some remediation attempted. However, the confirmatory samples were taken incorrectly and could not be used; the area of contamination was backfilled and concrete footings installed, thus the only option for confirmatory sampling would be to drill boreholes. Until such time that confirmatory sampling is completed, this site is considered contaminated. ***(Contaminated)***
14-002	A spill of 416 L of diesel fuel was reported in January 2014 (though spill occurred in December 2013) at Source Motors, Haines Junction, caused by an error by the driver. The contaminated material was relocated to licensed facility under a relocation permit, and confirmatory sampling was completed in accordance with the applicable protocols. The site was remediated in the area of the spill, and no further action was required. ***(Remediated)***
14-015	A spill of an unknown quantity of home heating fuel was reported in March 2014 at 118 Alsek Crescent, caused by a leak. The Environmental Programs Branch attempted to obtain access to the residence where the leak occurred, however the responsible party has not yet provided assistance and details as to how to enter. ***(Contaminated)***
15-071	A spill of 345 L of sewage was reported in April 2015 at the Haines Junction sewage lagoon (#3), cause by overtopping. An inspector's direction pursuant to the Waters Act to discharge through approved channels to lower water levels was issued. A public Health notice posted as per Environmental Health request. Discharge sampling undertaken bi-weekly. No further action was required. ***(Remediated)***
15-168	A spill of approximately 205 L of jet fuel (PHCs) was reported in November 2015 at the Haines Junction airport, caused by a leak. The spill quantity was below Schedule A thresholds, thus did not require a relocation permit. The contaminated material was transported to a licensed facility. ***(Remediated)***
16-067	A spill of unknown quantity of home heating fuel was reported in April 2016 at the Conservation Officer building, with a stated cause being a very slow leak in the tank. Spill pads were applied and the spill was investigated. A minimal amount spilled and it was cleaned up, no further action required. ***(Remediated)***
16-082	A spill of 200L of home heating fuel was reported in May 2016 at 133 Auriol Street. A site visit was performed and the Town indicated that they would transport the contaminated material from the spill site their LTF. No record of confirmatory sampling. ***(Contaminated)***

CONTAMINATED SITES

Fas Gas: Tank removal project occurred in summer 2012. Extent of contamination not fully delineated. Base and western wall of excavation above CSR CL. ***(Contaminated)***

Conservation Officer Services Building: Summer 2012 - EBA contracted to oversee removal of UST and conduct soil sampling. Excavation halted due to safety concerns and proximity to building footings. Remaining contaminated soil was delineated using hand auger. The excavation was backfilled with contamination remaining; an estimated 6 cubic meters of contaminated soil remains in place between approximately 0.5m and 2.5m bgs to the east, west, and below the excavated area at the north end of the excavation. The report (EBA, Oct 2, 2012) recommends addressing remaining contamination by alternative remediation methods such as vapour extraction or air sparging. ***(Contaminated)***

St. Elias Community School: One UST was removed from the site in July 1998. For an unknown period of time the tank was filled with water, and contained 3.1 ppm LEPH and 0.3 HEPH. This water was used as a dust suppressant by YTG Highways. Once it was excavated and removed from the school location the tank was moved to the YTG TMB Maintenance yard for storage. Contaminated soil was found around the tank during excavation. The contamination is thought to have originated from overfilling of the storage tank. The extent and magnitude of the contamination was not determined at this time (Groundtrax 1998, July). A contaminated soil removal program was conducted in August 1998. Approximately 65 cubic yards of soil was removed from site, however some contamination had migrated to below the westerly foundation of the school. This soil could not be excavated without compromising the building foundation (Groundtrax 1998, August). There is no additional information included in the file following summer 1998. Contaminated is likely still present beneath the west foundation of the school. ***(Contaminated)***

RCMP Detachment: Contamination a result of leaking AST adjacent to garage. Morrow Environmental Consultants Inc. (MECI) completed a Phase II/III Environmental Site Assessment in 2006 which involved excavating a test pit in area of surface staining, installation of 8 boreholes and 5 monitoring wells to delineate soil and groundwater contamination and sampling of soil in floor of building (Memorandum from MECI to L. Hartford, RCMP, Oct 12 2006). The test pit investigation was completed to a depth of 2.9 below grade and hydrocarbon staining was visible on soils on the south side of the pit towards the building. Approximately 7m³ of suspected contaminated soil was excavated and stockpiled. Soil samples were collected during the borehole investigation but no groundwater was sampled as all wells were dry. Laboratory analysis results show that soil contamination consisted of BTEX, F1 and F2 concentrations for the CCME standard and only Xylenes for the CSR standard. Contamination extends slightly beneath the edge of the building, and is limited to a depth of 3 m. The total volume of contaminated soil remaining is estimated at 30 m³. MECI recommended that the remaining contaminated soil be relocated from the site. A relocation permit was issued for 37 m³ of contaminated soil to be relocated to Arctic Backhoes' McLean Lake LTF by MECI (RP Aug 30 2007). It was confirmed that a total of 54 m³ of soil was transported to the LTF (Email from T. Lazorko, MECI to J. Farkas, EPB, Oct 19 2007). Twelve samples were taken from the stockpile (3), the imported backfill (1), the floor of the excavation (1), the walls of the excavation (5), and (2) blind duplicates. Stockpiled soil samples had LEPH from 300-12,000 ug/g and HEPH of <260 ug/g. All confirmatory samples were below standards. It is not clear though if soil was excavated from below the building, due to structural issues. ***(Minor or Unlikely Contamination)***

Highway Row, NW Corner of intersection of Alaska Highway and Haines Road: Surface staining was noticed at the ROW, a result of a private truck parked overnight. HPW - TMB cleaned up site and stockpiled soil at their Grader Station down the road (112 Haines Road). Approximately 80 m³ of soil was relocated (Email from S. Newnham, HPW to S. Jensen, EPB, Aug 7 2006). Analysis of composite soil samples was not in exceedance of YCSR CL standard, with LEPH of 1,090 and 630 mg/kg and HEPH of 430 and 310 mg/kg (ALS Environmental Results

submitted to HPW-TMB, July 28 2006). Because soil met standards it was used at the grader site to level out a low-lying area. ***(Remediated)***

Haines Junction YECL Station: Historically on site there was a diesel spill of approximately 150 gallons in September 1974. There is not thought to be any remaining contamination on site due to this spill. Remaining on site are two above ground storage tanks, and some surface hydrocarbon contamination noted in soil. Land was to be transferred to the village of Haines Junction when/if the building on site was demolished and the surrounding land was remediated to parkland standards. Remediation work on site was carried out in 1999 (EBA), and continued through 2000. Approximately 85m3 of soil was removed to the Haines Junction land fill for remediation. With the removal of the building on site additional contaminated soil was discovered. After additional excavation of contaminated soil the site that was acceptable by industrial standards, but not the parkland objective (2002). The total amount of soil removed from under the plant following demolition was 600 m3. Following final site cleanup in 2002 (AES), the site was deemed remediated to parkland standards. ***(Remediated)***

Haines Junction Highway/Grader Station: Upon removal of one UST, contaminated soil was found below the tank. Both contaminated and special waste soils were present on site. A full phase I was planned for the site, and cleanup was scheduled for spring 2006. Special waste to be moved to Arctic Backhoe LTF in Whitehorse, and exploring the potential of constructing an LTF in Haines Junction for the contaminated soil below the special waste guideline. Phase I (Access 2005) and Phase II reports (GLL 2007) indicated many problems exist on site including both PHC and road salt. A monitoring well program was completed in 2007. It revealed hydrocarbon contamination of soil and groundwater at two well locations, however this finding was not confirmed by lab analysis due to highly disturbed soils resulting from the air rotary drilling method. A remedial plan needs to be developed for this site. ***(Contaminated)***

Glacier View Motor Inn: Contaminated soils were located on site during a limited 1999 Phase I and II (EBA). An excavation project was undertaken in 2001 to remove some of this contaminated soil from site. The total volume of contaminated soil excavated was approximately 100 m3. Contaminated soil was still present on site in the excavation wall that bordered the existing UST nest (EBA 2001). Also there was no excavation of the soil off Lots 8 and 9, Block 10. It was estimated that 30 to 60 m3 of contaminated soil remained on site under the tank nest on lots 8 and 9 in 2001. It was believed that the contamination on site was due to the old tank nest, rather than the current one. Additional remediation work was undertaken in 2009 to remove the UST and excavated any and all contaminated soils on site (EBA 2009). At the conclusion of this work it was determined that the site was remediated. ***(Remediated)***

Cozy Corner Motel: A leak in a 500 gallon underground storage tank resulted in a fuel spill. The leak was discovered when the tank was removed to be replaced with a 250 gallon above ground tank. Contaminants included naphthalene (8.5 mg/kg), HEPH (3270 mg/kg), LEPH (14700 mg/kg), and xylenes (5.3 mg/kg). Following discovery of contamination approximately 99 m3 of soil was excavated from site (Grountrax 2008). Confirmatory sampling indicates that all contamination was removed from site. ***(Remediated)***

Village of Haines Junction Public Works: We have on record that a contamination of 10m3 of PHC-contaminated soils at the Public Works yard in December 2015. However, a relocation permit was not required, as the material was not to leave site. We also have a record of the discovery of 3 tote bags of contaminated material during an inspection. A relocation permit was not required as the material was to stay on site.

Please contact me at 667-8848 if you have any further questions, would like to view any of our files or require other information in the future.

Sincerely,

Vanessa Scharf
Environmental Programs Branch

Government of Canada / Gouvernement du Canada

Treasury Board of Canada Secretariat

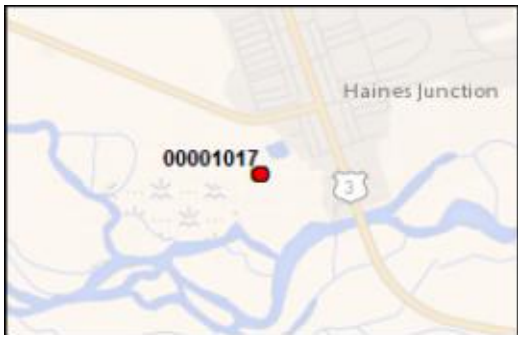
Site 00001017 - Haines Junction RCMP

Status	Confirmatory sampling completed. No further action required.
Site Status	Closed
Classification	Medium Priority for Action

Site Details

Reporting Organization	Royal Canadian Mounted Police
Reason for Involvement	Federal Real Property
Property Type	Federal (DFRP Property Number 20189)

Site Location



Latitude, Longitude	60.74976, -137.51518
Municipality	Haines Junction, YT
Federal Electoral District	Yukon

Contaminant Details

Contamination Estimate

Cubic Meters	54

The following contaminated media exist on the site:

Contaminant Type	Medium Type
PHCs (petroleum hydrocarbons)	Soil
BTEXs (benzene, toluene, ethylbenzene, and xylene)	Soil

Action Plan

Contaminated soil has been remediated. Risk assessment has been completed and has confirmed acceptable risk levels. No additional work is required

Population

This table contains the population estimates at distances around the site.

Radius	Population
1 km	37
5 km	529
10 km	591
25 km	596
50 km	615

Summary of Annually Reported Data

Total Expenditures

Assessment	$51,834.00
Remediation	$90,621.00

FCSAP Expenditures

Assessment	$41,467.20
Remediation	$72,497.00

Financial/Annual Information

2008-2009 | **2007-2008** | **2006-2007** | **2005-2006**

2008-2009

Reporting Organization	Royal Canadian Mounted Police
Internal Identifier	PR M/9
Highest Step Completed	**09** Confirmatory Sampling and Final Reporting
Total Assessment Expenditure	$0.00
Total Remediation Expenditure	$24,910.00
Total Care Maintenance Expenditure	$0.00
	$0.00

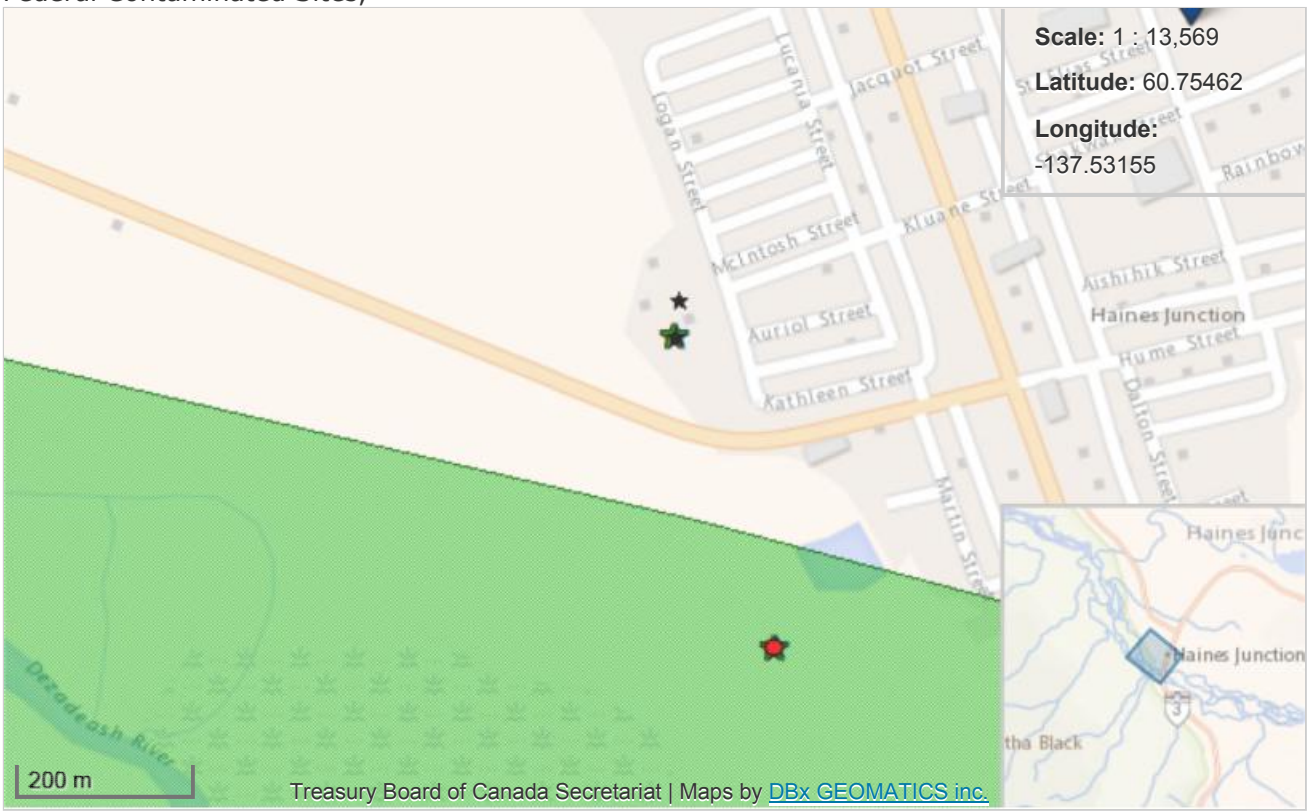
Total Monitoring Expenditure	
FCSAP Assessment Expenditure	$0.00
FCSAP Remediation Expenditure	$19,928.00
FCSAP Care Maintenance Expenditure	$0.00
FCSAP Monitoring Expenditure	$0.00
Actual Cubic Meters Remediated	54 m^3
Actual Hectares Remediated	0 ha
Actual Tons Remediated	0 t
Closed	Yes

Version: 10.3

Treasury Board of Canada Secretariat

DFRP/FCSI - Map Navigator

Area: Haines Junction, Yukon, Unorganized **Content:** 3 Federal Properties, 6 Federal Buildings, 1 Federal Contaminated Sites,



Information

Longitude: -137.506278 **Latitude:** 60.756276

Federal Buildings

Federal Properties

Census Subdivision (1)

Economic Region (1)

Census Divisions (1)

Federal Electoral District (1)

IMPORTANT NOTE: The tables below are currently not synchronized with the map content.
Please click on the following hyperlink if you want to update the tables content: **UPDATE TABLES**

Federal Properties

Federal Properties
Page(s):

Select the number of rows per page 5

Federal Buildings

Federal Contaminated Sites

Federal Contaminated Sites
Page(s):

Select the number of rows per page 5

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Fontaine Building
200 Sacré Coeur Blvd. 13th Floor
Gatineau, Québec K1A 0H3

Your File Votre référence
ID: 532869
Our File Notre référence
E-2016-00803 / TL

SEP 13 2016

Ms. Sarah Sternbergh
Tetra Tech EBA Inc.
61 Wasson Place
Whitehorse, Yukon
Y1A 0H7

Dear Ms. Sternbergh,

This letter is in response to your request under the *Access to Information Act* for:

"Site: 10 km radius around the Village of Haines Junction, Yukon

I would like all contaminated sites and spills records.

Authorization: {Rick Kent, Yukon Community Services}

Clarification received on August 29, 2016:
This search is for three properties in the Village of Haines Junction, Yukon. As far as I know, none of them have civic addresses. I have attached a map showing the locations of the three relevant properties.

These properties are all Village of Haines Junction Community Water wells.

1. VHJ Well #3 – the property is located at the junction of the Haines Highway and the Dezadeash River on the northwest side. The property is owned by the Village of Haines Junction, but is a former US military site from the building of the Alaska and Haines Highways in the 1940s. There are several properties of interest with respect to this site including the Parkside Inn, Cozy Corner Motel & restaurant, nursing station, Yukon Territorial Government Building, and RCMP station located on Martin Street, Bates Street and Steel street north of the well site. Additionally there is a property adjacent to the Dezadeash River on the east side of the Haines Highway from the well site. This was previously a military yard during the construction of the Alaska Highway and is currently the maintenance yard for the Yukon Government Highways Department.

2. VHJ Well #4 is located on the north side of Willow Acres Road just north of Otter Crescent. The properties of interest with respect to this site are located on Backe Street, Otter Crescent, Karman Street, Aishihik Street, Alsek Crescent.

.../2

Canada

3. VHJ Well #5 is located on an unnamed access road between Quill Crescent and the Alaska Highway. Properties of interest with respect to this site are located along the Alaska Highway, on Quill Crescent, on Fireweed Street, and Pringle Street."

After a thorough search, no records were found concerning this request.

Please be advised that you are entitled to file a complaint with the Information Commissioner of Canada concerning the processing of your request within sixty days of the receipt of this notice. In the event you decide to avail yourself of this right, your notice of complaint should be addressed to:

Information Commissioner of Canada
30 Victoria Street
Gatineau, Québec K1A 1H3

If you have any questions regarding this request, please do not hesitate to contact Travis Lamothe at 819-938-3748 or by email at travis.lamothe@canada.ca.

APPENDIX E
LABORATORY ANALYTICAL REPORTS

VILLAGE OF HAINES JUNCTION
ATTN: Collin Kallro
PO Box 5339
Haines Junction YT Y0B 1L0

Date Received: 01-APR-15
Report Date: 06-APR-15 15:42 (MT)
Version: FINAL

Client Phone: 867-336-2275

Certificate of Analysis

Lab Work Order #: L1594176

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers: 10-219075
Legal Site Desc:

Courtney Duncan
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1594176-1	L1594176-2	L1594176-3		
	Description	Water	Water	Water		
	Sampled Date	01-APR-15	01-APR-15	01-APR-15		
	Sampled Time	08:36	09:15	09:36		
	Client ID	PH TREATED	WELL 3 RAW	WELL 5 RAW		
Grouping	**Analyte**					
WATER						
Physical Tests	Colour, True (CU)	<5.0	<5.0	<5.0		
	Conductivity (uS/cm)	229	208	235		
	Hardness (as CaCO3) (mg/L)	31.7	46.8	10.5		
	pH (pH)	8.24	8.42	8.78		
	Total Dissolved Solids (mg/L)	142	125	148		
	Turbidity (NTU)	0.31	0.44	0.21		
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	110	98.0	120		
	Chloride (Cl) (mg/L)	1.89	<0.50	<0.50		
	Fluoride (F) (mg/L)	0.186	0.158	0.215		
	Nitrate (as N) (mg/L)	<0.0050	<0.0050	<0.0050		
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010		
	Sulfate (SO4) (mg/L)	18.4	19.7	16.2		
	Anion Sum (meq/L)	2.65	2.38	2.75		
	Cation Sum (meq/L)	2.53	2.20	2.61		
	Cation - Anion Balance (%)	-2.3	-3.7	-2.7		
Total Metals	Aluminum (Al)-Total (mg/L)	<0.010	<0.010	<0.010		
	Antimony (Sb)-Total (mg/L)	<0.00050	<0.00050	<0.00050		
	Arsenic (As)-Total (mg/L)	0.0135	0.0125	0.0174		
	Barium (Ba)-Total (mg/L)	<0.020	0.024	<0.020		
	Boron (B)-Total (mg/L)	<0.10	<0.10	0.12		
	Cadmium (Cd)-Total (mg/L)	<0.00020	<0.00020	<0.00020		
	Calcium (Ca)-Total (mg/L)	9.06	13.0	3.51		
	Chromium (Cr)-Total (mg/L)	<0.0020	<0.0020	<0.0020		
	Copper (Cu)-Total (mg/L)	0.0027	<0.0010	<0.0010		
	Iron (Fe)-Total (mg/L)	<0.030	<0.030	<0.030		
	Lead (Pb)-Total (mg/L)	<0.00050	<0.00050	<0.00050		
	Magnesium (Mg)-Total (mg/L)	2.20	3.49	0.42		
	Manganese (Mn)-Total (mg/L)	<0.0020	0.0154	<0.0020		
	Mercury (Hg)-Total (mg/L)	<0.00020	<0.00020	<0.00020		
	Potassium (K)-Total (mg/L)	1.74	2.80	0.29		
	Selenium (Se)-Total (mg/L)	<0.0010	<0.0010	<0.0010		
	Sodium (Na)-Total (mg/L)	42.6	27.6	55.0		
	Uranium (U)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Zinc (Zn)-Total (mg/L)	<0.050	<0.050	<0.050		

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

CL-IC-N-WR	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

COLOUR-TRUE-VA	Water	Colour (True) by Spectrometer	BCMOE Colour Single Wavelength

This analysis is carried out using procedures adapted from British Columbia Environmental Manual "Colour- Single Wavelength." Colour (True Colour) is determined by filtering a sample through a 0.45 micron membrane filter followed by analysis of the filtrate using the platinum-cobalt colourimetric method.
Colour measurements can be highly pH dependent, and apply to the pH of the sample as received (at time of testing), without pH adjustment. Concurrent measurement of sample pH is recommended.

EC-MAN-WR	Water	Conductivity by Meter	APHA 2510 (B)

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using an electrode.

F-IC-N-WR	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-TOT-CVAFS-VA	Water	Total Mercury in Water by CVAFS	EPA 245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-TOT-LOW-MS-VA	Water	Total Metals in Water by ICPMS(Low)	EPA SW-846 3005A/6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

NO2-L-IC-N-WR	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-MAN-WR	Water	pH by Meter	APHA 4500-H (B)

"This analysis is carried out using procedures adapted from APHA Method 4500-H ""pH Value"". The pH is determined in the laboratory using a pH electrode."

SO4-IC-N-WR	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)

Reference Information

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".

TURBIDITY-VA Water Turbidity by Meter APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA Water Turbidity by Meter APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

10-219075

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

L9075

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

L1594176-COFC

Page ____ of ____

Report To		Report Format / Distribution	
Company:	Village of Haines Junction	Standard:	Other (specify):
Contact:	Collin Isallio	Select: PDF X	Excel X Digital Fax
Address:	po Box 5339 Haines Junction YT Y0B1L0	Email 1:	waterworld-vhj@yknet.ca
		Email 2:	publicworks-vhj@yknet.ca
Phone:	867-634-5322 Fax: 867-634-2008		

Invoice To	Same as Report ? (circle) Yes or No (if No, provide details)
	Copy of Invoice with Report? (circle) Yes or No
Company:	
Contact:	
Address:	
Phone:	Fax:

Client / Project Information	
Job #:	
PO / AFE:	
LSD:	
Quote #:	

Lab Work Order # (lab use only)		ALS Contact:	Sampler:

Service Request (Rush subject to availability - Contact ALS to confirm TAT)

- Regular (Standard Turnaround Times - Business Days)
- Priority (2-4 Business Days) - 50% surcharge - Contact ALS to confirm TAT
- X Emergency (1-2 Business Days) - 100% Surcharge - Contact ALS to confirm TAT
- Same Day or Weekend Emergency - Contact ALS to confirm TAT

Analysis Request

(Indicate Filtered or Preserved, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	General	total metals	total mercury	Number of Containers
1	PH2 treated	01-04-2015	8:36 Am	water	X			
2	PH2 treated	01-04-2015	8:37 Am	water		P		
3	PH2 treated	01-04-2015	8:40 am	water			P	
4	well 3 Raw	01-04-2015	915 Am	water	X			
5	well 3 Raw	01-04-2015	920 Am	water		P		
6	well 3 Raw	01-04-2015	922 Am	water			P	
7	well 5 Raw	01-04-2015	936 Am	water	X			
8	well 5 Raw	01-04-2015	937 Am	water		P		
9	well 5 Raw	01-04-2015	938 Am	water			P	

RUSH

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Results ASAP please.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
				1 Apr 15	12:00	5.1 °C		Apr 2	1556	

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION | WHITE - LABORATORY COPY | YELLOW - CLIENT COPY | GENF 18.01 Front

2°C

Date: 05-NOV-15
PO No.:
WO No.: L1697154
Project Ref:
Sample ID: WELL 5
Sampled By:
Date Collected: 02-NOV-15
Lab Sample ID: L1697154-1
Matrix: Water

VILLAGE OF HAINES JUNCTION
PO Box 5339
Haines Junction YT Y0B 1L0
ATTN: Collin Kallro

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Alkalinity by Titration						
Alkalinity Species by Titration						
Alkalinity, Total (as CaCO3)	122		mg/L			05-NOV-15
Full Drinking Water Package (Total)						
Colour, True	5.1		CU			05-NOV-15
Total Dissolved Solids	156		mg/L		500	05-NOV-15
*Turbidity	0.10		NTU	0.1		05-NOV-15
Total Metals in Water by ICPOES						
Barium (Ba)-Total	<0.020		mg/L	1		05-NOV-15
Boron (B)-Total	0.11		mg/L	5		05-NOV-15
Calcium (Ca)-Total	3.78		mg/L			05-NOV-15
Iron (Fe)-Total	<0.030		mg/L		0.3	05-NOV-15
Magnesium (Mg)-Total	0.48		mg/L			05-NOV-15
Sodium (Na)-Total	60.3		mg/L		200	05-NOV-15
Zinc (Zn)-Total	<0.050		mg/L		5.0	05-NOV-15
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	<0.010		mg/L		0.1	05-NOV-15
Antimony (Sb)-Total	<0.00050		mg/L	0.006		05-NOV-15
Arsenic (As)-Total	0.0181		mg/L	0.01		05-NOV-15
Cadmium (Cd)-Total	<0.00020		mg/L	0.005		05-NOV-15
Chromium (Cr)-Total	<0.0020		mg/L	0.05		05-NOV-15
Copper (Cu)-Total	<0.0010		mg/L		1.0	05-NOV-15
Lead (Pb)-Total	<0.00050		mg/L	0.01		05-NOV-15
Manganese (Mn)-Total	<0.0020		mg/L		0.05	05-NOV-15
Potassium (K)-Total	0.29		mg/L			05-NOV-15
Selenium (Se)-Total	<0.0010		mg/L	0.05		05-NOV-15
Uranium (U)-Total	<0.00010		mg/L	0.02		05-NOV-15
Total Hg in Water by CVAFS LOR=50ppt						
Mercury (Hg)-Total	<0.00020		mg/L	0.001		05-NOV-15
Sulfate in Water by IC						
Sulfate (SO4)	17.1		mg/L		500	03-NOV-15
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		03-NOV-15
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		03-NOV-15
Ion Balance Calculation						
Cation - Anion Balance	0.6		%			05-NOV-15
Anion Sum	2.82		meq/L			05-NOV-15
Cation Sum	2.86		meq/L			05-NOV-15
Hardness						

Date: 05-NOV-15
PO No.:
WO No.: L1697154
Project Ref:
Sample ID: WELL 5
Sampled By:
Date Collected: 02-NOV-15
Lab Sample ID: L1697154-1
Matrix: Water

VILLAGE OF HAINES JUNCTION
PO Box 5339
Haines Junction YT Y0B 1L0
ATTN: Collin Kallro

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Full Drinking Water Package (Total)						
Hardness						
Hardness (as CaCO3)	11.4		mg/L		500	05-NOV-15
Fluoride in Water by IC						
Fluoride (F)	0.229		mg/L	1.5		03-NOV-15
Chloride in Water by IC						
Chloride (Cl)	0.64		mg/L		250	03-NOV-15
Conductivity	257		uS/cm			05-NOV-15
pH	9.00		pH		6.5-8.5	05-NOV-15

CDWQG = Health Canada Guideline Limits updated OCTOBER 2014

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Courtney Duncan
Account Manager

Date: 05-NOV-15
PO No.:
WO No.: L1697154
Project Ref:
Sample ID: WELL 3
Sampled By:
Date Collected: 02-NOV-15
Lab Sample ID: L1697154-2
Matrix: Water

VILLAGE OF HAINES JUNCTION
PO Box 5339
Haines Junction YT Y0B 1L0
ATTN: Collin Kallro

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Alkalinity by Titration						
Alkalinity Species by Titration						
Alkalinity, Total (as CaCO3)	94.1		mg/L			05-NOV-15
Full Drinking Water Package (Total)						
Colour, True	<5.0		CU			05-NOV-15
Total Dissolved Solids	125		mg/L		500	05-NOV-15
*Turbidity	0.11		NTU	0.1		05-NOV-15
Total Metals in Water by ICPOES						
Barium (Ba)-Total	0.025		mg/L	1		05-NOV-15
Boron (B)-Total	<0.10		mg/L	5		05-NOV-15
Calcium (Ca)-Total	13.3		mg/L			05-NOV-15
Iron (Fe)-Total	<0.030		mg/L		0.3	05-NOV-15
Magnesium (Mg)-Total	3.74		mg/L			05-NOV-15
Sodium (Na)-Total	29.1		mg/L		200	05-NOV-15
Zinc (Zn)-Total	<0.050		mg/L		5.0	05-NOV-15
Total Metals in Water by CRC ICPMS						
Aluminum (Al)-Total	<0.010		mg/L		0.1	05-NOV-15
Antimony (Sb)-Total	<0.00050		mg/L	0.006		05-NOV-15
Arsenic (As)-Total	0.0118		mg/L	0.01		05-NOV-15
Cadmium (Cd)-Total	<0.00020		mg/L	0.005		05-NOV-15
Chromium (Cr)-Total	<0.0020		mg/L	0.05		05-NOV-15
Copper (Cu)-Total	<0.0010		mg/L		1.0	05-NOV-15
Lead (Pb)-Total	<0.00050		mg/L	0.01		05-NOV-15
Manganese (Mn)-Total	0.0152		mg/L		0.05	05-NOV-15
Potassium (K)-Total	2.64		mg/L			05-NOV-15
Selenium (Se)-Total	<0.0010		mg/L	0.05		05-NOV-15
Uranium (U)-Total	<0.00010		mg/L	0.02		05-NOV-15
Total Hg in Water by CVAFS LOR=50ppt						
Mercury (Hg)-Total	<0.00020		mg/L	0.001		05-NOV-15
Sulfate in Water by IC						
Sulfate (SO4)	19.9		mg/L		500	03-NOV-15
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		03-NOV-15
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		03-NOV-15
Ion Balance Calculation						
Cation - Anion Balance	0.0		%			05-NOV-15
Anion Sum	2.30		meq/L			05-NOV-15
Cation Sum	2.31		meq/L			05-NOV-15
Hardness						

Date: 05-NOV-15
PO No.:
WO No.: L1697154
Project Ref:
Sample ID: WELL 3
Sampled By:
Date Collected: 02-NOV-15
Lab Sample ID: L1697154-2
Matrix: Water

VILLAGE OF HAINES JUNCTION
PO Box 5339
Haines Junction YT Y0B 1L0
ATTN: Collin Kallro

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Full Drinking Water Package (Total)						
Hardness						
Hardness (as CaCO3)	48.7		mg/L		500	05-NOV-15
Fluoride in Water by IC						
Fluoride (F)	0.164		mg/L	1.5		03-NOV-15
Chloride in Water by IC						
Chloride (Cl)	<0.50		mg/L		250	03-NOV-15
Conductivity	215		uS/cm			05-NOV-15
pH	8.44		pH		6.5-8.5	05-NOV-15

CDWQG = Health Canada Guideline Limits updated OCTOBER 2014

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Courtney Duncan
Account Manager

Guidelines & Objectives

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1697154-COFC

COC Number: 14 - 470123

Page ____ of ____

Report To	Report Format / Distribution	Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company: Village of Haines Junction	Select Report Format: ☒ PDF ☐ EXCEL ☐ EDD (DIGITAL)	R ☐ Regular (Standard TAT if received by 3pm)
Contact: Collin Kallio	Quality Control (QC) Report with Report ☒ Yes ☐ No	P ☒ Priority (2-4 business days if received by 3pm)
Address: PO Box 5339 Haines Junction	☐ Criteria on Report - provide details below if box checked	E ☐ Emergency (1-2 business days if received by 3pm)
	Select Distribution: ☒ EMAIL ☐ MAIL ☐ FAX	E2 ☐ Same day or weekend emergency if received by 10am – contact ALS for surcharge.
Phone: 867 634-5322	Email 1 or Fax [redacted] waterworks-VHJ@[redacted].ca	Specify Date Required for E2,E or P:
	Email 2 Publicworks-VHJ@yknet.ca	

Invoice To	Same as Report To ☐ Yes ☐ No	Invoice Distribution	Analysis Request
	Copy of Invoice with Report ☐ Yes ☐ No	Select Invoice Distribution: ☐ EMAIL ☐ MAIL ☐ FAX	Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below
Company: Village of Haines Junction		Email 1 or Fax	
Contact: Vanessa Ranson		Email 2	

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:		Approver ID:	Cost Center:
Job #:		GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:		Location:	

ALS Lab Work Order # (lab use only):

ALS Contact:

Sampler: Collin K.

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	general	metals	mercury	general	metals	mercury							Number of Containers
	well 5 - 1	02-11-15	130 pm	water	P												
	well 5 - 2	02-11-15	130pm	water		P											
	well 5 - 3	02-11-15	130pm	water			P										
	well 3 - 1	02-11-15	150pm	water				P									
	well 3 - 2	02-11-15	150pm	water					P								
	well 3 - 3	02-11-15	150pm	water						P							

RUSH

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System? ☒ Yes ☐ No	
Are samples for human drinking water use? ☒ Yes ☐ No	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No ☐	
Ice packs	Yes ☒	No ☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated	☒				

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
3.1					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Dave Hatherley	Date: Nov 3/15	Time: 10:05am	Received by:	Date: 3-Nov-15	Time: 1005am	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

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Report Transmission Cover Page

Bill To:	J. Gibson & Associates	Project:		Lot ID:	**1075087**
Report To:	J. Gibson & Associates	ID:	VHJ	Control Number:	C0041391
	Box 20913	Name:		Date Received:	Jun 10, 2015
	Whitehorse, YT, Canada	Location:	Supply Wells	Date Reported:	Jun 18, 2015
	Y1A 6P2	LSD:		Report Number:	2017366
Attn:	John Gibson	P.O.:			
Sampled By:	J. Gibson	Acct code:			
Company:					

Contact & Affiliation	Address	Delivery Commitments
John Gibson J. Gibson & Associates	Box 20913, Whitehorse, Yukon Territory Y1A 6P2 Phone: (867) 633-4522 Fax: (867) 668-6895 Email: ludditegibson@gmail.com	On [Lot Verification] send (COA) by Email - Single Report On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Report Approval] send (Test Report) by Email - Single Report On [Lot Approval and Final Test Report Approval] send (Invoice) by Email - Single Report On [Lot Creation] send (COR) by Email - Single Report

Notes To Clients:

- pH analysis was performed past the recommended holding time of 15 minutes from sample collection.

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Analytical Report

Bill To: J. Gibson & Associates
Report To: J. Gibson & Associates
Box 20913
Whitehorse, YT, Canada
Y1A 6P2
Attn: John Gibson
Sampled By: J. Gibson
Company:

Project:
ID: VHJ
Name:
Location: Supply Wells
LSD:
P.O.:
Acct code:

Lot ID: **1075087**
Control Number: C0041391
Date Received: Jun 10, 2015
Date Reported: Jun 18, 2015
Report Number: 2017366

		Reference Number	1075087-1	1075087-2	1075087-3	
		Sample Date	Jun 08, 2015	Jun 08, 2015	Jun 08, 2015	
		Sample Time	15:50	16:00	16:10	
		Sample Location				
		Sample Description	Well #3 Raw	Well #5 Raw	Well #3 + 5 Treated	
		Matrix	Water	Water	Water	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Total						
Mercury	Total	mg/L	<0.00001	<0.00001	<0.00001	0.00001
Aluminum	Total	mg/L	<0.005	<0.005	<0.005	0.005
Antimony	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Arsenic	Total	mg/L	0.0127	0.0201	0.0110	0.00005
Barium	Total	mg/L	0.0249	0.0127	0.0209	0.00005
Beryllium	Total	mg/L	<0.00005	<0.00005	<0.00005	0.00005
Bismuth	Total	mg/L	<0.0001	0.0001	<0.0001	0.0001
Boron	Total	mg/L	0.067	0.110	0.077	0.002
Cadmium	Total	mg/L	<0.00001	<0.00001	<0.00001	0.00001
Calcium	Total	mg/L	13.9	4.03	11.6	0.05
Chromium	Total	mg/L	<0.0005	0.0012	<0.0005	0.0005
Cobalt	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Copper	Total	mg/L	<0.0001	<0.0001	0.0015	0.0001
Iron	Total	mg/L	0.008	0.124	0.003	0.002
Lead	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Lithium	Total	mg/L	0.0006	0.0009	0.0007	0.0005
Magnesium	Total	mg/L	3.64	0.47	2.82	0.04
Manganese	Total	mg/L	0.0159	0.0029	<0.0010	0.001
Molybdenum	Total	mg/L	0.00447	0.00828	0.00524	0.00005
Nickel	Total	mg/L	<0.0002	0.0020	0.0002	0.0002
Potassium	Total	mg/L	2.9	0.3	2.3	0.1
Selenium	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Silicon	Total	mg/L	11.0	10.8	10.8	0.02
Silver	Total	mg/L	<0.00005	<0.00005	<0.00005	0.00005
Sodium	Total	mg/L	29.1	84.8	37.5	0.1
Strontium	Total	mg/L	0.124	0.0585	0.110	0.0001
Thallium	Total	mg/L	<0.00001	<0.00001	<0.00001	0.00001
Thorium	Total	mg/L	<0.00001	<0.00001	<0.00001	0.00001
Tin	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Titanium	Total	mg/L	<0.0005	<0.0005	<0.0005	0.0005
Uranium	Total	mg/L	0.00002	0.00001	0.00002	0.00001
Vanadium	Total	mg/L	<0.0001	0.0002	0.0001	0.0001
Zinc	Total	mg/L	0.0015	0.0018	0.0064	0.0005
Zirconium	Total	mg/L	<0.0005	<0.0005	<0.0005	0.0005
Hardness	as CaCO3	mg/L	50	12	40	1

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Analytical Report

Bill To:	J. Gibson & Associates	Project:		Lot ID:	**1075087**
Report To:	J. Gibson & Associates	ID:	VHJ	Control Number:	C0041391
	Box 20913	Name:		Date Received:	Jun 10, 2015
	Whitehorse, YT, Canada	Location:	Supply Wells	Date Reported:	Jun 18, 2015
	Y1A 6P2	LSD:		Report Number:	2017366
Attn:	John Gibson	P.O.:			
Sampled By:	J. Gibson	Acct code:			
Company:					

		Reference Number	1075087-1	1075087-2	1075087-3	
		Sample Date	Jun 08, 2015	Jun 08, 2015	Jun 08, 2015	
		Sample Time	15:50	16:00	16:10	
		Sample Location				
		Sample Description	Well #3 Raw	Well #5 Raw	Well #3 + 5 Treated	
		Matrix	Water	Water	Water	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Physical and Aggregate Properties						
Colour	True	Colour units	<5	<5	<5	5
Solids	Total Dissolved	mg/L	118	210	142	5
Turbidity		NTU	0.02	0.43	0.02	0.02
Routine Water						
pH	at 25 °C		8.03	8.61	8.00	
Electrical Conductivity		µS/cm at 25 C	215	373	229	1
Bicarbonate		mg/L	109	157	115	5
Carbonate		mg/L	<6	<6	<6	6
Hydroxide		mg/L	<5	<5	<5	5
P-Alkalinity	as CaCO3	mg/L	<5	<5	<5	5
T-Alkalinity	as CaCO3	mg/L	89	129	94	5
Chloride	Dissolved	mg/L	0.18	28.5	1.68	0.05
Fluoride	Dissolved	mg/L	0.21	0.18	0.22	0.01
Nitrate - N	Dissolved	mg/L	0.03	0.07	0.06	0.01
Nitrite - N	Dissolved	mg/L	0.08	<0.01	0.12	0.01
Sulfate (SO4)	Dissolved	mg/L	19.7	16.5	18.6	0.5

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Analytical Report

Bill To:	J. Gibson & Associates	Project:	
Report To:	J. Gibson & Associates	ID:	VHJ
	Box 20913	Name:	
	Whitehorse, YT, Canada	Location:	Supply Wells
	Y1A 6P2	LSD:	
Attn:	John Gibson	P.O.:	
Sampled By:	J. Gibson	Acct code:	
Company:			

Lot ID:	**1075087**
Control Number:	C0041391
Date Received:	Jun 10, 2015
Date Reported:	Jun 18, 2015
Report Number:	2017366

Reference Number	1075087-4
Sample Date	Jun 08, 2015
Sample Time	16:20
Sample Location	
Sample Description	TCC Supply
Matrix	Water

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Trihalomethanes Screen - Water						
Chloroform		mg/L	0.007			0.001
Bromodichloromethane		mg/L	<0.001			0.001
Dibromochloromethane		mg/L	<0.001			0.001
Bromoform		mg/L	<0.001			0.001
Total Trihalomethanes		mg/L	0.007			0.001
Trihalomethanes - Surrogate Recovery						
Dibromofluoromethane	EPA Surrogate	%	112			86-118
Toluene-d8	EPA Surrogate	%	104			85-115
Bromofluorobenzene	EPA Surrogate	%	91			86-115

Approved by:

Mathieu Simoneau
Operations Manager

Data have been validated by Analytical Quality Control and Exova's Integrated Data Validation System (IDVS).
Generation and distribution of the report, and approval by the digitized signature above, are performed through a secure and controlled automatic process.

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Methodology and Notes

Bill To:	J. Gibson & Associates	Project:	
Report To:	J. Gibson & Associates	ID:	VHJ
	Box 20913	Name:	
	Whitehorse, YT, Canada	Location:	Supply Wells
	Y1A 6P2	LSD:	
Attn:	John Gibson	P.O.:	
Sampled By:	J. Gibson	Acct code:	
Company:			

Lot ID:	**1075087**
Control Number:	C0041391
Date Received:	Jun 10, 2015
Date Reported:	Jun 18, 2015
Report Number:	2017366

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
Alk, pH, EC, Turb in water (Surrey)	APHA	*	Alkalinity - Titration Method, 2320 B	12-Jun-15	Exova Surrey
Alk, pH, EC, Turb in water (Surrey)	APHA	*	Conductivity, 2510 B	12-Jun-15	Exova Surrey
Alk, pH, EC, Turb in water (Surrey)	APHA	*	pH - Electrometric Method, 4500-H+ B	12-Jun-15	Exova Surrey
Anions by IEC in water (Surrey)	APHA	*	Ion Chromatography with Chemical Suppression of Eluent Cond., 4110 B	11-Jun-15	Exova Surrey
BC ICP-MS Total Metals in Water	US EPA	*	Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	17-Jun-15	Exova Edmonton
BC Trace Total Metals in Water	APHA	*	Inductively Coupled Plasma (ICP) Method, 3120 B	17-Jun-15	Exova Edmonton
Mercury Low Level (Total) in water (Surrey)	EPA	*	Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry, 245.7	15-Jun-15	Exova Surrey
Solids Dissolved (Total, Fixed and Volatile) - Surrey	APHA	*	Total Dissolved Solids Dried at 180 C, 2540 C	11-Jun-15	Exova Surrey
THM - Water	US EPA	*	US EPA method, 524	12-Jun-15	Exova Calgary
True Color in water (Surrey)	APHA	*	Spectrophotometric - Single Wavelength Method, 2120 C	15-Jun-15	Exova Surrey
Turbidity - Water (Surrey)	APHA	*	Turbidity - Nephelometric Method, 2130 B	12-Jun-15	Exova Surrey

** Reference Method Modified*

References

APHA	Standard Methods for the Examination of Water and Wastewater
US EPA	US Environmental Protection Agency Test Methods

Comments:

- pH analysis was performed past the recommended holding time of 15 minutes from sample collection.

Exova Testing, calibrating, advising

www.exova.com ED 120-02

Project Information

Project ID: VHJ
Project Name:
Project Location: SUPPLY WELLS.
Legal Location:
PO/AFE#:
Proj. Acct. Code:
Quote #

Invoice to:

Company: J. ~~Gibson & Associates~~
Address: ~~Whitehorse, YT Y1A 6P2~~
Attention: ~~John Gibson~~
Phone: ~~(867) 633-4522~~
Cell:
Fax: ~~(867) 668-6895~~
E-mail: ~~luddite gibson@gmail.com~~
Agreement ID: 6646
Copy of report:

Report To:

Company: J. ~~Gibson & Associates~~
Address: ~~Whitehorse, YT Y1A 6P2~~
Attention: John Gibson
Phone: ~~(867) 633-4522~~
Cell:
Fax: ~~(867) 668-6895~~
E-mail 1: luddite gibson@gmail.com
E-mail 2:
Copy of invoice:

Report Results		Regulatory Requirement	
E-Mail		HCDWQG	
Mail		Ab Tier 1	
Online		SPIGEC	
Fax		BCCSR	
PDF		Other (list below)	
Excel			
QA/QC			

Sample Custody (please print)

Sampled by: J GIBSON
Company:

RUSH Priority

- Emergency (contact lab for turnaround and pricing)
- Priority 1-2 working days (100% surcharge)
- Urgent 2-3 working days (50% surcharge)

When "ASAP" is requested, turn around will default to a 100% RUSH priority, with pricing and turn around time to match. Please contact the lab prior to submitting RUSH samples. If not all samples require RUSH, please indicate in the special instructions.

Date Required: Signature:

This section for Lab use only

Date/Time stamp: RECEIVED JUN 10 2015

Special Instructions/Comments (please include contact information including ph. # if different from above).

RCHEM = PH, EC, COLO, TURB, TDS, HARDT, ALK, Cl, F, SO4, N2, N3.

	Site I.D.	Sample Description	Depth start	Depth end	Date/Time Sampled	Matrix	Sampling Method	Number of Containers	RCHEM	THg	TW24hr	THMs	
1													
2	Well #3	RAW	—		Jun 8 1550	H2O	GRAB	3	✓	✓	✓		
3													
4	Well #5	RAW			Jun 8 1600	H2O	"	3	✓	✓	✓		
5													
6	Well 345	Treated			Jun 8 1610	H2O	"	3	✓	✓	✓		
7													
8	TCC	SUPPLY			Jun 8 1620	H2O	"	1				✓	
9													
10													
11													
12													
13													
14		NOTE: TW24 + WITH C, THg + HCl											
15													

Enter tests above (√ relevant samples below)

Indicate in the space allotted any deficiencies by the corresponding number.

1. Indicate any samples that were not packaged well
2. Indicate any samples not received in Exova supplies
3. Indicate any samples that were not clearly labeled
4. Indicate any samples not received within the required hold time or temp.
5. Indicate any missing or extra samples
6. Indicate any samples that were received broken
7. Indicate any samples where sufficient volume was not received
8. Indicate any samples received in an inappropriate container

ED 120-02

Submission of this form acknowledges acceptance of Exova's Standard Terms and Conditions (http://www.exova.com/about/terms-and-conditions/)

Please indicate any potentially hazardous samples

Page 1 of 1 Control # C 0041391

LOT: 1075087 COC

Shipping: COD Y/ N
and size of coolers
Temp. received: 6.2°C
Delivery Method:
Waybill:
Received by:

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Report Transmission Cover Page

Bill To:	J. Gibson & Associates	Project:		Lot ID:	**1141309**
Report To:	J. Gibson & Associates Box 20913 Whitehorse, YT, Canada Y1A 6P2	ID: Name: Location: LSD:	Village Haines Jnt supply	Control Number: Date Received: Date Reported: Report Number:	C0049875 Jun 3, 2016 Jun 10, 2016 2108006
Attn:	John Gibson	P.O.:			
Sampled By:	J Gibson	Acct code:			
Company:					

Contact & Affiliation	Address	Delivery Commitments
John Gibson J. Gibson & Associates	Box 20913, Whitehorse, Yukon Territory Y1A 6P2 Phone: (867) 633-4522 Fax: (867) 668-6895 Email: ludditegibson@gmail.com	On [Lot Verification] send (COA) by Email - Single Report On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Report Approval] send (Test Report) by Email - Single Report On [Lot Approval and Final Test Report Approval] send (Invoice) by Email - Single Report On [Lot Creation] send (COR) by Email - Single Report

Notes To Clients:

- Analysis was performed on lot 1141309 samples 1, 2 and 3 that exceeded the recommended holding time for Turbidity analysis.

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Analytical Report

Bill To:	J. Gibson & Associates	Project:		Lot ID:	**1141309**
Report To:	J. Gibson & Associates	ID:	Village Haines Jnt supply	Control Number:	C0049875
	Box 20913	Name:		Date Received:	Jun 3, 2016
	Whitehorse, YT, Canada	Location:		Date Reported:	Jun 10, 2016
	Y1A 6P2	LSD:		Report Number:	2108006
Attn:	John Gibson	P.O.:			
Sampled By:	J Gibson	Acct code:			
Company:					

Reference Number		1141309-1	1141309-2	1141309-3	
Sample Date		Jun 01, 2016	Jun 01, 2016	Jun 01, 2016	
Sample Time		13:50	13:35	13:15	
Sample Location					
Sample Description		Raw Supply / Well #3	Raw Supply / Well #5	Treated Supply / PH#2	
Matrix		Water	Water	Water	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Total						
Calcium	Total	mg/L	13.9	3.88	9.37	0.05
Magnesium	Total	mg/L	3.90	0.47	2.21	0.05
Potassium	Total	mg/L	3.0	0.3	1.7	0.1
Silicon	Total	mg/L	10.8	10.7	10.7	0.05
Sulfur	Total	mg/L	6.8	5.9	6.4	0.1
Sodium	Total	mg/L	29.7	61.5	46.1	0.02
Titanium	Total	mg/L	0.002	<0.001	<0.001	0.001
Mercury	Total	mg/L	<0.00001	<0.00001	<0.00001	0.00001
Physical and Aggregate Properties						
Colour	True	Colour units	<5	<5	<5	5
Solids	Total Dissolved	mg/L	186	234	218	5
Turbidity		NTU	0.18	0.21	0.08	0.02
Routine Water						
pH - Holding Time			Exceeded	Exceeded	Exceeded	
pH	at 25 °C		7.65	8.43	7.47	
Electrical Conductivity		µS/cm at 25 C	212	252	235	1
Bicarbonate		mg/L	111	136	128	5
Carbonate		mg/L	<6	6	<6	6
Hydroxide		mg/L	<5	<5	<5	5
P-Alkalinity	as CaCO3	mg/L	<5	5	<5	5
T-Alkalinity	as CaCO3	mg/L	91	122	105	5
Chloride	Dissolved	mg/L	0.15	0.56	1.64	0.05
Fluoride	Dissolved	mg/L	0.15	0.19	0.17	0.01
Nitrate - N	Dissolved	mg/L	<0.01	<0.01	<0.01	0.01
Nitrite - N	Dissolved	mg/L	<0.01	<0.01	<0.01	0.01
Sulfate (SO4)	Dissolved	mg/L	20.1	16.6	18.6	0.5
Hardness	Total	mg CaCO3/L	50.7	11.6	32.5	1
Trace Metals Total						
Aluminum	Total	mg/L	0.002	0.026	0.002	0.001
Antimony	Total	mg/L	<0.00002	0.00002	0.00003	0.00002
Arsenic	Total	mg/L	0.0123	0.0186	0.0015	0.0001
Barium	Total	mg/L	0.0230	0.0094	0.0167	0.0001
Beryllium	Total	mg/L	<0.00005	<0.00005	<0.00005	0.00005
Bismuth	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Boron	Total	mg/L	0.065	0.110	0.089	0.002

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Analytical Report

Bill To:	J. Gibson & Associates	Project:		Lot ID:	**1141309**
Report To:	J. Gibson & Associates	ID:	Village Haines Jnt supply	Control Number:	C0049875
	Box 20913	Name:		Date Received:	Jun 3, 2016
	Whitehorse, YT, Canada	Location:		Date Reported:	Jun 10, 2016
	Y1A 6P2	LSD:		Report Number:	2108006
Attn:	John Gibson	P.O.:			
Sampled By:	J Gibson	Acct code:			
Company:					

Reference Number		1141309-1	1141309-2	1141309-3	
Sample Date		Jun 01, 2016	Jun 01, 2016	Jun 01, 2016	
Sample Time		13:50	13:35	13:15	
Sample Location					
Sample Description		Raw Supply / Well #3	Raw Supply / Well #5	Treated Supply / PH#2	
Matrix		Water	Water	Water	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Trace Metals Total - Continued						
Cadmium	Total	mg/L	<0.00001	<0.00001	<0.00001	0.00001
Chromium	Total	mg/L	<0.00005	<0.00005	0.00012	0.00005
Cobalt	Total	mg/L	<0.00002	<0.00002	<0.00002	0.00002
Copper	Total	mg/L	<0.0002	<0.0002	0.0071	0.0002
Iron	Total	mg/L	0.010	0.002	<0.002	0.002
Lead	Total	mg/L	<0.00001	0.00001	0.00008	0.00001
Lithium	Total	mg/L	0.0006	0.0009	0.0007	0.0005
Manganese	Total	mg/L	0.015	0.001	<0.001	0.001
Molybdenum	Total	mg/L	0.00382	0.00682	0.00544	0.00002
Nickel	Total	mg/L	<0.0002	<0.0002	<0.0002	0.0002
Selenium	Total	mg/L	<0.0002	<0.0002	<0.0002	0.0002
Silver	Total	mg/L	<0.00001	<0.00001	<0.00001	0.00001
Strontium	Total	mg/L	0.109	0.0471	0.0818	0.0001
Tellurium	Total	mg/L	<0.00005	<0.00005	<0.00005	0.00005
Thallium	Total	mg/L	<0.00001	<0.00001	<0.00001	0.00001
Thorium	Total	mg/L	<0.00005	<0.00005	<0.00005	0.00005
Tin	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Uranium	Total	mg/L	0.00002	0.00001	<0.00001	0.00001
Vanadium	Total	mg/L	<0.00005	0.00010	<0.00005	0.00005
Zinc	Total	mg/L	0.0011	0.0006	0.0602	0.0005
Zirconium	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001

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Analytical Report

Bill To: J. Gibson & Associates
Report To: J. Gibson & Associates
Box 20913
Whitehorse, YT, Canada
Y1A 6P2
Attn: John Gibson
Sampled By: J Gibson
Company:

Project:
ID: Village Haines Jnt supply
Name:
Location:
LSD:
P.O.:
Acct code:

Lot ID: **1141309**
Control Number: C0049875
Date Received: Jun 3, 2016
Date Reported: Jun 10, 2016
Report Number: 2108006

		Reference Number	1141309-4	1141309-5	1141309-6	
		Sample Date	Jun 01, 2016	Jun 01, 2016	Jun 01, 2016	
		Sample Time	13:42	13:55	14:05	
		Sample Location				
		Sample Description	PH#4	Health Centre	CAFN C.C	
		Matrix	Water	Water	Water	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Trihalomethanes Screen - Water						
Chloroform		mg/L	0.008	0.008	0.008	0.001
Bromodichloromethane		mg/L	<0.001	<0.001	<0.001	0.001
Dibromochloromethane		mg/L	<0.001	<0.001	<0.001	0.001
Bromoform		mg/L	<0.001	<0.001	<0.001	0.001
Total Trihalomethanes		mg/L	0.008	0.008	0.008	0.001
Trihalomethanes - Surrogate Recovery						
Dibromofluoromethane	EPA Surrogate	%	97	96	97	86-118
Toluene-d8	EPA Surrogate	%	94	96	96	85-115
Bromofluorobenzene	EPA Surrogate	%	93	92	94	86-115

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Analytical Report

Bill To:	J. Gibson & Associates	Project:		Lot ID:	**1141309**
Report To:	J. Gibson & Associates	ID:	Village Haines Jnt supply	Control Number:	C0049875
	Box 20913	Name:		Date Received:	Jun 3, 2016
	Whitehorse, YT, Canada	Location:		Date Reported:	Jun 10, 2016
	Y1A 6P2	LSD:		Report Number:	2108006
Attn:	John Gibson	P.O.:			
Sampled By:	J Gibson	Acct code:			
Company:					

Reference Number	1141309-7	1141309-8	
Sample Date	Jun 01, 2016	Jun 01, 2016	
Sample Time	14:22	14:30	
Sample Location			
Sample Description	Game Branch	Yukon College	
Matrix	Water	Water	

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Trihalomethanes Screen - Water						
Chloroform		mg/L	0.008	0.009		0.001
Bromodichloromethane		mg/L	<0.001	<0.001		0.001
Dibromochloromethane		mg/L	<0.001	<0.001		0.001
Bromoform		mg/L	<0.001	<0.001		0.001
Total Trihalomethanes		mg/L	0.008	0.009		0.001
Trihalomethanes - Surrogate Recovery						
Dibromofluoromethane	EPA Surrogate	%	101	99		86-118
Toluene-d8	EPA Surrogate	%	96	94		85-115
Bromofluorobenzene	EPA Surrogate	%	93	93		86-115

Approved by:

Mathieu Simoneau
Operations Manager

Data have been validated by Analytical Quality Control and Exova's Integrated Data Validation System (IDVS).
Generation and distribution of the report, and approval by the digitized signature above, are performed through a secure and controlled automatic process.

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Methodology and Notes

Bill To:	J. Gibson & Associates	Project:		Lot ID:	**1141309**
Report To:	J. Gibson & Associates	ID:	Village Haines Jnt supply	Control Number:	C0049875
	Box 20913	Name:		Date Received:	Jun 3, 2016
	Whitehorse, YT, Canada	Location:		Date Reported:	Jun 10, 2016
	Y1A 6P2	LSD:		Report Number:	2108006
Attn:	John Gibson	P.O.:			
Sampled By:	J Gibson	Acct code:			
Company:					

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
Alk, pH, EC, Turb in water (Surrey)	APHA	*	Alkalinity - Titration Method, 2320 B	06-Jun-16	Exova Surrey
Alk, pH, EC, Turb in water (Surrey)	APHA	*	Conductivity, 2510 B	06-Jun-16	Exova Surrey
Alk, pH, EC, Turb in water (Surrey)	APHA	*	pH - Electrometric Method, 4500-H+ B	06-Jun-16	Exova Surrey
Anions by IEC in water (Surrey)	APHA	*	Ion Chromatography with Chemical Suppression of Eluent Cond., 4110 B	04-Jun-16	Exova Surrey
Mercury Low Level (Total) in water (Surrey)	EPA	*	Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry, 245.7	06-Jun-16	Exova Surrey
Metals SemiTrace (Total) in Water (Surrey)	US EPA	*	Metals & Trace Elements by ICP-AES, 6010C	06-Jun-16	Exova Surrey
Solids Dissolved (Total, Fixed and Volatile) - Surrey	APHA	*	Total Dissolved Solids Dried at 180 C, 2540 C	07-Jun-16	Exova Surrey
THM - Water	US EPA	*	US EPA method, 8260B/5035	06-Jun-16	Exova Calgary
Trace Metals (Total) in Water (Surrey)	US EPA	*	Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	06-Jun-16	Exova Surrey
Trace Metals (Total) in Water (Surrey)	US EPA	*	Metals & Trace Elements by ICP-AES, 6010C	06-Jun-16	Exova Surrey
True Color in water (Surrey)	APHA	*	Spectrophotometric - Single Wavelength Method, 2120 C	07-Jun-16	Exova Surrey
Turbidity - Water (Surrey)	APHA	*	Turbidity - Nephelometric Method, 2130 B	06-Jun-16	Exova Surrey

** Reference Method Modified*

References

APHA	Standard Methods for the Examination of Water and Wastewater
EPA	Environmental Protection Agency Test Methods - US
US EPA	US Environmental Protection Agency Test Methods

Comments:

- Analysis was performed on lot 1141309 samples 1, 2 and 3 that exceeded the recommended holding time for Turbidity analysis.

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Methodology and Notes

Bill To:	J. Gibson & Associates	Project:		Lot ID:	**1141309**
Report To:	J. Gibson & Associates	ID:	Village Haines Jnt supply	Control Number:	C0049875
	Box 20913	Name:		Date Received:	Jun 3, 2016
	Whitehorse, YT, Canada	Location:		Date Reported:	Jun 10, 2016
	Y1A 6P2	LSD:		Report Number:	2108006
Attn:	John Gibson	P.O.:			
Sampled By:	J Gibson	Acct code:			
Company:					

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Invoice to:
Company: J GIBSON ENV. CONS.
Address:
Attention:
Phone:
Cell:
Fax:
E-mail: juddite.gibson@gmail.com
Agreement ID: 6646
Copy of report:

Report To:
Company:
Address:
Attention:
Phone:
Cell:
Fax:
E-mail 1:
E-mail 2:
Copy of invoice:

Report Results		Regulatory Requirement	
E-Mail		HCDWQG	
Mail		Ab Tier 1	
Online		SPIGEC	
Fax		BCCSR	
PDF		Other (list below)	
Excel			
QA/QC			

Project Information
Project ID: Village Haines Jnt
Project Name: Supply
Project Location:
Legal Location:
PO/AFE#:
Proj. Acct. Code:
Quote #

Sample Custody (please print)
Sampled by: J Gibson
Company: /

RUSH Priority
- Emergency (contact lab for turnaround and pricing)
- Priority 1-2 working days (100% surcharge)
- Urgent 2-3 working days (50% surcharge)

When "ASAP" is requested, turn around will default to a 100% RUSH priority, with pricing and turn around time to match. Please contact the lab prior to submitting RUSH samples. If not all samples require RUSH, please indicate in the special instructions.

Date Required: Signature:

Special Instructions/Comments (please include contact information including ph. # if different from above).
RCHEM = pH, EC, COLO, TURB, TDS, HARDT, ALK, Cl, F, SO4, N_2, N_3

This section for Lab use only
Date/Time stamp: RECEIVED JUN 0 3 2016

Indicate in the space allotted any deficiencies by the corresponding number.

	Site I.D.	Sample Description	Depth start in	Depth start cm	Depth end m	Date/Time Sampled	Matrix	Sampling Method	Number of Containers	RCHEM	TW24ew	THg	THM's							
1	WELL#3	RAW SUPPLY				Jun1 @ 1350	H_2O	PtG	3	✓	✓	✓								
2																				
3	WELL#5	RAW SUPPLY				Jun1 @ 1335	H_2O	PtG	3	✓	✓	✓								
4																				
5	PH#2	TREATED SUPPLY				Jun1 @ 1315	H_2O	PtG	3	✓	✓	✓								
6																				
7	PH#4					Jun1 @ 1342	H_2O	PtG	1				✓							
8	HEALTH CENTRE					" 1355	↓	↓	1				✓							
9	CAFN C.C.					" 1405			1				✓							
10	GAME BRANCH					" 1422			1				✓							
11	YUKON COLLEGE					" 1430			1				✓							
12																				
13																				
14	NOTES:	TW24 + Nitric																		
15		THg + HCL																		

1. Indicate any samples that were not packaged well
2. Indicate any samples not received in Exova supplies
3. Indicate any samples that were not clearly labeled
4. Indicate any samples not received within the required hold time or temp.
5. Indicate any missing or extra samples
6. Indicate any samples that were received broken
7. Indicate any samples where sufficient volume was not received
8. Indicate any samples received in an inappropriate container

Submission of this form acknowledges acceptance of Exova's Standard Terms and Conditions (http://www.exova.com/about/terms-and-conditions/)

Please indicate any potentially hazardous samples

Page 1 of 1 Control # C 0049875

Lot: 1141309 COC

Shipping: COD Y/ N
and size of coolers
Temp. received: 7.5°C
Delivery Method:
Waybill:
Received by:

ED 120-02

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Report Transmission Cover Page

Bill To:	Village of Haines Junction	Project:	
Report To:	Village of Haines Junction	ID:	
	PO Box 5339	Name:	
	Haines Junction, YT, Canada	Location:	Haines Junction, Yukon
	Y0B 1L0	LSD:	
Attn:	Collin Kellio	P.O.:	
Sampled By:		Acct code:	
Company:	CK		

Lot ID: **1062491**
Control Number:
Date Received: Apr 2, 2015
Date Reported: Apr 8, 2015
Report Number: 2000181

Contact & Affiliation	Address	Delivery Commitments
Accounts Payable Village of Haines Junction	, PO Box 5339 Haines Junction, Yukon Territory Y0B 1L0 Phone: (867) 634-7100 Fax: null Email: vhj@yknet.ca	On [Lot Approval and Final Test Report Approval] send (Invoice) by Email - Single Report
Collin Kellio Village of Haines Junction	, PO Box 5339 Haines Junction, Yukon Territory Y0B 1L0 Phone: (867) 634-5322 Fax: null Email: waterworld-vhj@yknet.ca	On [Lot Verification] send (COA) by Email - Single Report On [Report Approval] send (Test Report, COC) by Email - Multiple Reports By Lot On [Report Approval] send (Test Report) by Email - Multiple Reports By Lot
Results Village of Haines Junction	, PO Box 5339 Haines Junction, Yukon Territory Y0B 1L0 Phone: (867) 634-5322 Fax: null Email: publicworks-vhj@yknet.ca	On [Report Approval] send (Test Report, COC) by Email - Multiple Reports By Lot On [Report Approval] send (Test Report) by Email - Multiple Reports By Lot

Notes To Clients:

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Analytical Report

Bill To:	Village of Haines Junction	Project:		Lot ID:	**1062491**
Report To:	Village of Haines Junction	ID:		Control Number:	
	PO Box 5339	Name:		Date Received:	Apr 2, 2015
	Haines Junction, YT, Canada	Location:	Haines Junction, Yukon	Date Reported:	Apr 8, 2015
	Y0B 1L0	LSD:		Report Number:	2000181
Attn:	Collin Kellio	P.O.:			
Sampled By:		Acct code:			
Company:	CK				

		Reference Number	1062491-1	1062491-2	1062491-3	
		Sample Date	Apr 01, 2015	Apr 01, 2015	Apr 01, 2015	
		Sample Time	09:03	09:30	09:45	
		Sample Location	Village of H.J.	Village of H.J.	Village of H.J.	
		Sample Description	pH2 treated	Well 3 Raw	Well 5 Raw	
		Matrix	Water	Water	Water	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Total						
Mercury	Total	mg/L	<0.00001	<0.00001	<0.00001	0.00001
Aluminum	Total	mg/L	<0.005	<0.005	0.012	0.005
Antimony	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Arsenic	Total	mg/L	0.0140	0.0131	0.0195	0.00005
Barium	Total	mg/L	0.0145	0.0243	0.0128	0.00005
Beryllium	Total	mg/L	<0.00005	<0.00005	<0.00005	0.00005
Bismuth	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Boron	Total	mg/L	0.081	0.064	0.108	0.002
Cadmium	Total	mg/L	<0.00001	<0.00001	<0.00001	0.00001
Calcium	Total	mg/L	9.30	13.8	3.82	0.05
Chromium	Total	mg/L	<0.0005	<0.0005	<0.0005	0.0005
Cobalt	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Copper	Total	mg/L	0.0043	0.0006	0.0005	0.0001
Iron	Total	mg/L	0.004	0.014	0.005	0.002
Lead	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Lithium	Total	mg/L	0.0007	0.0005	0.0008	0.0005
Magnesium	Total	mg/L	2.28	3.69	0.46	0.04
Manganese	Total	mg/L	<0.0010	0.0162	0.0011	0.001
Molybdenum	Total	mg/L	0.00652	0.00444	0.00754	0.00005
Nickel	Total	mg/L	<0.0002	<0.0002	0.0003	0.0002
Potassium	Total	mg/L	1.8	2.9	0.3	0.1
Selenium	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Silicon	Total	mg/L	10.7	10.8	10.8	0.02
Silver	Total	mg/L	<0.00005	<0.00005	<0.00005	0.00005
Sodium	Total	mg/L	43.2	28.9	58.2	0.1
Strontium	Total	mg/L	0.0899	0.124	0.0548	0.0001
Thallium	Total	mg/L	<0.00001	<0.00001	<0.00001	0.00001
Thorium	Total	mg/L	<0.00001	<0.00001	<0.00001	0.00001
Tin	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Titanium	Total	mg/L	<0.0005	<0.0005	<0.0005	0.0005
Uranium	Total	mg/L	0.00002	0.00002	0.00001	0.00001
Vanadium	Total	mg/L	<0.0001	<0.0001	0.0002	0.0001
Zinc	Total	mg/L	0.0097	0.0035	0.0013	0.0005
Zirconium	Total	mg/L	<0.0005	<0.0005	<0.0005	0.0005
Physical and Aggregate Properties						
Colour	True	Colour units	<5	<5	<5	5

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Analytical Report

Bill To:	Village of Haines Junction	Project:	
Report To:	Village of Haines Junction	ID:	
	PO Box 5339	Name:	
	Haines Junction, YT, Canada	Location:	Haines Junction, Yukon
	Y0B 1L0	LSD:	
Attn:	Collin Kellio	P.O.:	
Sampled By:		Acct code:	
Company:	CK		

Lot ID: **1062491**
Control Number:
Date Received: Apr 2, 2015
Date Reported: Apr 8, 2015
Report Number: 2000181

Reference Number	1062491-1	1062491-2	1062491-3
Sample Date	Apr 01, 2015	Apr 01, 2015	Apr 01, 2015
Sample Time	09:03	09:30	09:45
Sample Location	Village of H.J.	Village of H.J.	Village of H.J.
Sample Description	pH2 treated	Well 3 Raw	Well 5 Raw
Matrix	Water	Water	Water

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties - Continued						
Turbidity		NTU	<0.02	<0.02	<0.02	0.02
Routine Water						
Digestion			Lab filtered & preserved	Lab filtered & preserved	Lab filtered & preserved	
pH	at 25 °C		8.08	8.17	8.75	
Electrical Conductivity		µS/cm at 25 C	234	214	250	1
Calcium	Dissolved	mg/L	8.25	12.3	3.21	0.1
Iron	Dissolved	mg/L	0.013	0.011	<0.005	0.005
Magnesium	Dissolved	mg/L	2.10	3.48	0.42	0.1
Manganese	Dissolved	mg/L	<0.001	0.015	<0.001	0.001
Potassium	Dissolved	mg/L	1.7	2.7	0.3	0.1
Sodium	Dissolved	mg/L	40.9	27.4	54.5	0.1
Bicarbonate		mg/L	120	109	134	5
Carbonate		mg/L	<6	<6	<6	6
Hydroxide		mg/L	<5	<5	<5	5
T-Alkalinity	as CaCO3	mg/L	98	89	110	5
Chloride	Dissolved	mg/L	1.76	0.21	0.61	0.05
Fluoride	Dissolved	mg/L	0.20	0.18	0.23	0.01
Nitrate - N	Dissolved	mg/L	<0.01	0.05	<0.01	0.01
Nitrite - N	Dissolved	mg/L	<0.01	0.07	0.08	0.01
Nitrate and Nitrite - N	Dissolved	mg/L	<0.02	0.13	0.08	0.01
Sulfate (SO4)	Dissolved	mg/L	17.2	19.1	16.3	0.5
Hardness	as CaCO3	mg/L	29	45	10	5
Total Dissolved Solids	Calculated	mg/L	131	120	142	1
Ionic Balance	Dissolved	%	101	98.5	101	90-110

Approved by:

Randy Neumann, BSc
Vice President

Data have been validated by Analytical Quality Control and Exova's Integrated Data Validation System (IDVS).
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Methodology and Notes

Bill To:	Village of Haines Junction	Project:	
Report To:	Village of Haines Junction	ID:	
	PO Box 5339	Name:	
	Haines Junction, YT, Canada	Location:	Haines Junction, Yukon
	Y0B 1L0	LSD:	
Attn:	Collin Kellio	P.O.:	
Sampled By:		Acct code:	
Company:	CK		

Lot ID:	**1062491**
Control Number:	
Date Received:	Apr 2, 2015
Date Reported:	Apr 8, 2015
Report Number:	2000181

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
Alk, pH, EC, Turb in water (Surrey)	APHA	*	Alkalinity - Titration Method, 2320 B	07-Apr-15	Exova Surrey
Alk, pH, EC, Turb in water (Surrey)	APHA	*	Conductivity, 2510 B	07-Apr-15	Exova Surrey
Alk, pH, EC, Turb in water (Surrey)	APHA	*	pH - Electrometric Method, 4500-H+ B	07-Apr-15	Exova Surrey
Anions by IEC in water (Surrey)	APHA	*	Ion Chromatography with Chemical Suppression of Eluent Cond., 4110 B	07-Apr-15	Exova Surrey
Anions by IEC in water (Surrey)	APHA	*	Single-Column Ion Chromatography with Electronic Suppression, 4110 C	07-Apr-15	Exova Surrey
BC ICP-MS Total Metals in Water	US EPA	*	Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	06-Apr-15	Exova Edmonton
BC Trace Total Metals in Water	APHA	*	Inductively Coupled Plasma (ICP) Method, 3120 B	06-Apr-15	Exova Edmonton
Mercury Low Level (Total) in water (Surrey)	EPA	*	Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry, 245.7	07-Apr-15	Exova Surrey
Metals SemiTrace (Dissolved) in water (Surrey)	US EPA	*	Metals & Trace Elements by ICP-AES, 6010C	02-Apr-15	Exova Surrey
True Color in water (Surrey)	APHA	*	Spectrophotometric - Single Wavelength Method, 2120 C	07-Apr-15	Exova Surrey
Turbidity - Water (Surrey)	APHA	*	Turbidity - Nephelometric Method, 2130 B	07-Apr-15	Exova Surrey

** Reference Method Modified*

References

US EPA	US Environmental Protection Agency Test Methods
APHA	Standard Methods for the Examination of Water and Wastewater

Comments:

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Methodology and Notes

Bill To:	Village of Haines Junction	Project:	
Report To:	Village of Haines Junction	ID:	
	PO Box 5339	Name:	
	Haines Junction, YT, Canada	Location:	Haines Junction, Yukon
	Y0B 1L0	LSD:	
Attn:	Collin Kellio	P.O.:	
Sampled By:		Acct code:	
Company:	CK		

Lot ID:	**1062491**
Control Number:	
Date Received:	Apr 2, 2015
Date Reported:	Apr 8, 2015
Report Number:	2000181