

5.53 Whitehorse – City of Whitehorse Water Supply System

The City of Whitehorse is home to approximately 25,100 people (Yukon Bureau of Statistics 2016). The Whitehorse public water supply system serves water to the majority of Whitehorse residents by piped water distribution. The public water system is supplied from groundwater wells completed in the Riverdale Aquifer (formerly referred to as the Selkirk and Riverdale Aquifers). The City of Whitehorse water supply system is classified as a Large Public Drinking Water Supply System under the Yukon Drinking Water Regulations – Guidelines for Part I – Large Public Drinking Water Systems (YG 2007).

5.53.1 Data Compilation Methodology

Tetra Tech approached stakeholders including water system operators and owners to let them know the project was in progress and to request their assistance in compiling the most complete data set possible. Tetra Tech contacted the following proponents regarding data for the City of Whitehorse public water supply system:

- City of Whitehorse – Provided SWAPP (Summit Environmental 2013), gave approval for use of Tetra Tech data for the project, provided review comments for the final draft.
- YG Environmental Health – YG EHS was contacted for use of the 2012 LPDWS review report, verification of water treatment and to provide review comments and feedback throughout the project.

5.53.2 Hydrogeology

The Whitehorse public water supply wells are completed in overburden sand and gravel deposits of glaciofluvial origin. Wells in use include WW4, WW4N, WW5N, WW6, WW8, WW9 and WW10. The wells are completed in the Riverdale Aquifer with well clusters in two distinct areas:

- Wells WW8, WW9 and WW10 are completed in the southern area of Riverdale near the Chadburn Lake road. Tetra Tech understands that the majority of water supplied to the system is preferentially sourced from these three wells (p.c. Wayne Tuck 2017).
- Wells WW5N, WW4, WW4N and WW6 are completed along the Yukon River near the Selkirk Elementary School and F.H. Collins High school.

Lithology logs for the area indicate that there are some discontinuous fine-grained sediments overlying the aquifer in both wellfields; however, Tetra Tech considers the aquifer to be unconfined and vulnerable to surface sources of contamination.

As part of the 2012 LPDWSA of the Whitehorse water supply system, Tetra Tech assessed the vulnerability of the Riverdale Aquifer in the vicinity of the two well fields using the semi quantitative ISI method suggested by the Ontario Ministry of Environment (2001). The ISI method defines aquifers with ISI scores of less than 30 as having high intrinsic susceptibility to surface sources of contamination. The ISI method resulted in values in the high 20's at WW4 and WW6, an indication that the aquifer underlying the site has a relatively high vulnerability to potential surface sources of contamination. WW8 and WW9 had ISI values of 11 and 13, which also suggest high vulnerability to surface sources of contamination.

Tetra Tech understands that in 2016 wells WW1, WW2, and WW3 were decommissioned in accordance to the Canadian Groundwater Association Well Construction Guidelines for water well decommissioning to ensure they would not be a potential contaminant pathway in future. We also understand that the City plans to decommission well WW5 in 2017, and that WW4 will, in future, be replaced entirely by WW4N (p.c. L. Shipman 2017, p.c. Wayne Tuck 2017).

5.53.3 Summary of Wells

The well logs for the City of Whitehorse public supply wells are included in the GIS map and database produced for this project. The following tables summarize the completion characteristics of the City of Whitehorse wells.

Well Construction Parameters	Details	Source
Date of construction	Well was completed by International Water Supply Limited in March 1972	Tetra Tech 2012
Total well depth	21.3 m bgs	Summit 2013
Casing	12" ID (305 mm) Steel Well Casing with welded joints	Well Log
Casing depth	16.8 m bgs	
Well screen	3 m 77-slot (0.18 mm) and 1.5 m 6-slot (0.15 mm) v-wire well screen from 16.8 m bgs to 21.3 m bgs.	Summit 2013
Static water level	1.7 m bgs	Well Log
Sanitary seal	A sanitary seal was not installed at the time of well construction, and there are no records indicating that a seal has ever been installed.	Tetra Tech 2012
Wellhead completion	Housed in a heated pump house with a removable roof hatch which is located within a locked fence enclosure.	
Wellhead stickup	0.70 m ags	
Well rated capacity	30.2 L/s (398 IGPM)	GLL 2000
Well GUDI status	Non-GUDI	AECOM 2010a
Well Construction Comments:	As the well is not completed with a sanitary seal, the well was not constructed to meet Canadian Groundwater Association Well Construction Guidelines.	

Well Construction Parameters	Details	Source
Date of construction	Encore Coring & Drilling Inc. 2010	AECOM 2011a
Total well depth	36.7 m bgs	Well Log
Casing	16" OD (406 mm) steel well casing with welded joints	
Casing depth	27.1 m bgs	

Table 5-135: City of Whitehorse Public Drinking Water Supply, Well WW4N Summary		
Well Construction Parameters	Details	Source
Well screen	9.57 m 200-slot (5.08 mm) -wire well screen from 27.1 m bgs to 36.7 m bgs.	
Static water level	9.15 m bgs	AECOM 2011b
Sanitary seal	5.5 m bgs	AECOM 2011a
Wellhead completion	Well completed in a concrete vault with Bilco hatch, floor at ground level, walls 1.2 m ags, ground built up and sloped away at 2% grade. The wellhouse is located within a locked and fenced enclosure	p.c. L. Shipman 2017
Wellhead stickup	0.84 m ags	p.c. L. Shipman 2017
Well rated capacity	77 L/s (1,016 IGPM)	AECOM 2011b
Well GUDI status	Not assessed	
Well Construction Comments:	Well was constructed to meet Canadian Groundwater Association Well Construction Guidelines.	

Table 5-136: City of Whitehorse Public Drinking Water Supply, Well WW5N Summary		
Well Construction Parameters	Details	Source
Date of construction	Well was completed by Midnight Sun Drilling Co. Ltd. In September 2005	
Total well depth	45.2 m bgs	
Casing	16" (406 mm) Steel Well Casing with welded joints	Well Log
Casing depth	36.1 m bgs	
Well screen	9.1 m 200 slot (5.08 mm) v-wire well screen from 36.1 m bgs to 45.2 m bgs.	
Static water level	3.99 m bgs (October 27, 2005)	
Sanitary seal	Surface seal to 3.35 m bgs	Summit 2013
Wellhead completion	Housed in a heated pump house with a removable roof hatch which is located within a locked fence enclosure	Tetra Tech 2012
Wellhead stickup	0.9 m ags	Tetra Tech 2012
Well rated capacity	168 L/s (2,200 IGPM)	GLL 2006

Table 5-136: City of Whitehorse Public Drinking Water Supply, Well WW5N Summary

Well Construction Parameters	Details	Source
Well GUDI status	Non-GUDI	AECOM 2010a
Well Construction Comments:	Well was not constructed to meet Canadian Groundwater Association Well Construction Guidelines as the surface seal was not completed to the recommended depth of 5.0 m bgs.	

Table 5-137: City of Whitehorse Public Drinking Water Supply, Well WW6 Summary

Well Construction Parameters	Details	Source
Date of construction	1974	Summit 2013
Total well depth	26.2 m bgs	
Casing	16" (406 mm) OD steel well casing with welded joints (15 1/4" / 378 mm ID)	Well Log
Casing depth	19.2 m bgs	
Well screen	6.2 m 200 slot (5.08 mm) v-wire well screen from 20.4 m bgs to 26.6 m bgs	
Static water level	8.9 m bgs (August 2009)	Tetra Tech 2012
Sanitary seal	A sanitary seal was not installed at the time of well construction. A silty, sandy barrier was installed around the perimeter of the wellhouse.	Tetra Tech 2012 City of Whitehorse 2016
Wellhead completion	Housed in a heated pump house located within a locked fence enclosure. Site grading was completed in 2016 to prevent water ponding around well building.	Tetra Tech 2012
Wellhead stickup	0.60 m ags	
Well rated capacity	90.9 L/s (1,200 IGPM)	GLL 2005
Well GUDI status	Non-GUDI; however it was recommended that ongoing monitoring related to GUDI status be completed.	AECOM 2010a, Summit 2013, Tetra Tech 2013
Well Construction Comments:	As the well is not completed with a sanitary seal, the well was not constructed to meet Canadian Groundwater Association Well Construction Guidelines.	

Table 5-138: City of Whitehorse Public Drinking Water Supply, Well WW8 Summary

Well Construction Parameters	Details	Source
Date of construction	Completed by Encore Coring & Drilling Inc. in October 2008.	Tetra Tech 2009
Total well depth	27.4 m bgs	
Casing	16" (406 mm) Steel Well Casing	
Casing depth	21.6 m	
Well screen	1.5 m 60 slot (1.52 mm) from 22.7 m bgs to 24.2 m bgs, 3.2 m 200 slot (5.08 mm) v-wire well screen from 24.2 m bgs to 27.4 m bgs. The total screen length is 4.7 m.	
Static water level	6.1 m bgs (November 3, 2008)	
Sanitary seal	Surface seal to 5.8 m bgs	
Wellhead completion	Housed in a heated pump house with a removable roof hatch which is located within a locked fence enclosure	Tetra Tech 2012
Wellhead stickup	0.80 m ags	Tetra Tech 2009
Well rated capacity	72.9 L/s (962 IGPM)	
Well GUDI status	Non-GUDI	AECOM 2010b
Well Construction Comments:	Well was constructed to meet Canadian Groundwater Association Well Construction Guidelines.	

Table 5-139: City of Whitehorse Public Drinking Water Supply, Well WW9 Summary

Well Construction Parameters	Details	Source
Date of construction	Completed by Encore Coring & Drilling Inc. in October 2008	Tetra Tech 2009
Total well depth	29.0 m bgs	
Casing	16" (406 mm) Steel Well Casing	
Casing depth	20.6 m bgs	
Well screen	2.4 m 60 slot (1.52 mm) from 21.7 m bgs to 24.2 m bgs, 1.5 m 120 slot (3.05 mm) from 24.2 m bgs to 25.8 m bgs, 1.5 m 150 slot (3.81 mm) v-wire well screen from 25.8 m bgs to 27.4 m bgs; 1.5 m 20 slot (0.51 mm) screen from 27.4 m bgs to 29 m bgs. The total screen length is 7.3 m.	

Table 5-139: City of Whitehorse Public Drinking Water Supply, Well WW9 Summary

Well Construction Parameters	Details	Source
Static water level	5.7 m bgs (November 7, 2008)	
Sanitary seal	12.1 m bgs	
Wellhead completion	Housed in a heated pump house with a removable roof hatch which is located within a locked fence enclosure.	Tetra Tech 2012
Wellhead stickup	0.75 m ags	
Well rated capacity	78.7 L/s (1,039 IGPM)	Tetra Tech 2009
Well GUDI status	Non-GUDI	AECOM 2010b
Well Construction Comments:	Well was constructed to meet Canadian Groundwater Association Well Construction Guidelines.	

Table 5-140: City of Whitehorse Public Drinking Water Supply, Well WW10 Summary

Well Construction Parameters	Details	Source
Date of construction	Completed by Midnight Sun Drilling Ltd. in 2014	Morrison Hershfield 2015
Total well depth	62.2 m bgs	
Casing	16" (406 mm) OD Steel Well Casing with welded joints	Well Log
Casing depth	52.93 m bgs	
Well screen	9.14 m 150 slot (3.81 mm) v-wire well screen from 53.9 m bgs to 63.04 m bgs	
Static water level	7.32 m bgs (September 7, 2014)	Morrison Hershfield 2015
Sanitary seal	5 m bgs	
Wellhead completion	Housed in a heated pump house with a removable roof hatch which is located within a locked fence enclosure	p.c. L. Shipman 2017
Wellhead stickup	0.80 m ags	Morrison Hershfield 2015
Well rated capacity	163 L/s (2,151 IGPM)	
Well GUDI status	Not assessed	
Well Construction Comments:	Well was constructed to meet Canadian Groundwater Association Well Construction Guidelines.	

5.53.4 Source Water Quality

Tetra Tech reviewed the water quality summary from the Summit Environmental SWAPP as well as the most recent water quality results from City of Whitehorse 2016 monitoring. City of Whitehorse conducts ongoing monitoring for a number of water quality parameters, and Tetra Tech has not completed a comprehensive review of these results.

Based on a review of the water quality data from 2008 and 2010 included in the SWAPP, as well as the 2016 water quality results, Tetra Tech makes the following observations:

- The samples met the GCDWQ for all parameters tested.
- The water chemistry differs between the two wellfield areas of Riverdale. Water from Wells WW8 and WW9, in the south Riverdale area, is calcium-bicarbonate type is considered medium hard with measured hardness between 68 mg/L and 77 mg/L (as CaCO₃), while water from wells WW4, WW5N, and WW6, located near the Selkirk Elementary School, is calcium-sulphate to calcium-bicarbonate type and is considered hard to very hard with a measured hardness of 143 mg/L to 220 mg/L (as CaCO₃). Water samples from wells in the Selkirk Well Field (WW4, WW5N, and WW6) have higher chloride concentrations than wells in the South Riverdale Well Field (WW8 and WW9).
- Chloride concentrations in all of the results observed were far below the GCDWQ AO of 250 mg/L with concentrations varying from <0.05 to 3.0 mg/L in 2016; and,
- Nitrate concentrations in the wells varied between testing events with a range of about 0.03 mg/L to 0.13 mg/L. All the nitrate concentrations measured in the results reviewed were well below the GCDWQ guideline value of 10 mg/L.

5.53.5 Water Treatment and Distribution

The table below summarizes the characteristics of the City of Whitehorse Public Drinking Water Supply System.

Item	Details	Source
Owner/Operator	City of Whitehorse	Tetra Tech 2012
Water source	Groundwater	
Wells serving the system	WW4, WW4N, WW5N, WW6, WW8, WW9 and WW10	Summit 2013
Treatment type	Chlorination	YES 2012
Population served by System	Approximately 23,500 people	City of Whitehorse (Population of 26,608 minus residents in country residential)
Delivery method	Piped Distribution	YES 2012
Age of system/last known update	New water wells completed in 2010 and 2014	AECOM 2010, Morrison Hershfield 2014

5.53.6 Source Water Protection Planning

A source water protection plan (SWAPP) for the Riverdale Aquifer was developed by Summit Environmental on behalf of the City of Whitehorse in 2013. Summit Environmental followed the methodology laid out by the British

Columbia Ministry of Healthy Living and Sport Comprehensive Source-To-Tap Assessment Guideline (STTAG) to prepare the Source Water Assessment and Protection Plan for the City of Whitehorse water supply. Modules 3, 4, 5 and 6 of the BC STTAG, which apply to the engineering and governance of the water supply, were not addressed by the plan.

The capture zones for the Whitehorse water supply wells were characterized using the Numerical Flow Modelling Technique in 2011 by AECOM, and are indicated on the associated GIS map. Summit used the capture zones delineated by the numerical modelling to define aquifer protection areas. As part of the source water protection planning, Summit Environmental identified potential sources of contamination in the vicinity of the City of Whitehorse water supply wells. From the 2013 SWAPP, the following are noted:

- The air photos indicate that potential contamination sources associated with residential and business land use date back to about the 1950s;
- Records review search identified eight contaminated sites, two spills and three permitted fuel storage tanks within the primary and secondary Aquifer Protection Areas (APAs);
- Biological insecticides have been used around the City of Whitehorse. The most commonly used brands are Aquabac and Vectobac. These use a subspecies of the bacteria *Bacillus thuringiensis* (Bt) to limit the mosquito populations. There is low potential for these bacteria to infiltrate into the groundwater, so their risk is not discussed further;
- The area within the primary and secondary APAs is zoned by the City as residential (single detached and multiple housing), neighbourhood commercial, environmental protection, greenbelt, parks and recreation and public utilities. These zones typically pose low to moderate environmental concerns; and
- One significant conclusion from this work was the identification of 58 wells and/or boreholes in the study area. These provide preferential pathways to the groundwater aquifer and rarely have basic security (i.e., locked well caps and surface seals).

Key conclusions and recommendations from the SWAPP for Whitehorse include:

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

Tetra Tech notes that the following recommendations from the SWAPP have been implemented:

- The City of Whitehorse has placed signage indicating the location of the Riverdale Source Water Area;
- City of Whitehorse has a public awareness campaign addressing source water protection underway.

In addition to the current additional source water protection measures, City of Whitehorse is considering the best way to address fuel storage in the source water protection area and is in the process of compiling water quality data to allow for analysis of changes and trends in water quality (p.c. Wayne Tuck 2017).

5.53.7 Water Supply Information Data Gaps

Tetra Tech has reviewed available data from YG Community Services, and data provided by the City of Whitehorse, as well as records kept by YG Environmental Health Services. At this time, Tetra Tech has not identified any significant data gaps related to the scope of this study. Tetra Tech understands that City of Whitehorse are working towards addressing the recommendations in the SWAPP to improve protection of the drinking water resource.