5.55 Whitehorse Area - Deep Creek Water Supply System

The Deep Creek water system is located approximately 45 km north of Whitehorse, Yukon and provides a self-serve potable water source to residents in the area, including Deep Creek and Grizzly Valley subdivisions, residents of the Ta'an Kwach'an First Nation (TKFN) and Horse Creek (Service Area). Water for the self-serve system is sourced from a bedrock well and the water treatment includes filtration and chlorine disinfection. The small self-serve system is governed under the Sections 12.1 (a) and (b) and 17 of the Public Health and Safety Act and Section 5 of the Public Health Regulations (C.O. 1958/079, O.I.C. 2009/194), which require safety measures and inspection for water and water sources for systems that provide water for human consumption.

5.55.1 Data Compilation Methodology

Tetra Tech approached stakeholders including YG departments, 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. Through the process of compiling the data, Tetra Tech obtained data regarding the Deep Creek Water Supply system from the following proponents:

- YG Community Services (the client) – YG CS provided data for the Deep Creek Water Supply as this system is owned and operated by YG CS. The YG CS operator provided review comments and edits for the final summary to ensure completeness and accuracy.

5.55.2 Hydrogeology

The Deep Creek area has undergone several episodes of glaciation, the most recent being the Quaternary McConnell glaciation. The topography and surficial geology of the Deep Creek area have been heavily influenced by glacial erosion and deposition (Tetra Tech 2014a).

The surficial geology in the Deep Creek area is characterized by both outcropping bedrock and glacial deposits. Glacial deposits are varied, including till, valley bottom complexes composed of alluvial, colluvial and glacial deposits, meltwater channels and glaciofluvial complexes (Tetra Tech 2014a). The bedrock is comprised of sedimentary members of the lower to middle Jurassic Laberge Group (around 160 to 200 myo) and Lower Jurassic Nordenskjold Group (around 175 to 200 myo). Laberge Group rock types in the study area are mapped as sedimentary rock, with interbedded mudstones, siltstones and sandstones and a conglomerate member. Nordenskjold Group rock types occurring in this area are mapped as sedimentary rocks with volcanic beds, dacite, tuff, sandstone, and conglomerate. Rock types encountered during drilling were members of the Laberge group (Tetra Tech 2014a).

Available logs of wells in the Deep Creek region show bedrock at depths typically between 4.5 m and 17 m, although bedrock outcropped at two well locations (Tetra Tech 2014a). In the Deep Creek region, bedrock was typically overlain by gravelly clay/silt (inferred to be till) with gravel or sand logged at surface in several logs (Tetra Tech 2014a).

The regional groundwater flow regime is interpreted to consist of groundwater recharging via infiltration in the upland areas to the west of DC-2 and groundwater discharging into Deep Creek and Lake Laberge (Tetra Tech 2014a). The regional groundwater flow direction was interpreted to be in an east, northeast direction, which generally corresponds to topography (Tetra Tech 2014a).

The water supply well, DC-2, is completed in the deep confined or semi confined bedrock aquifer (Tetra Tech 2014a). Water-bearing fractures were encountered at DC-2 location between 54.3 m and 121.0 m bgs (Tetra Tech 2014a). Some protection of the aquifer from surface sources of contamination is provided by overburden sediments to 10.5 m below grade, and a thick layer of competent bedrock extending from 17.1 m bgs to the first water bearing

fracture at 54.3 m bgs (Tetra Tech 2014a). The thick competent bedrock layer and properly constructed well completed with a sanitary seal and a bedrock seal decreases the potential for surface water and surface sources of contamination to infiltrate though and impact the water supply at DC-2 (Tetra Tech 2014a).

Well yields from fractured bedrock aquifers can be highly variable and are dependent upon the degree of fracturing and fracture connectivity. Pumping test results from DC-2 indicate a bulk aquifer transmissivity in the order of 7.5×10-5 m^2/s (6.5 m^2/day) (Tetra Tech 2014a).

5.55.3 Well Summary

Well log for DC-2 serving the new Deep Creek Water Supply Facility is included in the GIS map and database. The following tables summarize the completion characteristics of the well.

Table 5-148: Deep Creek Water Supply System, Well DC-2 Summary

Well Construction Parameters	Details	Source
Date of construction	Well was completed by Midnight Sun Drilling Inc. in January 2014	Well log
Total well depth	122.5 m bgs	
Casing	6" (152 mm) ID Steel Well Casing	
Casing depth	17.1 m bgs (approximately 3.4 m into bedrock)	
Well screen	No well screen installed. However, 5” (127 mm) nominal diameter PVC liner was installed to 121.0 m bgs, with slotted section (20 slots; 0.51 mm) from 67.7 m bgs to 122.5 m bgs.	Tetra Tech 2014a
Static water level	6.70 m bgs (January 18, 2014)	
Sanitary seal	Bentonite surface seal to 6.1 m bgs	Tetra Tech 2014b
Wellhead completion	Pitless unit installed c/w heat trace strapped to the top of the well. Spray foam insulation on pitless unit	Tetra Tech 2014b
Wellhead stickup	0.89 m ags	Tetra Tech 2014a
Well rated capacity	1.6 L/s (621 IGPM)	
Well GUDI status	Non-GUDI	
Well Construction Comments:	Well was constructed to meet Canadian Groundwater Association Well Construction Guidelines.	

5.55.4 Source Water Quality

Tetra Tech collected a groundwater sample from DC-2 at the end of the 48-hour constant-rate pumping test conducted in January 2014 and the following are the key observations and comments noted on the water quality (Tetra Tech 2014a):

- Based on analytical results from the sample collected at DC-2 on January 21, 2014, the water quality results meet the GCDWQ for all parameters tested, except for TDS, iron and hardness, which exceeded AO. When compared to the water quality encountered at test well DC-1, the key water quality design parameters are very similar;
- The total dissolved concentrations of iron, manganese, calcium and magnesium (hardness) contribute to the high TDS;
- Water from DC 2 is hard, with a harness of 433 mg/L (as CaCO3). Residents using water with high hardness face issues with scaling of plumbing features and more soap/detergent is required for washing;
- Sample results for radiological parameters were above the GCDWQ for gross alpha (0.74 Bq/L), but below the GCDWQ for gross beta. Further analysis was recommended to determine the concentration of radium-226 radionuclides, as radium has the most stringent MAC of radiological parameters contributing to the gross alpha concentration. The resulting concentration in DC-2 was below the detection limit (<0.05 Bq/L). Because this result is below the guideline for radium-226 (0.2 Bq/L), the source of the gross alpha remains unknown. However, all other species that contribute to the gross alpha have much higher MACs (greater than 5 Bq/L). As the concentration of the radium-226 was below the detection limit and the total gross alpha concentration does not exceed any MAC for individual species potentially contributing to the concentration of gross alpha, these results confirm that there are no exceedances of any radiological parameters in the samples collected from DC 2;
- The concentration of total THM was 0.023 mg/L, which is below the MAC of 0.1 mg/L; and,
- All hydrocarbons analysed were below detection limit and in consideration with the other water quality data (metals, nutrients) there was no indication of impact of the former landfill on the water quality from the test well (as expected given the distance and the Creek flow divide between the well and the dump site);

Tetra Tech did not review recent water quality data but understands water chemistry analysis is completed at this system annually and bacteriological monitoring is completed on a regular basis with results sent to YG EHS for review.

5.55.5 Water Treatment and Distribution

Table 5-149: Deep Creek Water Supply System Treatment and Distribution Details

Item	Details	Source
Owner/Operator	Government of Yukon	Tetra Tech 2014a
Water source	Groundwater	
Wells serving the system	Well DC-2	
Treatment type	Pressure filtration, greensand filtration and chlorination	Urban Systems 2014 p.c. Steve Perrin 2017
Number of connections	Deep Creek and Grizzly Valley subdivisions, and residents of the Ta'an Kwach'an First Nation (TKFN) and Horse Creek	Tetra Tech 2014b p.c. Steve Perrin 2017

Table 5-149: Deep Creek Water Supply System Treatment and Distribution Details		
Item	**Details**	**Source**
Delivery method	Self-serve fill station including blue jug fill, 2" pickup truck fill and 4" fire suppression fill point	
Age of system/last known update	The new Facility was recently completed in 2014	Tetra Tech 2014c p.c. Steve Perrin 2017

5.55.6 Source Water Protection Planning

A risk-based Aquifer and Wellhead Protection Plan (AWPP) has been completed for DC-2. The AWPP includes capture zones of varying vulnerability for DC-2 which consists of three zones (Zones 1, 2 and 3). The capture zones were determined based on several assumptions including Deep Creek being considered a natural groundwater flow boundary, topography being considered to estimate a logical maximum width of the watershed and capture zone and two scenarios of groundwater transport in the bedrock aquifer (Tetra Tech 2014a). Zone 1 is the sanitary zone immediately around the wellhead with a capture zone within a 90 day travel time. Zone 2 is the capture zone within 90 day to one year travel time and Zone 3 is the capture zone within one year to seven year travel time (Tetra Tech 2014a). Based on the findings of the 2014 AWPP, Tetra Tech made the following conclusions:

- There has been no identified contamination in groundwater sampled from DC-2 at the time of the study;
- There are no known sources of contamination in the well capture zones at the time of the study;
- Any release of contaminants within the identified capture zone would represent a potential risk to the aquifer and water quality of the Deep Creek Water Supply Facility;
- The highest risks to DC-2 are from potential spills or releases within the capture zone areas up-gradient of DC 2;
- Risk reduction strategies to be considered include the following:
  - Prevent future development (with the exception of the water treatment plant) within Zones 1 and 2;
  - Ensure proper grading away from the wellhead;
  - Prohibit higher risk (commercial and industrial) development in the capture zones (Zone 1 to 3);
  - Do not have on-site sewage disposal or fuel storage at the water treatment plant;
  - Develop and implement an Emergency Response Plan; and
  - Community engagement and education regarding Best Management Practices for fuel storage and septic disposal in Zone 3;
- Risk monitoring, which includes periodic inspections of the DC-2 wellhead and the capture zones for new AWPP hazards, working together with the community of Deep Creek to identify and create zoning by-laws and updating the status of risks, is recommended and should be implemented as part of the Risk Monitoring Plan for the AWPP.

The AWPP is a living document which should be updated based on activities around the community wells that might result in additional risks, or when risks have been addressed. Tetra Tech understands that YG CS is in the process of implementing the recommendations from the AWPP including the development of an ERP which is currently underway.

5.55.7 Water Supply Information Data Gaps

Tetra Tech has received review comments regarding this system from YG CS and we believe the summary to be complete and accurate to March 2017.