

5.19 Dawson City - Water Supply System

The City of Dawson (CoD) was established in the late 1800s at the confluence of the Yukon and Klondike Rivers during the Yukon Gold Rush. Industrial activity in the area has included riverboat transport, placer gold mining in the Klondike River Valley and industrial services to the community and ongoing placer operations including repair shops and heavy equipment operation in the surrounding watershed.

CoD owns and operates a public water supply system providing domestic water to the residents of Dawson City. The system has water sourced from four water supply wells, PW-1N, PW-2N, PW-3N and PW-4N that provide water in a common raw water main to a water treatment plant where it is chlorinated and stored prior to distribution via a piped distribution network or by bulk truck delivery. The system, which serves approximately 2,075 residents of Dawson City (Yukon Bureau of Statistics September 2015), is considered a LPDWS under the Yukon Drinking Water Regulations – Guidelines for Part I – Large Public Drinking Water Systems (YG 2007).

5.19.1 Data Compilation Methodology

Tetra Tech approached CoD water supply stakeholders including the CoD water system operators and owners, YG Community Services and YG Environmental Health Services to request their assistance in compiling the most complete data set possible. Through the process of compiling the data, Tetra Tech has had communication with the following parties regarding the City of Dawson Water Supply System:

- City of Dawson – Provided the majority of data for this summary including data for wells PW-1N through PW-4N and the planned new water treatment plant.
- YG Community Services (the client) – YG CS provided data for recent upgrades to the City of Dawson Water Supply System.
- YG Environmental Health – YG EHS was contacted and assisted with confirming the data compiled for the COD water supply system.

5.19.2 Hydrogeology

Dawson City is located on a low-lying alluvial terrace at the confluence of the Klondike and Yukon Rivers. The sedimentary deposits comprise of discontinuous permafrost, with unfrozen sand and gravel sediments found near the mouth of the Klondike River in the southern end of the City and ice rich, organic sediments found in the northern portion (MH 2014).

A shallow water table aquifer (the Dawson City Aquifer (DCA)) exists under parts of the town where sand and gravel deposits are unfrozen in close proximity to the Yukon and Klondike Rivers. The DCA is inferred to be hydraulically connected to the Klondike and Yukon Rivers and the majority of recharge to the DCA is interpreted to be via horizontal infiltration of surface water from these water bodies. To a lesser extent, recharge is expected through vertical infiltration of surface water throughout the city area and on the slopes of the Midnight Dome, and there may be some upwards discharge from the underlying bedrock to the DCA. Little to no horizontal groundwater flow into the DCA is expected from the frozen zones to the north and east. Discharge from the DCA is ultimately to the Yukon River. General groundwater flow direction is inferred to be in a west to northwesterly direction from the Klondike River, through the course sedimentary deposits towards the Yukon River and is bounded to the west and north by the effectively impermeable permafrost boundary.

The four CoD production wells are located in the area between Front Street and the Yukon River, in the general vicinity of the Commissioner's residence. The wells were completed in the shallow unconfined aquifer consisting of native sands and gravels. Under pumping conditions, the DCA flow regime is much the same, however in the vicinity

of the four wells, the hydraulic gradient towards the Yukon River is reversed and flow is induced from the river towards the pumping wells.

While, geographically, the four wells are inferred to draw a significant proportion of their water directly from the Yukon River, review of aerial images indicates that under high water levels, water from the Klondike River flows almost mid-way across the Yukon River and water from the two rivers does not appear to be mixing until several hundred metres past the wells. Under low river level conditions, a gravel bar at the confluence of the two rivers is exposed to approximately mid-way across the Yukon River. The bar diverts Yukon River flow to the west and away from the wells, while the Klondike River flows along several channels, one aligned directly past the wells. Given these observations, it is inferred that the majority of water pumped by the wells from the Yukon River is likely sourced from the Klondike River and is representative of Klondike River water quality. Based on this reasoning, there is considered to be little to no contribution from Yukon River water (i.e. water sourced from upstream of the confluence) to any of the four water supply wells. Based on the modelled capture zone, approximately 90% of water pumped by the wells is drawn from the Yukon River while approximately 5% of water is drawn from the capture zone extending to the east and south and ultimately from the Klondike River (Tetra Tech 2017); however, due to lack of mixing at the confluence of the two rivers, the 90% drawn from the Yukon River is expected to essentially have the same water quality as the Klondike River. The remaining 5% is sourced from recharge to the DCA from surface water, lateral flow of perched groundwater from the adjacent permafrost zone and discharge from underlying bedrock.

As part of the well completion reporting for the Dawson community wells, Morrison Hershfield completed an analysis of the vulnerability of the wells and aquifer based on the semi-quantitative ISI (Ontario Ministry of Environment 2001). The ISI score for the shallow, unconfined aquifer was found to be between 5.6 and 6.0. The OME 2001 ISI method defines aquifers with scores of less than 30 as having high intrinsic susceptibility to surface sources of contamination. The calculated ISI scores therefore suggest that the DCA at the location of the water supply wells has a high vulnerability to surface-based contamination. A high ISI is to be expected given the permeable nature of the sand and gravel that overly the aquifer.

5.19.3 Summary of Wells

There are four wells (PW-1N through PW-4N) supplying the COD LPDWS that have been in service since October 2015. Logs for these four wells are included in the GIS map and database attached. The three former CoD water supply wells (PW-1, PW-2 and PW 3) located in the vicinity of the current water supply wells were decommissioned in 2016 and another former CoD water supply well PW-4 (YEC-Well), a dug well adjacent to the Klondike River and close to the end of Fifth Ave, was decommissioned in 2015 (p.c. Geoff Quinsey 2017). All four old water supply wells are believed to have been decommissioned in conformance with the Canadian Ground Water Association Guidelines for Water Well Construction (p.c. Geoff Quinsey 2017). The following tables summarize the completion characteristics of the current water supply wells.

Well Construction Parameters	Details	Source
Date of construction	The well was completed by Midnight Sun Drilling Ltd. in July 2014	MH 2014
Total well depth	20.1 m bgs	
Casing	15 3/16" (386 mm) ID Steel Well Casing	
Casing depth	16.4 m bgs	

Table 5-45: City of Dawson, Well PW-1N Summary

Well Construction Parameters	Details	Source
Well screen	3.3 m 120 slot (3.05 mm) stainless steel well screen exposed from approximately 16.87 m bgs to 20.1 m bgs	
Static water level	6.3 m bgs (314.151 m asl) (July 28, 2014)	
Sanitary seal	Bentonite surface seal to 5 m bgs	
Wellhead completion ¹	Pitless unit with vented well cap. Wellhead in locked, heated enclosure.	
Slab Elevation (m asl) ²	320.740	
Top of Casing Elevation (m asl) ²	321.291	
Wellhead stickup	0.551 m ag ³	MH 2014
Well rated capacity	37 L/s (488 IGPM)	Stantec 2013
Inferred well GUDI status	GUDI	
Well Construction Comments:	Well was constructed to meet Canadian Groundwater Association Well Construction Guidelines.	

¹ Observations by Tetra Tech during February 2017 inspection. ² Elevations surveyed by Underhill Geomatics in February 2017.

Table 5-46: City of Dawson, Well PW-2N Summary

Well Construction Parameters	Details	Source
Date of construction	The well was completed by Midnight Sun Drilling Ltd. in July 2014	
Total well depth	18.8 m bgs	
Casing	15 3/16" (386 mm) ID Steel Well Casing	
Casing depth	15.1 m bgs	MH 2014
Well screen	3.4 m 120 slot (3.05 mm) stainless steel well screen exposed from 15.4 m bgs to 18.8 m bgs	
Static water level	6.0 m bgs (July 22, 2014)	
Sanitary seal	Bentonite surface seal to 5 m bgs	
Wellhead completion ¹	Pitless unit with vented well cap. Wellhead in locked, heated enclosure.	
Slab Elevation (m asl) ²	320.628	Tetra Tech 2017
Top of Casing Elevation (m asl) ²	321.139	
Wellhead stickup	0.511 m ag	MH 2014
Well rated capacity	41 L/s (541 IGPM)	Stantec 2013

Table 5-46: City of Dawson, Well PW-2N Summary

Well Construction Parameters	Details	Source
Inferred well GUDI status	GUDI	
Well Construction Comments:	Well was constructed to meet Canadian Groundwater Association Well Construction Guidelines.	

¹ Observations by Tetra Tech during February 2017 inspection. ² Elevations surveyed by Underhill Geomatics in February 2017.

Table 5-47: City of Dawson, Well PW-3N Summary

Well Construction Parameters	Details	Source
Date of construction	The well was completed by Midnight Sun Drilling Ltd. in July 2014	
Total well depth	18.2 m bgs	
Casing	15 3/16" (386 mm) ID Steel Well Casing	
Casing depth	14.5 m bgs	MH 2014
Well screen	3.4 m 120 slot (3.05 mm) stainless steel v-wire screen exposed from approximately 14.8 m bgs to 18.2 m bgs	
Static water level	5.09 m bgs (314.41 m asl) (July 26, 2014)	
Sanitary seal	Bentonite surface seal to 5 m bgs	
Wellhead completion ¹	Pitless unit with vented well cap. Wellhead in locked, heated enclosure.	
Slab Elevation (m asl) ²	320.566	
Top of Casing Elevation (m asl) ²	321.116	
Wellhead stickup	0.55 m ag	
Well rated capacity	42 L/s (554.5 IGPM)	MH 2014 Stantec 2013
Inferred well GUDI status	GUDI	
Well Construction Comments:	Well was constructed to meet Canadian Groundwater Association Well Construction Guidelines.	

¹ Observations by Tetra Tech during February 2017 inspection. ² Elevations surveyed by Underhill Geomatics in February 2017.

Table 5-48: City of Dawson, Well PW-4N Summary

Well Construction Parameters	Details	Source ¹
Date of construction	The well was completed by Midnight Sun Drilling Ltd. in July 2014	MH 2014
Total well depth	19.0 m bgs	
Casing	15 3/16" (386 mm) ID Steel Well Casing	
Casing depth	15.3 m bgs	
Well screen	3.4 m 120 slot (3.05 mm) stainless steel v-wire screen exposed from 15.6 m bgs to 19.0 m bgs	
Static water level	5.7 m bgs (314.51 m asl) (July 27, 2014)	
Sanitary seal	Bentonite surface seal to 5 m bgs	
Wellhead completion ¹	Pitless unit with vented well cap. Wellhead in locked, heated enclosure.	
Slab Elevation (m asl) ²	320.639	
Top of Casing Elevation (m asl) ²	321.154	
Wellhead stickup	0.515 m ag	MH 2014 Stantec 2013
Well rated capacity	45 L/s (591 IGPM)	
Inferred well GUDI status	GUDI	
Well Construction Comments:	Well was constructed to meet Canadian Groundwater Association Well Construction Guidelines.	

¹ Observations by Tetra Tech during February 2017 inspection. ² Elevations surveyed by Underhill Geomatics in February 2017.

5.19.4 Source Water Quality

Source water quality was tested upon completion of the four CoD water supply wells in 2014 and the analytical results met the GCDWQ for the aesthetic and health related parameters analyzed (MH 2014). Based on these water quality results the following observations can be made:

- The water from the four wells is of similar quality and derived from the same aquifer.
- Water from the City of Dawson production wells can be classified as calcium-sulphate type and considered hard, with hardness in the initial samples ranging from 149 mg/L to 168 mg/L (MH 2014).
- This water chemistry is similar to that observed in the previous production wells and suggests that the Dawson City Aquifer water quality is relatively consistent.
- As the City of Dawson wells are classified as GUDI, Health Canada requires that water from GUDI sources have appropriate filtration and disinfection. Filtration is expected to achieve a turbidity level of 1.0 NTU for slow sand or diatomaceous earth filtration, 0.3 NTU for conventional direct filtration and 0.1 NTU for membrane filtration in 95% of samples between filter changes or per month with no measurements exceeding 3.0 NTU. We understand that a new water treatment plant is currently being designed and is scheduled for construction in 2019.

5.19.5 Water Treatment and Distribution

Table 5-49: City of Dawson Water Treatment and Distribution Details		
Item	Details	Source
Owner/Operator	City of Dawson	
Water source	Groundwater under the influence of Surface Water	MH 2014
Wells serving the system	Wells PW-1N, PW-2N, PW-3N, and PW-4N	MH 2014
Treatment type	Water is disinfected through a gas chlorination feed system. The chlorine gas dosage is manually controlled and adjusted and residual free chlorine is monitored manually by the operator once a day. After chlorine application, the treated water is stored in two reservoirs (storage capacity of 961 m ³ and 1,352 m ³ respectively), where an uncontrolled contact time is provided before water is pumped into the distribution system. Increasing chlorine concentration in water supply from 0.4 mg/L to 0.6 mg/L following detection of biological contaminant in raw water supply.	Stantec 2013
Number of connections	700 (and approximately 1375 people)	Stantec 2013; Yukon Bureau of Statistics 2016
Bleeding	Water is bled through the system during cold months to prevent freezing.	p.c. Louis Gerberding 2017
Delivery method	Piped and Trucked	Stantec 2013
Age of system/last known update	New wells in 2014	p.c. Louis Gerberding 2017
Planned Upgrades	New Water Treatment Plant in the planning stages, which will be equipped with filtration as well as UV and chlorine disinfection	p.c. Louis Gerberding 2017

5.19.6 Source Water Protection Planning

City of Dawson is currently in the process of completing an AWPP with support from Tetra Tech and project management from YG Community Services. The AWPP is due to be completed in summer 2017.

A key first step of an AWHPP is to define the well capture zones. Tetra Tech (2017) used a finite difference numerical model of the Dawson City hydrogeological regime to assist in the delineation of the capture zone of the four CoD water supply wells. A copy of the modeling technical with appended figures showing the modelled capture zones is included in the GIS database.

Preliminary findings from the AWHPP work to date are:

- The primary water source for the four water supply wells is the Yukon River (approximately 90%) with approximately 5% sourced from the Klondike River; however, the water quality in the portion drawn from the Yukon River is expected to be essentially the same as the Klondike River water. Approximately 5% is sourced

from recharge to the DCA from surface water, lateral flow of perched groundwater from the adjacent permafrost zone and discharge from underlying bedrock.

- The well capture zones are presented in Tetra Tech (2017) and extend from the four wells west to the Yukon River, north and east to the defined permafrost boundary and south to the Klondike River.
- The majority of water pumped from the four water supply wells is considered to be sourced from the Klondike River. Given the potential for rapid migration of contamination along the Klondike River and tributaries, the well capture zone has been extended to include the Klondike River Valley (up to Rock Creek) and tributary valleys to the south to include current and historical placer mining operations.
- A preliminary list of potential sources of contamination and primary contaminants identified in the community within the well capture zones are:
 - Above-ground fuel storage tanks (Petroleum Hydrocarbons)
 - Underground fuel storage tanks (Petroleum Hydrocarbons)
 - CoD sanitary sewer system (Biological, Nutrients)
 - Wastewater treatment plant: (Biological, Nutrients)
 - Yukon River and Klondike River (Biological)
 - In ground septic disposal systems in the Klondike River valley (Biological, Nutrients)
 - Placer mining activities (Turbidity, Metals, Hydrocarbons)

The four new supply wells are expected to meet the water demand in City of Dawson, and will provide redundancy in the system to prevent loss of water supply should one (or more) well(s) fail or be temporarily shut off for maintenance or repair.

5.19.7 Water Supply Information Data Gaps

Tetra Tech has been in contact with the City of Dawson and requested all recent data. To the best of our knowledge, this summary is up to date and complete. Tetra Tech notes the following could be addressed by future work:

- The City of Dawson source water protection planning is in progress and the resulting AWPP should be included in the database once completed.