Aquifer Name: Fort Fraser Bedrock

Date of Mapping: March 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Sean Funk, Ph.D., and Tibor Lengyel, M.Sc.

A. AQUIFER DESCRIPTION FOR AQUIFER 0239

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The aquifer is located east of Fraser Lake, near Fort Fraser. The bedrock aquifer is bounded to the north, west, and east by the Nechako River. The southern boundary of the aquifer is constrained by an observed topographic low in the bedrock elevation (see Hinnell et al., 2020, Figure 3.)

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

Overlying materials consist of Quaternary unconsolidated sediment. Immediately above the bedrock are Fraser glaciofluvial deposits, followed by finer-grained sediment from the glaciolacustrine Fraser ice advance, Fraser till, and glaciolacustrine Fraser ice retreat deposits. At the surface, there is a veneer of post-glacial sediment, intermixed with organics. Well records also indicate that there are layers of sand and gravel intermixed within the clay or till package.

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 6B FACTURED CRYSTALLINE ROCK

The bedrock aquifer consists of blocks of Jurassic granitic rocks of the Endako Batholith, Eocene to Oligocene andesitic to rhyolitic volcanic rocks of the Endako Formation (Massey et al. 2005; Struik et al. 2007; Erdmer and Cui 2009), and Triassic to Jurassic sequence of sedimentary and volcanic rocks of the Cache Creek complex (Struik et al. 2007). Permeability is assumed to be associated with fractures.

A.1.4 VULNERABILITY - LOW

Surficial geology of the area indicates that much of the land surface is covered by Fraser Glaciation till or fine-grained glaciolacustrine sediment. Well records indicate that the thickness of the clay or till units is variable, ranging from a few metres to nearly 100 m in some wells. The overall vulnerability of the bedrock aquifer to surface contamination is assessed as low.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels range from shallow (1 m) to deep (60 m). No provincial observation wells exist within the aquifer extents. There is one well with artesian conditions in the aquifer.

Static water levels in the well records suggest that the groundwater is a subdued representation of bedrock topography. Groundwater is interpreted to flow towards the Nechako River.

A.2.2 RECHARGE

Overburden cover is not continuous over the aquifer (see Hinnell et al. 2020 Figure 4). Where overburden is thin or absent, recharge of the aquifer could occur via distributed infiltration of precipitation. In the areas where overburden is present, the aquifer may be recharged from infiltration from various overlying units, including the overlying Nechako Buried Valley Aquifer (0242).

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater is inferred to be hydraulically connected to Nechako River. Groundwater in the bedrock may be hydraulically connected to the overlying Nechako Buried Valley Aquifer (0242) if fine-grained layers are not present between them.

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

Well records indicate that the water is fresh, clear, with no color, gas, or odor concerns. There are no other comments of concern noted in the well records. Stated yields in the well records range from less than 0.1 L/s to 11.7 L/s, with geometric mean of 0.5 L/s indicating a moderately productive aquifer.

Groundwater is used primarily for domestic purposes, with some wells indicating commercial use (livestock watering), based on well records.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

No water availability or water budget studies have been completed in the area.

A.4 AQUIFER REFERENCES

ERDMER, P., CUI, Y. 2009. Geological Map of British Columbia. Ministry of Energy and Mines, BC Geological Survey, Geoscience Map 2009-1

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof and Houston Aquifer Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

MASSEY, N.W.D., MACINYRE, D.G., DESJARDINS, P.J. & COONEY, R.T. 2005. Geology of British Columbia. Ministry of Energy and Mines, BC Geological Survey, Geoscience Map 2005-3.

STRUIK, L.C., MACINTYRE, D.G. & WILLIAMS, S.P. 2007. Nechako NATMAP Project: A Digital Suite of Geoscience Information for Central British Columbia (NTS Map Sheets 093N, 093K, 093F, 093G/W, 093L/9,16, & 093M/1,2,7,8). Geological Survey of Canada, Open File 5623.

A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
1996	1	Major	Initial Mapping of Aquifer	N/A
20200324	2	Major	Remapping of Aquifer	Andrew Hinnell, P.Geo., Sean Funk, and Tibor Lengyel

Exact date and author of first mapping not available.

Aquifer Name: Sinkut Mountain North Surficial Aquifer

Date of Mapping: March 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Tibor Lengyel, M.Sc. and Sean Funk, Ph.D.

A. AQUIFER DESCRIPTION FOR AQUIFER 0240

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The aquifer is located in the area bounded by Nulki Lake, Sinkut Lake, Cluculz Lake and Sinkut Mountain. The aquifer boundaries largely follow the outline of alluvial and glaciofluvial sediments exposed at surface (mapped by Clague, 1998 and Tipper 1971, see Hinnell et al. 2020, Figure 5). The boundary of the aquifer derived from surficial mapping was modified based on lithology records in the northern part of the aquifer, south of Sinkut Lake.

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

The Sinkut Mountain North Surficial Aquifer is a surficial alluvial and glaciofluvial aquifer, and thus no overlying materials are present.

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 1A UNCONFINED FLUVIAL/4A UNCONFINED GLACIFLUVIAL

Aquifer 0240 is a combination of recent alluvial sediments and glaciofluvial sands and gravels occurring at surface. Borehole descriptions indicate that the material is typically medium sand to gravel.

A.1.4 VULNERABILITY-HIGH

The alluvial and glaciofluvial sands of the aquifer are exposed at the surface, and thus are deemed to have high vulnerability to surface contamination.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels in the aquifer range from shallow (0.6 m) to moderately deep (48.7 m). No provincial observation wells exist within the aquifer extents. Artesian wells were not reported for any of the wells in the aquifer.

Calculated groundwater surface elevations appear to correspond to topography, suggesting that the groundwater surface may be a subdued replica of the topography. Accordingly, groundwater flow is

expected to flow towards Sinkut Lake, and towards the South Vanderhoof Unconsolidated Aquifer (0246).

A.2.2 RECHARGE

Recharge of the aquifer could occur via distributed infiltration of precipitation. It is also possible that the aquifer may be recharged from surface water features, like Nulki and Sinkut Lakes and the minor lakes and creeks in the footprint of the area; however, further investigation is required.

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater may be connected to the surface water features. Furthermore, where not separated by fine grained (low permeability) sediments, it may also be connected with the underlying bedrock aquifers (South Nechako Terrace Bedrock Aquifer [0243] and the West Cluculz Lake Bedrock Aquifer [1246]), see Hinnell et al. 2020, Figure 6H), and the confined unconsolidated aquifer to the north (South Vanderhoof Unconsolidated Aquifer [0246], see Hinnell et al. 2020, Figure 6H)

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

There were no water quality concerns recorded in the well records. Driller's well yield estimates are available for two wells located within the aquifer and both are approximately 0.2 L/s to 2.5 L/s with a geometric mean of 0.8 L/s suggesting a moderately productive aquifer. No other comments regarding water use were noted in the well records.

Where groundwater use records were available, the water wells were dominantly used for domestic water supply, with some locations used for commercial (livestock watering) purposes.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

No water use or water budget studies have been identified in the area.

A.4 AQUIFER REFERENCES

CLAGUE, J. J. 1998. Surficial Geology, Cluculz Lake, British Columbia. Geological Survey of Canada.

Geographic datasets from the BC Data Catalogue, accessed March 2020 https://data.gov.bc.ca/

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof and Houston Aquifer Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

TIPPER, H. W. 1971. Surficial Geology, McLeod Lake, 1:250000. Geological Survey of Canada.

A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
1996	1	Major	Initial Mapping of Aquifer	N/A
20200325	2	Major	Remapping Aquifer extents to match with surficial mapping	Andrew Hinnell, P.Geo., Tibor Lengyel and Sean Funk

Exact date and author of first mapping not available.

Aquifer Name: Nechako Buried Valley Aquifer

Date of Mapping: March 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Tibor Lengyel, M.Sc. and Sean Funk, Ph.D.

A. AQUIFER DESCRIPTION FOR AQUIFER 0242

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The aquifer is located west of Fraser Lake and east of Stuart River, in an interpolated bedrock low, roughly coinciding with the lower topographical elevations on the plain of the Nechako River. In its western extent near Fort Fraser, the bedrock low coincides with the current path of the Nechako River and thus underlies a mapped alluvial aquifer (Fort Fraser Alluvial Aquifer 1247, see Hinnell et al. 2020, Figure 6A). Similarly, east of Redmond Creek the aquifer underlies another mapped alluvial aquifer (Vanderhoof Alluvial Aquifer [0244], see Hinnell et al. 2020, Figures 6B and 6C). North of Tachick Lake, the aquifer was extended to include an area identified as a buried valley (Plouffe et al. 2004). In the northeast, the aquifer appears to follow the bedrock low (see Hinnell et al., 2020, Figure 3); however, exact delineation requires detailed review of data for adjacent map sheets. Near Vanderhoof a bedrock high limits the extent of the aquifer.

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

Aquifer 0242 is typically overlaid by glaciolacustrine sediments and till. The fine-grained sediments are in turn overlain by coarse-grained sediments, which may be locally continuous (the Vanderhoof and Fort Fraser alluvial aquifers [0244 and 1247] along the Nechako River).

A.1.3 GEOLOGIC FORMATION (AQUIFER) –4B CONFINED GLACIOFLUVIAL

As interpreted in cross-sections (Hinnell et al, 2020, Figures 6A – 6G) the Fraser-aged glaciofluvial sands of Aquifer 0242 are generally confined. The aquifer material is typically coarse grained (coarse sands and gravels), but locally can include fine grained sediment.

A.1.4 VULNERABILITY - LOW

Available lithology and surficial mapping (Clague, 1998, Plouffe, 1996, Tipper, 1971a, Tipper 1971b) indicate that the aquifer is covered by fine-grained, glaciolacustrine sediments across most of its extent, except along the Nechako River, where recent alluvial and colluvial sediments cover it (see Hinnell et al. 2020, Figure 5). Accordingly, the aquifer is interpreted to have a low vulnerability to surface contamination.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels range from the surface (artesian wells and licensed springs) to greater than 100 m below ground surface. One inactive provincial observation well exists within the aquifer footprint (OW 199).

There are 17 wells with artesian conditions (~5% of all wells assigned to the aquifer) in the aquifer and multiple licensed springs. Foweraker (1973) prepared a memo on an artesian well installed in this confined aquifer that could not be capped.

Interpolated groundwater levels suggest that groundwater flows towards the Nechako River. Two groundwater divides appear to exist within the aquifer: one of them is located east of Fort Fraser, where the higher topographic elevations divide groundwater flowing east and west towards the Nechako River, and one west of Stuart River, where the divide separates groundwater flowing east towards Stuart River, and west-southwest towards Nechako River.

A.2.2 RECHARGE

Recharge of the aquifer is expected to occur via distributed infiltration of precipitation along the undulating uplands north and south of Vanderhoof (Brown and Cockfield, 1950, Foweraker, 1979) where the overlying fine grained sediments may be thinner or absent. It is also possible that the aquifer is recharged from the surface water features (e.g. Fraser Lake) where low-permeability layers are absent; however, further investigation is required.

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Aquifer 0242 is expected to be connected to the underlying bedrock aquifers (South Nechako Terrace Bedrock Aquifer [0243], North Nechako Terrace River Bedrock Aquifer [0650] and South Fraser Lake Bedrock Aquifer [0673]). However, where intervening tills and clays are thin or absent, groundwater in the aquifer may also be connected to the overlying alluvial aquifers (Vanderhoof Alluvial Aquifer [0244] and Fort Fraser Alluvial Aquifer [1247]) and to the nearby major surface water features, where the low-permeability confining layers are absent.

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

There were no water quality concerns recorded in the well records. Estimated well yields range from less than 0.1 L/s to 100 L/s with a geometric average of 1.0 L/s. While some locations in the aquifer appear to have poor productivity, the overall productivity of the aquifer is moderate, with pockets of highly productive intervals. No other comments regarding water use were noted in the well records.

Where groundwater use records were available, the water wells were dominantly used for domestic water supply, with some commercial uses (mostly for livestock watering) or irrigation.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

Brown and Cockfield (1950) undertook a groundwater scoping study at Vanderhoof to review the potential success of installing an artesian well in this confined aquifer system. Based on the limited information they have indicated that the confined aquifer should be present in the larger area albeit with the presence of lower conductivity lenses (e.g. well drilled at the Vanderhoof Hotel). Foweraker (1973) reported on an artesian well installed in the confined aquifer system that could not be capped. Foweraker (1979) also provided a general summary of groundwater availability near Vanderhoof at the request of the regional engineer.

No water availability or water budget studies have been completed in the area.

A.4 AQUIFER REFERENCES

BROWN, W. L. & COCKFIELD, W. E. 1950. Groundwater Investigation at Vanderhoof, B.C.

CLAGUE, J. J. 1998. Surficial Geology, Cluculz Lake, British Columbia. Geological Survey of Canada.

FOWERAKER, J. C. 1973. Flowing Artesian Well Vanderhoof Area.

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PLOUFFE, A. 1996. Surficial geology, Fraser Lake, British Columbia (93K/SE), 1;100 000. Victoria, B.C.: Geological Survey of Canada.

PLOUFFE, A., LEVSON, V. M. & MATE, D. J. 2004. Surficial Geology: Nechako River, British Columbia, 1:250000. Geological Survey of Canada, "A" Series Map 2067A.

TIPPER, H. W. 1971a. Surficial Geology, McLeod Lake, 1:250000. Geological Survey of Canada.

TIPPER, H. W. 1971b. Surficial Geology, Prince George, 1:250000. Geological Survey of Canada.

A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
20031227	1	Major	Initial Mapping	S.L. Kenny.
20200325	2	Major	Remapping of aquifer extents; aquifer extents include former aquifers 0669 and 0670.	Andrew Hinnell, P.Geo., Tibor Lengyel, and Sean Funk

2003 mapping is assumed to be the initial mapping of the aquifer.

Aquifer Name: South Nechako Terrace Bedrock

Date of Mapping: March 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Sean Funk, Ph.D., and Tibor Lengyel, M.Sc.

A. AQUIFER DESCRIPTION FOR AQUIFER 0243

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The footprint of the aquifer includes the town of Vanderhoof. The bedrock aquifer is bounded to the north by Nechako River. The western extent is partially constrained by the Nechako River, and abuts a topographic low in the bedrock elevation. The southern extent of the aquifer is constrained by topography, which also approximately coincides with a rise in bedrock elevation. The eastern extent is constrained by a series of faults, assumed to be impermeable. However, the hydraulic properties of the faults are speculative and require further investigation.

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

Overlying materials consist of Quaternary unconsolidated sediment. Immediately above the bedrock are Fraser glaciofluvial deposits (see Hinnell et al. 2020, Figures 6A-6H), followed by finer-grained sediment from the glaciolacustrine Fraser ice-advance, Fraser Glaciation till, and glaciolacustrine Fraser ice-retreat deposits. At the surface, there is a veneer of post-glacial sediment, intermixed with organics. Well records also indicate that there are layers of sand and gravel intermixed within the clay and till package. This geological sequence aligns with what Brown and Cockfield (1950) described.

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 6B FRACTURED CRYSTALLINE ROCK

The bedrock aquifer consists of numerous blocks of Eocene to Oligocene andesitic to rhyolitic volcanic rocks of the Endako Formation (Massey et al. 2005; Struik et al. 2007; Erdmer and Cui 2009), the Jurassic sequence of sedimentary (mudstones, siltstones, shales) and volcanic (basalt) of the Cache Creek Complex (Massey et al. 2005), the Miocene to Pleistocene basaltic rocks of the Chilcotin Group (Logan et al. 2010), and the Permian to Jurassic metamorphic rocks (Logan et al. 2010). Permeability is assumed to be associated with fractures.

A.1.4 VULNERABILITY - MEDIUM

Surficial geology of the area indicates that much of the land surface is covered by Fraser Glaciation till or fine-grained glaciolacustrine sediment. Well records indicate that the thickness of the clay or till units is variable, ranging from a few metres to nearly 100 m in some wells. The vulnerability of the aquifer is variable between medium and low based on overlying low permeability material thickness. The overall vulnerability of the aquifer to surface contamination is defined as medium.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels range from ground surface (artesian wells) to deep (90 m). One active provincial observation well exists within the aquifer footprint (OW-455). There are two artesian wells within the aquifer.

Static water levels in the well records suggest that the groundwater is a subdued representation of bedrock topography. Assuming that groundwater follows bedrock topography, groundwater likely discharges into the Nechako River. There is some indication that groundwater may also flow into Tachick Lake, Nulki Lake, and Sinkut Lake, but information around these areas is sparse, and the inferred groundwater direction is speculative.

A.2.2 RECHARGE

The aquifer is generally covered by thick packages of unconsolidated sediments. Therefore, primary recharge to the aquifer is expected to occur as infiltration from various overlying aquifers (Sinkut Mountain North Surficial [0240], Nechako Buried Valley [0242], Tachick Lake Unconsolidated [0245], and South Vanderhoof Unconsolidated [0246]), if the intervening low permeability units are absent.

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater in the bedrock aquifer is inferred to be hydraulically connected to Nechako River, and potentially connected to Tachick, Nulki, and Sinkut lakes, based on observed shallow static water depths in the vicinity of the lakes. Brown and Cockfield (1950) noted that parts of the Nechako River flow over bedrock. Fraser glaciofluvial deposits form aquifers, which often directly overlay the bedrock aquifer in some parts (see Hinnell et al. 2020, Figures 6A-6H) and are potentially hydraulically connected. As the faults delineating the aquifer are assumed to be impermeable, groundwater is not expected to flow between Aquifer 0243 and the West Cluculz Lake Bedrock Aquifer (1246).

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

Well records do not comment on the quality of the groundwater produced. Stated yields in the well records range from less than 0.1 L/s to 31.5 L/s, with a geometric mean of 0.7 L/s suggesting moderate productivity with pockets of poor productivity and high productivity.

Groundwater is used primarily for domestic purposes, with some wells indicating use for commercial purposes (livestock watering), based on well records.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

No water availability or water budget studies have been completed in the area.

A.4 AQUIFER REFERENCES

BROWN, W.L., AND COCKFIELD, W.E. 1950. Ground-Water Investigation at Vanderhoof, B.C. Province of British Columbia, Ministry of Environment, Report ID 5382.

ERDMER, P., AND CUI, Y. 2009. Geological Map of British Columbia. Ministry of Energy and Mines, BC Geological Survey, Geoscience Map 2009-1

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof and Houston Aquifer Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

LOGAN, J.M., SCHIARIZZZA, P., STRUIK, L.C., BARNETT, C., NELSON, J.L., KOWALCZYK, P., FERRI, F., MIHALYNUK, M.G., THOMAS, M.D., GAMMON, P., LETT, R., JACKAMAN, W. & FERBEY, T. 2010. Bedrock Geology of the QUEST Map Area, Central British Columbia. Geoscience BC Report, British Columbia Geological Survey Geoscience Map 2010-1, Geological Survey of Canada Open File 6476.

MASSEY, N.W.D., MACINYRE, D.G., DESJARDINS, P.J. & COONEY, R.T. 2005. Geology of British Columbia. Ministry of Energy and Mines, BC Geological Survey, Geoscience Map 2005-3.

STRUIK, L.C., MACINTYRE, D.G. & WILLIAMS, S.P. 2007. Nechako NATMAP Project: A Digital Suite of Geoscience Information for Central British Columbia (NTS Map Sheets 093N, 093K, 093F, 093G/W, 093L/9,16, & 093M/1,2,7,8). Geological Survey of Canada, Open File 5623.

A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
1996	1	Major	Initial Mapping of Aquifer	N/A
20200324	2	Major	Remapping of Aquifer 243.	Andrew Hinnell, P.Geo., Sean Funk, and Tibor Lengyel

Exact date and author of first mapping not available.

Aquifer Name: Vanderhoof Alluvial Aquifer

Date of Mapping: March 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Tibor Lengyel, M.Sc. and Sean Funk, Ph.D.

A. AQUIFER DESCRIPTION FOR AQUIFER 0244

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The aquifer is located along the Nechako River extending approximately from Redmond Creek to Hulatt. The aquifer boundaries follow the mapped extents of the alluvial sediments along the Nechako River (Clague, 1998, Tipper 1971a, 1971b, see Hinnell et al. 2020, Figure 5).

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

Aquifer 0244 is a surficial alluvial aquifer, and thus there are no overlying geological materials.

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 1A UNCONFINED FLUVIAL

Aquifer 0244 is an alluvial aquifer along the Nechako River. Borehole descriptions indicate that the material can range from fine sands to gravels. The position and the relation of the aquifer with other units is illustrated by Figures 6B and 6C in Hinnell et al. (2020).

A.1.4 VULNERABILITY - HIGH

The alluvial sands of the aquifer are exposed at the surface, and thus the aquifer is classified highly vulnerable to surface contamination.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels in the aquifer are shallow (0.9 m to 6.7 m). No provincial observation wells exist within the aquifer extents. Artesian wells were not reported for any of the wells in the aquifer.

The limited number of calculated groundwater surface elevations appear to correspond to topography. Accordingly, groundwater flow is expected to be directed towards the Nechako River.

A.2.2 RECHARGE

Recharge of the aquifer could occur via distributed infiltration of precipitation. The aquifer is interpreted to be well connected to the Nechako River with the potential of seasonal recharge from the river. These potential surface water/groundwater interactions require additional investigation to define local conditions.

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater is likely connected to the Nechako River. Furthermore, it may also be connected with the underlying Nechako Buried Valley Aquifer (0242), where separating fine-grained sediments are thin/absent. The aquifer is also underlain by multiple bedrock aquifers (South Nechako Terrace Bedrock Aquifer [0243], and North Nechako Terrace Bedrock Aquifer [0650]). Connections are inferred where low conductivity sediments separating the bedrock aquifers from the alluvial aquifer are absent. Such connections are especially likely closer to the edges of the alluvial plane, where the bedrock rises closer to the ground surface (see Hinnell et al. 2020, Figure 3).

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

There were no water quality concerns recorded in the well records. Driller's well yield estimate are available for two wells located within the aquifer and are both approximately 0.9 L/s suggesting a moderately productive aquifer. No other comments regarding water use were noted in the well records.

Where groundwater use records were available (11 of the 17 wells), the water wells were used for domestic water supply.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

Brown and Cockfield (1950) undertook a groundwater investigation at Vanderhoof to review the potential for installing an artesian well in the Vanderhoof area. While the main interest of the study was the deeper, confined system, they noted that shallow water wells existed in the area. The location of the shallow water wells was not mapped, and thus it is not known whether they are located in the alluvial aquifer or on a higher river terrace.

In their study, Brown and Cockfield (1950) commented both on the quantity and the quality of groundwater produced from these wells:

- the quantity was sufficient to support domestic needs;
- the quality was found to be relatively poor, as they indicated that most of the groundwater is "unpalatable" due to iron-oxide and hydrogen sulfide and that more than half of the shallow wells contained polluted water from sewage.

Foweraker (1979) also reported on groundwater availability near Vanderhoof; however, the focus of the investigation was the confined system and they only confirmed the existence of shallow groundwater resources.

No water budget studies have been completed in the area.

A.4 AQUIFER REFERENCES

BROWN, W. L. & COCKFIELD, W. E. 1950. Groundwater Investigation at Vanderhoof, B.C.

CLAGUE, J. J. 1998. Surficial Geology, Cluculz Lake, British Columbia. Geological Survey of Canada.

FOWERAKER, J. C. 1979. Vanderhoof Groundwater Availability.

Geographic datasets from the BC Data Catalogue, accessed March 2020 https://data.gov.bc.ca/

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof and Houston Aquifer Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

TIPPER, H. W. 1971. Surficial Geology, McLeod Lake, 1:250000. Geological Survey of Canada.

TIPPER, H. W. 1971. Surficial Geology, Prince George, 1:250000. Geological Survey of Canada.

A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
1996	1	Major	Initial Mapping of Aquifer	N/A
20200325	2	Minor	Remapping Aquifer extents to match with surficial mapping	Andrew Hinnell, P.Geo., Tibor Lengyel, and Sean Funk

Exact date and author of first mapping not available.

Aquifer Name: Tachick Lake Unconsolidated Aquifer

Date of Mapping: March 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Sean Funk, Ph.D., and Tibor Lengyel, M.Sc.

A. AQUIFER DESCRIPTION FOR AQUIFER 0245

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The unconsolidated aquifer is located on the east side of Tachick Lake. In the west, the aquifer is partially bounded by the coastline of Tachick Lake. The southern, northern, and eastern extents of the aquifer are informed by the lithological descriptions and distribution of well records.

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

Overlying materials consist of Quaternary unconsolidated sediment. Finer-grained sediment from the Fraser Glaciation till and glaciolacustrine Fraser ice-retreat deposits immediately overlay the aquifer (cross-section K-L; Figure 6F, Hinnell et al. 2020). At the surface, patches of post-glacial sediment, intermixed with organics are present.

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 4B CONFINED

The unconsolidated aquifer consists of Fraser glaciofluvial deposits, which are described in well records as consisting of sand and gravel usually directly over bedrock. In some areas, pre-Fraser fine-grained sediment intervenes between the bedrock and the Fraser glaciofluvial deposits (cross-section K-L; Figure 6F, Hinnell et al. 2020).

A.1.4 VULNERABILITY - LOW

Surficial geology of the area indicates that much of the land surface is covered by Fraser Glaciation till or fine-grained glaciolacustrine sediment. Well records indicate that the thickness of the clay or till units is variable, ranging from 7 m to over 60 m in some wells. While the vulnerability will be dependent on the thickness of the overlying sediments, the overall vulnerability of the aquifer is assessed as low.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels range from shallow (5 m) to deep (50 m) with groundwater elevation generally decreasing to the west. Artesian conditions are not recorded for this aquifer. No provincial observation wells exist within the aquifer extents.

Groundwater is interpreted to generally flow from east to west, towards Tachick Lake.

A.2.2 RECHARGE

Recharge from precipitation likely occurs in the eastern topographically relatively elevated portion of the aquifer where overlying materials are thin.

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater is inferred to be hydraulically connected to Tachick Lake. As the Fraser glaciofluvial deposits directly overlay bedrock over much of its areal extent, Aquifer 0245 may be hydraulically connected to the South Nechako Terrace Bedrock Aquifer (0243).

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

Well records do not comment on the quality of the groundwater produced. Stated yields in the well records range from 0.3 and 1.9 L/s, with a geometric average and median of 0.9 L/s indicating a moderately good producer.

Groundwater is used primarily for domestic purposes based on land use and well records.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

No water availability or water budget studies have been completed in the area.

A.4 AQUIFER REFERENCES

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof and Houston Aquifer Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
1996	1	Major	Initial Mapping of Aquifer	N/A
20200324	2	Major	Remapping of Aquifer	Andrew Hinnell, P.Geo., Sean Funk, and Tibor Lengyel

Exact date and author for initial mapping not available.

Aquifer Name: South Vanderhoof Unconsolidated Aquifer

Date of Mapping: March 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Sean Funk, Ph.D., and Tibor Lengyel, M.Sc.

A. AQUIFER DESCRIPTION FOR AQUIFER 0246

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The unconsolidated aquifer is located between Tachick Lake and Cluculz Lake, south of the town of Vanderhoof. Portions of the southern and northern extents of the aquifer were delineated by lithological descriptions included in well records. The western portion of the unconsolidated aquifer follows a valley in bedrock topography, extending from Tachick Lake and encompassing Nulki Lake and Sinkut Lake (see Hinnell et al. 2020, Figure 3). Parts of the shorelines of Tachick and Nulki lakes were used as boundaries for the aquifer; however, the aquifer boundary could be below the lake. The eastern extent is constrained by the shoreline of Cluculz Lake.

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

Overlying materials consist of Quaternary unconsolidated sediment. Finer-grained sediment from the Fraser Glaciation till and glaciolacustrine Fraser ice-retreat deposits immediately overlay the aquifer. A veneer of post-glacial sand and fine-grained sediment overlay the Fraser Glaciation till and Fraser ice-retreat deposits, and in some locations, directly overlay the aquifer (shown in cross-section O-P; Figure 6H; Hinnell et al. 2020).

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 4A UNCONFINED/4B CONFINED GLACIOFLUVIAL

The unconsolidated aquifer consists of Fraser glaciofluvial deposits, which are described in well records as consisting of sand and gravel directly overlaying bedrock. However, in some locations, the Fraser glaciofluvial deposits overlay pre-Fraser fine-grained sediments (cross-section O-P; Figure 6H; Hinnell et al. 2020).

A.1.4 VULNERABILITY - MEDIUM

Surficial geology of the area indicates that much of the land surface is covered by Fraser Till or fine-grained glaciolacustrine sediment. Well records indicate that the thickness of the clay or till units is variable, ranging from a few metres to over 60 m in some wells. Where thick clay or till units overlay the aquifer, the aquifer vulnerability is likely low. However, along the southern boundary of the unconsolidated aquifer post-glacial sands directly overlay parts of Aquifer 0246; elsewhere the overlying till or clay may be absent, for example along the southern edge of Nulki Lake. These areas have high vulnerability to surface contamination. Therefore, the aquifer is assessed to have a medium vulnerability to surface contamination.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels range from ground surface (artesian wells) to deep (70 m). No provincial observation wells exist within the aquifer footprint. There are two artesian wells in the aquifer.

Groundwater elevations decrease from east to west along the channel feature, and from southeast to northwest in the main aquifer body. Groundwater is interpreted to flow towards the west in the channel, towards Sinkut, Nulki Lake, or Tachick lakes and towards Nechako River in the main aquifer body.

A.2.2 RECHARGE

Recharge of the aquifer could occur via distributed infiltration of precipitation. Overburden in the south appears to thin as topography rises, possibly allowing for infiltration of precipitation. Where post-glacial sands (e.g. the Sinkut Mountain North Surficial Aquifer [0240]) overlie Aquifer 0246, they may also be a conduit for precipitation to enter the aquifer. It is possible that some surface water features may also recharge the aquifer; however, further investigation is required.

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater is inferred to be hydraulically connected to Sinkut Lake, Nulki Lake, Tachick Lake, and Cluculz Lake. There is the possibility that the unconsolidated aquifer is hydraulically connected to streams (Klinsake Creek, Hulatt Creek, Tultsau Creek, Kinowsa Creek, McKay Creek, and several unnamed creeks), lakes (Sob Lake), and wetlands where overlying low conductivity materials are absent.

As the unconsolidated aquifer directly overlays the bedrock over much of the extent and is covered by another unconsolidated aquifer, Aquifer 0246 may be hydraulically connected both to the bedrock aquifers (South Nechako Terrace Bedrock Aquifer [0243] and West Cluculz Lake Bedrock Aquifer [1246]) and the overlying unconsolidated aquifer (North Sinkut Lake Surficial Aquifer [0240]).

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

Well records do not comment on the quality and quantity of the groundwater produced. Stated yields in the well records range from less than 0.1 L/s to 3.2 L/s, with a geometric mean of 0.8 L/s indicating a moderately productive aquifer.

Groundwater is used primarily for domestic purposes, with some wells indicating use for commercial purposes (livestock watering), based on well records.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

No water availability or water budget studies have been completed in the area.

A.4 AQUIFER REFERENCES

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof and Houston Aquifer Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
1996	1	Major	Initial mapping of aquifer	N/A
20200324	2	Major	Remapping of Aquifer	Andrew Hinnell, P.Geo., Sean Funk, and Tibor Lengyel

Exact date and author for initial mapping of aquifer not available.

Aquifer Name: North Nechako Terrace Bedrock Aquifer

Date of Mapping: March 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Sean Funk, Ph.D., and Tibor Lengyel, M.Sc.

A. AQUIFER DESCRIPTION FOR AQUIFER 0650

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The aquifer is an extensive bedrock aquifer located on the northside of Nechako River, spanning from the western extent of Fraser Lake to close to Stuart River. The southern extent of the bedrock aquifer is constrained by the Nechako River and the coastline of Fraser Lake. The eastern, and northern extents of the aquifer are constrained by watershed boundaries (topographic highs). The western extent is constrained by watershed boundaries, which approximately coincides with a topographic rise in bedrock elevation (see Hinnell et al. 2020, Figure 3).

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

Overlying materials north of Nechako River consist of Quaternary unconsolidated sediment. Immediately above the bedrock are Fraser glaciofluvial deposits (Nechako Buried Valley Aquifer [0242], see Hinnell et al. 2020, Figure 6D), followed by finer-grained sediment from the glaciolacustrine Fraser ice-advance, Fraser Glaciation till, and glaciolacustrine Fraser ice-retreat deposits. At the surface, a veneer of post-glacial sediments, intermixed with organics occur.

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 5A FRACTURED SEDIMENTARY/6B FRACTURED CRYSTALLINE ROCKS

The bedrock aquifer consists of blocks of Jurassic granitic rocks of the Endako Batholith, Eocene to Oligocene andesitic to rhyolitic volcanic rocks of the Endako Formation (Massey et al. 2005; Struik et al. 2007; Erdmer and Cui 2009), the Jurassic sequence of sedimentary rocks (mudstones, siltstones, shales) of the Cache Creek Complex, and the Miocene to Pleistocene basaltic rocks of the Chilcotin Group (Logan et al. 2010). Permeability of the bedrock is interpreted to be associated with fractures and in case of the sedimentary rocks with primary porosity.

A.1.4 VULNERABILITY - MEDIUM

Surficial geology of the area indicates that much of the land surface is covered by Fraser Glaciation till or fine-grained glaciolacustrine sediment. Well records indicate that the thickness of the clay or till units is variable, ranging from a few metres near the shoreline of Fraser Lake or Nechako River, up to over 60 m in some wells. However, some well records indicate that this clay or till unit is absent and only sand and gravel exist above the bedrock. Thus localized “windows” of high vulnerability exist. Based on this, the aquifer generally has a low vulnerability to surface contamination with the potential for localized areas

of high vulnerability. The overall vulnerability of the aquifer to surface contamination is defined as medium.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels range from the ground surface (artesian wells) to deep (60 m). No provincial observation wells exist within the aquifer extents. There are seven artesian wells in the aquifer.

Although there are few wells in the norther portions of the aquifer, groundwater is inferred to flow south towards the Nechako River and Fraser Lake.

A.2.2 RECHARGE

The western half of the aquifer appears to be exposed at surface or is only covered by thin, localized sediments based on interpolated overburden thickness (see Hinnell et al. 2020, Figure 4). In these portions of the aquifer, recharge of the aquifer could occur via distributed infiltration of precipitation. In the eastern half of the aquifer, it appears to be overlain by thick overlying sediments. In this part of the study area, Aquifer 0650 may be recharged from infiltration from various overlying units, including overlying Nechako Buried Valley Aquifer (0242).

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater may be hydraulically connected to the Nechako River, Endako River, and Fraser Lake, where fine grained sediments are absent between the aquifer and these surface water features. Groundwater may also by hydraulically connected with overlying aquifers in the unconsolidated sediments (Nechako Buried Valley Aquifer [0242], Vanderhoof Alluvial Aquifer [0244], and Stellako Unconsolidated Aquifer System [0668]), where intervening low conductivity sediments are absent.

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

Well records do not comment on the quality and quantity of the groundwater produced. Stated yields in the well records range from less than 0.1 L/s and 1.9 L/s, with a geometric mean of 0.4 L/s suggesting a moderately productive aquifer with extended zones of low productivity.

Groundwater is used primarily for domestic water supply, with a few wells indicating commercial uses (including livestock watering), based on well records.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

No water availability or water budget studies have been completed in the area.

A.4 AQUIFER REFERENCES

ERDMER, P. AND CUI, Y. 2009. Geological Map of British Columbia. Ministry of Energy and Mines, BC Geological Survey, Geoscience Map 2009-1

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof and Houston Aquifer Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

LOGAN, J.M., SCHIARIZZZA, P., STRUIK, L.C., BARNETT, C., NELSON, J.L., KOWALCZYK, P., FERRI, F., MIHALYNUK, M.G., THOMAS, M.D., GAMMON, P., LETT, R., JACKAMAN, W. & FERBEY, T. 2010. Bedrock Geology of the QUEST Map Area, Central British Columbia. Geoscience BC Report, British Columbia Geological Survey Geoscience Map 2010-1, Geological Survey of Canada Open File 6476.

MASSEY, N.W.D., MACINYRE, D.G., DESJARDINS, P.J. & COONEY R.T. 2005. Geology of British Columbia. Ministry of Energy and Mines, BC Geological Survey, Geoscience Map 2005-3.

STRUIK, L.C., MACINTYRE, D.G. & WILLIAMS, S.P. 2007. Nechako NATMAP Project: A Digital Suite of Geoscience Information for Central British Columbia (NTS Map Sheets 093N, 093K, 093F, 093G/W, 093L/9,16, & 093M/1,2,7,8). Geological Survey of Canada, Open File 5623.

A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
20031119	1	Major	Initial mapping of aquifer	S. Kenny
20200324	2	Major	Remapping of Aquifers 650, 674, and 241.	Andrew Hinnell, P.Geo, Sean Funk, and Tibor Lengyel

2003 mapping is assumed to be the initial mapping of the aquifer.

Aquifer Name: Topley Bedrock

Date of Mapping: September 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Sean Funk, Ph.D., and Tibor Lengyel, M.Sc.

A. AQUIFER DESCRIPTION FOR AQUIFER 0654

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The aquifer is located around the town of Topley, north of the Upper Bulkley River. The bedrock aquifer is bounded to the north by the 900 m topographic elevation line, in the west by a watershed boundary, in the south by the Upper Bulkley River, and in the east by Watson Creek.

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

Overlying materials consist of Quaternary unconsolidated sediment. Overlying sediments may be coarse grained (Fraser ice-advance glaciofluvial) or fine grained (pre-Fraser sediments, Fraser ice-advance glaciolacustrine or Fraser till, see Hinnell et al., 2020 Figure 7E). Much of the overlying material consists of finer-grained sediments. Well records also indicate that there are lenses of sand and gravel intermixed within the clay or till package. At the surface, there is a veneer of post-glacial sediment localized within the valley bottom, composed of clean sand and gravel.

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 6B FACTURED CRYSTALLINE ROCK

The bedrock aquifer consists of blocks of Jurassic calc-alkaline volcanic rocks of the Telkwa Formation of the Hazelton Group, Jurassic aged granodioritic intrusive rocks of Topley Plutonic Suite, and the Eocene aged coarse-grained volcaniclastic rocks of the Endako Formation of the Nechako Plateau Group, alkaline volcanic rocks of the Goosly Lake Formation of the Endako Group, and andesitic volcanic rocks of the Kasalka Group. Permeability is inferred to be associated with fractures.

A.1.4 VULNERABILITY - HIGH

Surficial geological mapping by Tipper (1976) indicates that parts of the bedrock aquifer are covered by Fraser Glaciation till or fine-grained glaciolacustrine sediment, typically confined to around the valley floor. Well records indicate that the thickness of the clay or till units is somewhat variable, with thickness averaging 50 m. However, Stumpf (2008) described the till in the area to contain vertical jointing and sub-horizontal fissility, which facilitates downward seepage of surface water to the aquifer. The vulnerability of the aquifer is classified as medium, where the bedrock is covered by Quaternary sediments and high where the aquifer outcrops at surface. Thus, the overall vulnerability of the aquifer to surface contamination is defined as high.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels range from moderate (15.2 m) to deep (82.3 m). No provincial observation wells exist within the aquifer extents. Several springs located along river terraces and one artesian well are interpreted to be associated with the bedrock aquifer (see Hinnell et al., 2020 Figure 8B).

Static water levels in the well records suggest that groundwater is a subdued representation of bedrock topography. Based on the conceptual understanding of groundwater flow and the observed springs groundwater is interpreted to flow towards the Upper Bulkley River with upward seepage potential near the river.

A.2.2 RECHARGE

Overburden cover is not continuous over the aquifer (see Tipper 1976). Where overburden is thin or absent, recharge of the aquifer could occur via distributed infiltration of precipitation. In the areas where overburden is present, the aquifer may be recharged by infiltration from various overlying units, including the overlying Bulkley Buried Channel aquifer (0659).

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater is inferred to be hydraulically connected to Upper Bulkley River, and possibly Watson Creek. Groundwater in the bedrock may be hydraulically connected to the overlying Bulkley Buried Channel (0660) where the intervening fine-grained glaciolacustrine sediment is not present or thin. The bedrock aquifer may be hydraulically connected to several unnamed lakes.

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

There are no water quality concerns documented within this aquifer in well records. There were wells noted to be dry within the aquifer. Stated yields in the well records range from 0.03 L/s to 0.95 L/s, with geometric mean of 0.22 L/s indicating a poorly productive aquifer, with localized regions of moderate productivity.

Groundwater is used primarily for domestic purposes based on well records.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

No water availability or water budget studies have been completed in the area.

A.4 AQUIFER REFERENCES

Geographic datasets from the BC Data Catalogue, accessed August 2020 https://data.gov.bc.ca/

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof and Houston Aquifer Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

MASSEY, N.W.D., MACINYRE, D.G., DESJARDINS, P.J. & COONEY, R.T. 2005. Geology of British Columbia. Ministry of Energy and Mines, BC Geological Survey, Geoscience Map 2005-3.

STUMPF, A. J. 2008. Till Geochemistry and Clast Lithology Studies of the Bulkley River Valley, West-Central British Columbia (parts of NTS 093L). Geoscience BC Report.

TIPPER, H. W. 1976. Geology of Smithers Map Area, British Columbia, 1:250000. Geological Survey of Canada, Open File 351.

A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
20031116	1	Major	Initial Mapping of Aquifer	D.A. Lowen, P.Geo.
20200909	2	Major	Remapping of Aquifer	Andrew Hinnell, P.Geo., Sean Funk, and Tibor Lengyel

Mapping by D.A. Lower is assumed to be initial mapping.

Aquifer Name: Houston Bedrock

Date of Mapping: September 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Sean Funk, Ph.D., and Tibor Lengyel, M.Sc.

A. AQUIFER DESCRIPTION FOR AQUIFER 0658

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The aquifer is located around the town of Houston, south of the Upper Bulkley River and east of the Morice River. The bedrock aquifer is bounded to the north by the Upper Bulkley River, in the west by the Morice River and a fault, in the south by the 900 m topographic elevation line and faults, and in the east by topography and faults. The faults that bound the aquifer are inferred to be impermeable, however this should be confirmed.

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

Overlying materials consist of Quaternary unconsolidated sediment. Overlying sediments may be coarse grained (Fraser ice-advance glaciofluvial) or fine grained (pre-Fraser sediments, Fraser ice-advance glaciolacustrine or Fraser till, see Hinnell et al., 2020 Figure 7E). Much of the overlying material consists of finer-grained sediments. Well records also indicate that there are lenses of sand and gravel intermixed within the clay or till package. At the surface, there is a veneer of post-glacial sediment localized within the valley bottom, composed of clean sand and gravel.

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 6B FACTURED CRYSTALLINE ROCK

The bedrock aquifer consists of blocks of Cretaceous andesitic volcanic rocks of the Kasalka Group, Jurassic calc-alkaline volcanic rocks of the Telkwa Formation of the Hazelton Group, and the Eocene basaltic volcanic rocks of the Goosly Lake Formation within the Endako Group (Massey et al. 2005). Permeability is inferred to be associated with fractures.

A.1.4 VULNERABILITY - MEDIUM

Surficial geological mapping by Tipper (1976) indicates that much of the bedrock aquifer is covered by Fraser Glaciation till or fine-grained glaciolacustrine sediment. Well records indicate that the thickness of the clay or till units is variable, ranging from a few metres to nearly 100 m in some wells. Stumpf (2008) described the till in the area to contain vertical jointing and sub-horizontal fissility, which facilitates downward seepage of surface water to the aquifer. The vulnerability of the aquifer is classified as medium, where the bedrock is covered by Quaternary sediments and high where the aquifer outcrops at surface. The overall vulnerability of the bedrock aquifer to surface contamination is assessed as medium. However, where where the bedrock is potentially exposed at the surface or in localized areas around the Morice River where permeable sand and gravels dominate the overburden, the risk of contamination is high.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels range from shallow (1.5 m) to deep (91.4 m). No provincial observation wells exist within the aquifer extents. Two springs are interpreted to be associated with the bedrock aquifer (see Hinnell et al., 2020 Figure 8B).

Static water levels in the well records suggest that the groundwater is a subdued representation of bedrock topography. Based on the conceptual understanding of groundwater flow and the observed springs, groundwater is interpreted to flow towards the Upper Bulkley and Morice rivers with potential upward seepage near the rivers.

A.2.2 RECHARGE

Overburden cover is not continuous over the aquifer. Where overburden is thin or absent, recharge of the aquifer could occur via distributed infiltration of precipitation. In the areas where overburden is present, the aquifer may be recharged by infiltration from various overlying units, including the overlying Bulkley Buried Channel (0660) or the shallow surficial aquifer (0659) near the Upper Bulkley River where the Bulkley Buried Channel (0660) appears to be absent.

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater is inferred to be hydraulically connected to Upper Bulkley and Morice Rivers, and possibly the Buck Creek. Groundwater in the bedrock may be hydraulically connected to the overlying Bulkley Buried Channel (0660) or the shallow surficial aquifer (0659) if the intervening fine-grained glaciolacustrine sediment is not present or thin between them. The bedrock aquifer may be hydraulically connected to several unnamed lakes.

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

Well records indicate that the water is fresh, clear, with no color, gas, or odor concerns. There are no other comments of concern noted in the well records. Stated yields in the well records range from 0.03 L/s to 3.2 L/s, with geometric mean of 0.20 L/s indicating a poorly productive aquifer with localized regions of moderate and high productivity.

Groundwater is used primarily for domestic purposes based on well records.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

No water availability or water budget studies have been completed in the area.

A.4 AQUIFER REFERENCES

Geographic datasets from the BC Data Catalogue, accessed August 2020 https://data.gov.bc.ca/

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof and Houston Aquifer Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

MASSEY, N.W.D., MACINYRE, D.G., DESJARDINS, P.J. & COONEY, R.T. 2005. Geology of British Columbia. Ministry of Energy and Mines, BC Geological Survey, Geoscience Map 2005-3.

STUMPF, A. J. 2008. Till Geochemistry and Clast Lithology Studies of the Bulkley River Valley, West-Central British Columbia (parts of NTS 093L). Geoscience BC Report.

TIPPER, H. W. 1976. Geology of Smithers Map Area, British Columbia, 1:250000. Geological Survey of Canada, Open File 351.

A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
20031122	1	Major	Initial Mapping of Aquifer	W.S. Hodge
20061210	2	N/A	N/A	A.P. Kohut
20200909	3	Major	Remapping of Aquifer	Andrew Hinnell, P.Geo., Sean Funk, and Tibor Lengyel

Mapping by W.S. Hodge assumed to be initial mapping of aquifer. N/A – The extent of revisions implemented by A.P. Kohut not documented.

Aquifer Name: Upper Bulkley Alluvial Aquifer

Date of Mapping: September 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Tibor Lengyel, M.Sc. and Sean Funk, Ph.D.

A. AQUIFER DESCRIPTION FOR AQUIFER 0659

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The aquifer is located along the Upper Bulkley River, extending from the town of Topley towards the town of Houston. The aquifer is bounded in the west by topography along the western banks of the Morice River, the northern boundary is bounded in parts by the Upper Bulkley River or topography, and by borehole logs, the eastern boundary is bounded by a watershed boundary, and the southern boundary is bounded in parts by the Upper Bulkley River, topography, and borehole logs. Around Buck Creek and near the confluence of the Upper Bulkley and the Morice rivers, the interpreted alluvial fans of the Morice River and the Buck Creek expand the aquifer to the south.

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

The Upper Bulkley Alluvial Aquifer is a surficial alluvial aquifer, and thus no overlying materials are present.

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 1A UNCONFINED FLUVIAL

Aquifer 0659 consists of recent Holocene alluvial sediments occurring at surface. Borehole descriptions indicate that the material is typically clean sands and gravels.

A.1.4 VULNERABILITY-HIGH

The alluvial sands of the aquifer are exposed at the surface, and thus are deemed to have high vulnerability to surface contamination.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels in the aquifer range from relatively shallow (0.6 m) to moderately deep (22.6 m). One active provincial observation well (OW 386) exists within the aquifer extents. Artesian conditions were not reported for any of the wells in the aquifer.

Calculated groundwater surface elevations appear to correspond to topography, suggesting that the groundwater surface may be a subdued replica of the topography. Accordingly, groundwater is expected to flow towards the Upper Bulkley River.

A.2.2 RECHARGE

Recharge of the aquifer could occur via distributed infiltration of precipitation. It is also possible that the aquifer may be recharged by surface water features, like the Upper Bulkley River; however, further investigation is required.

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater may be connected to the surface water features such as the Upper Bulkley River. Furthermore, where not separated by fine grained (low permeability) sediments, it may also be hydraulically connected with the underlying aquifers (Houston Bedrock Aquifer [0658] and Bulkley Buried Channel [0660], see Hinnell et al. 2020, Figure 7A).

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

There were no water quality concerns recorded in the well records. Driller's well yield estimates range from between approximately 0.2 L/s to 37.9 L/s with a geometric mean of 2.3 L/s suggesting a moderately productive aquifer with localized pockets of both poorly and highly productive intervals. There were wells noted to be dry within the aquifer.

Where groundwater use records were available, the water wells were dominantly used for domestic water supply purposes.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

Brown (1967) undertook a preliminary groundwater survey for the proposed pulp mill to review the feasibility of using groundwater at the mill. They concluded that there was a good likelihood of developing a well field capable of supporting the needs of the mill from the Upper Bulkley Alluvial Aquifer near either the Morice or the Upper Bulkley Rivers.

Brown and Erdman (1970) undertook an intrusive groundwater exploration for the proposed pulp mill. They identified an upper aquifer (equivalent to the Upper Bulkley Alluvial Aquifer [0659]) and a lower aquifer (equivalent to the Bulkley Buried Channel Aquifer [0660]). Both aquifers were found to be capable of meeting the required demand for the pulp mill.

A.4 AQUIFER REFERENCES

BROWN, W.L. 1967 Preliminary Groundwater Survey for Bulkley Valley Pulp & Timber Ltd., Proposed Pulp Mill at Houston B.C. Sandwell & Company Project No. 1676, November 1967.

BROWN, W. L., ERDMAN, R.B. 1970. Bulkley Valley Forest Industries Ltd. Groundwater Exploration for Proposed Pulp Mill at Houston, British Columbia. Sandwell and Company Ltd. December 1970.

Geographic datasets from the BC Data Catalogue, accessed August 2020 https://data.gov.bc.ca/

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof and Houston Aquifer Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
20031122	1	Major	Initial Mapping of Aquifer	W.S. Hodge
20061210	2	N/A	N/A	A.P. Kohut
20200922	3	Major	Remapping Aquifer extents to match with surficial mapping	Andrew Hinnell, P.Geo., Tibor Lengyel and Sean Funk

Mapping by W.S. Hodge assumed to be initial mapping of aquifer. N/A – The extent of revisions implemented by A.P. Kohut not documented.

Aquifer Name: Bulkley Buried Channel Aquifer

Date of Mapping: September 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Tibor Lengyel, M.Sc. and Sean Funk, Ph.D.

A. AQUIFER DESCRIPTION FOR AQUIFER 0660

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The aquifer follows a low in the bedrock surface, which runs roughly parallel with the Upper Bulkley River, extending from the town of Topley down toward the town of Houston. The aquifer is bounded in the west by the Morice River, with the rest of the boundaries primarily defined based on borehole logs with some information from surface water features and topography.

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

The Bulkley Buried Channel Aquifer is typically immediately overlain by glaciolacustrine Fraser ice advance deposits but can be locally overlain by Fraser till (see Hinnell et al., 2020, Figures 7A to 7E). Glaciolacustrine Fraser ice retreat deposits overlay those deposits, with Holocene clean sand and gravel alluvial deposits associated with the Bulkley Surficial Aquifer (0659).

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 4B CONFINED GLACIOFLUVIAL

As interpreted in cross-sections (Hinnell et al., 2020, Figures 7A to 7E) the Fraser-aged glaciofluvial sands of Aquifer 0660 are generally confined. The aquifer material is typically clean sand and gravel, with sand and fines in some locations.

A.1.4 VULNERABILITY-LOW

Available lithological information obtained from borehole logs indicate that the aquifer is covered by fine-grained, glaciolacustrine sediment or till across its extent. Accordingly, the aquifer is interpreted to have a low vulnerability to surface contamination.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels in the aquifer range from relatively shallow (0.9 m) to deep (48.5 m). No provincial observation wells exist within the aquifer extents. Artesian wells were not reported for any of the wells in the aquifer.

Calculated groundwater surface elevations appear to correspond to topography, suggesting that the groundwater surface may be a subdued replica of the topography. Accordingly, groundwater is expected to flow towards the Upper Bulkley and Morice rivers.

A.2.2 RECHARGE

The aquifer is expected to be primarily recharged from overlying and underlying aquifers (i.e. Topley Bedrock Aquifer [0654], Houston Bedrock Aquifer [0658], Upper Bulkley Alluvial Aquifer [0659], and the North Houston Bedrock Aquifer [0775]). The aquifer may be recharged by surface water features, like the Upper Bulkley River; however, further investigation is required.

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater may be connected to the surface water features such as the Upper Bulkley River where the intervening fine-grained layers are thin, absent, and or fractured. Furthermore, where not separated by fine grained (low permeability) sediments, it may also be hydraulically connected with the underlying bedrock aquifers (Houston Bedrock Aquifer [0658], North Houston Bedrock Aquifer [0775], and Topley Bedrock Aquifer [0654]) and overlying unconsolidated sediment aquifer (Upper Bulkley Alluvial Aquifer [0659], see Hinnell et al. 2020, Figures 7A to 7E).

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

There were no water quality concerns recorded in the well records. Driller's well yield estimates range from between approximately 0.06 L/s to 12.6 L/s with a geometric mean of 0.86 L/s, suggesting a moderately productive aquifer with localized pockets of poorly and highly productive intervals. There were wells noted to be dry within the aquifer.

Where groundwater use records were available, the water wells were dominantly used for domestic water supply purposes.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

Brown and Erdman (1970) undertook an intrusive groundwater exploration for the proposed pulp mill. They identified an upper aquifer (equivalent to the Upper Bulkley Alluvial Aquifer [0659]) and a lower aquifer (equivalent to the Bulkley Buried Channel Aquifer [0660]). Both aquifers were found to be capable of meeting the required demand for the pulp mill.

A.4 AQUIFER REFERENCES

BROWN, W. L., ERDMAN, R.B. 1970. Bulkley Valley Forest Industries Ltd. Groundwater Exploration for Proposed Pulp Mill at Houston, British Columbia. Sandwell and Company Ltd. December 1970.

Geographic datasets from the BC Data Catalogue, accessed August 2020 https://data.gov.bc.ca/

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof and Houston Aquifer Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

TIPPER, H. W. 1971. Surficial Geology, McLeod Lake, 1:250000. Geological Survey of Canada.

A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
20031124	1	Major	Initial Mapping of Aquifer	W.S. Hodge
20061114	2	N/A	N/A	A.P. Kohut
20200909	3	Major	Remapping Aquifer extents to match with surficial mapping	Andrew Hinnell, P.Geo., Tibor Lengyel and Sean Funk

Mapping by W.S. Hodge assumed to be initial mapping of aquifer. N/A – The extent of revisions implemented by A.P. Kohut not documented.

Aquifer Name: Stellako Unconsolidated Aquifer System

Date of Mapping: March 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Tibor Lengyel, M.Sc. and Sean Funk, Ph.D.

A. AQUIFER DESCRIPTION FOR AQUIFER 0668

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The aquifer is located west of Fraser Lake. The aquifer boundaries largely follow the alluvial plain of the Stellako and Endako rivers as defined by Plouffe (1996, see Hinnell et al. 2020, Figure 5) with slight adjustments based on borehole information. The east boundary of the aquifer follows Fraser Lake. The southeast extent of the aquifer has been extended towards the Village of Fraser Lake to incorporate permeable sediments observed in the vicinity of the village. The boundary of the aquifer near the Village of Fraser Lake is defined based on interpolated overburden thickness (Hinnell et al. 2020, Figure 4).

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

Aquifer 0668 appears to occur at the surface between the Endako and Stellako rivers. Near the village of Fraser Lake, as well as north of Endako River the overlying materials appear to be glaciolacustrine silts and clays associated with the Fraser Glaciation (Plouffe 1996).

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 2 UNCONFINED DELTAIC/4A UNCONFINED GLACIOFLUVIAL/4B CONFINED GLACIOFLUVIAL

Aquifer 0668 appears to be a layered (2) aquifer system comprising of recent, deltaic sediments overlying interlayered glaciofluvial sand and gravels. West of Fraser Lake, a discontinuous fine-grained unit appears to separate the lower sands from the upper sands in several boreholes.

A.1.4 VULNERABILITY - MEDIUM

Available lithology and surficial mapping (Plouffe 1996) indicate that the sands are covered by fine-grained, glaciolacustrine sediments (particularly, near the Village of Fraser Lake and in its northwest and southwest extremities). However, in a large portion of the aquifer the alluvial sands are exposed at the surface, where, if the intervening lower conductivity layers are absent, localized “windows” of high permeability material could potentially exist.

The aquifer is considered low vulnerability to surface contamination near the Village of Fraser Lake, where overlying fine-grained sediments protect it from infiltration (Plouffe 1996, see Hinnell et al. 2020, Figure 5). West of Fraser Lake, where the aquifer is at surface and no intervening low conductivity layers separate the lower layer from the upper layer, the aquifer is considered to be of high vulnerability. The overall vulnerability of the aquifer to surface contamination is deemed medium.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels range from surface (0.3 m) to moderately deep (> 30 m). No provincial observation wells exist within the aquifer extents. There are no known wells with artesian conditions in the aquifer.

Groundwater is inferred to flow towards Fraser Lake.

A.2.2 RECHARGE

Recharge of the aquifer could occur via distributed infiltration of precipitation. It is possible the aquifer is also recharged from the Stellako and Endako rivers However, further investigation of this is required.

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater may be connected surface water features, specifically the Stellako and Endako rivers and Fraser Lake given the setting of the aquifer. Furthermore, it may also be connected with the underlying North Nechako Terrace Bedrock Aquifer (0650), where no fine-grained sediments separate the two. The Endako Confined Aquifer (0643) exists west of the aquifer. A connection between aquifer 0668 and the Endako Confined Aquifer (0643) may exist, however further studies are required to confirm hydraulic connections.

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

There were no water quality concerns recorded in the well records. However, a few holes were dry upon installation suggesting the presence of potential low permeability pockets within the aquifer. Estimated well yields range from 0.1 L/s to over 12 L/s with a geometric average of 0.9 L/s suggesting moderately productive aquifer with highly productive pockets. No other comments regarding water use were noted in the well records.

Where groundwater use records were available, the water wells were used for domestic water supply.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

No water availability or water budget studies have been completed in the area.

A.4 AQUIFER REFERENCES

Geographic datasets from the BC Data Catalogue, accessed March 2020 https://data.gov.bc.ca/

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof and Houston Aquifer Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

PLOUFFE, A. 1996. Surficial geology, Fraser Lake, British Columbia (93K/SE), 1;100 000. Victoria, B.C.: Geological Survey of Canada.

A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
20031227	1	Major	Initial Mapping	S.L. Kenny.
20200325	2	Major	Remapping of aquifer extents; aquifer extents include former aquifers 0669 and 0670 as well.	Andrew Hinnell, P.Geo., Tibor Lengyel, and Sean Funk

2003 mapping is assumed to be the initial mapping of the aquifer.

Aquifer Name: South Fraser Lake Bedrock Aquifer

Date of Mapping: March 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Sean Funk, Ph.D., and Tibor Lengyel, M.Sc.

A. AQUIFER DESCRIPTION FOR AQUIFER 0673

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The aquifer is located on the southern shore of Fraser Lake. The bedrock aquifer is bounded to the north by the shoreline of Fraser Lake and by a watershed boundary. The aquifer is bounded in the east by Nechako River. The southern and western extents of the aquifer are constrained by several faults, inferred to be impermeable boundaries. However, the hydraulic properties of the faults are speculative and require further investigation.

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

Overlying materials consist of Quaternary unconsolidated sediment. Immediately above the bedrock are Fraser glaciofluvial deposits of the Stellako Unconsolidated Aquifer System (0668), followed by finer-grained sediment from the glaciolacustrine Fraser ice-advance, Fraser till, and glaciolacustrine Fraser ice-retreat deposits. A veneer of post-glacial sediments intermixed with organics are present at the surface. Well records also indicate towards the eastern portion of the bedrock aquifer, near Nechako River, that Fraser glaciofluvial deposits of the Nechako Buried Valley Aquifer (0242) and recent alluvial sands of the Fort Fraser Alluvial Aquifer (1247) overlie bedrock.

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 6B FRACTURED CRYSTALLINE ROCK

The bedrock aquifer consists of blocks of Jurassic granitic rocks of the Endako Batholith, and Eocene to Oligocene andesitic to rhyolitic volcanic rocks of the Endako Formation (Massey et al. 2005; Struik et al. 2007; Erdmer and Cui 2009). Permeability of the bedrock aquifer is inferred to be associated with fractures.

A.1.4 VULNERABILITY - MEDIUM

Surficial geology of the area indicates that much of the land surface is covered by Fraser till or fine-grained glaciolacustrine sediment. Well records indicate that the thickness of the clay or till units is variable, ranging from a few metres near the coastline of Fraser Lake or Nechako River, to nearly 100 m in some wells. However, some well records indicate that this clay or till unit is absent and only sand and gravel exist above the bedrock. Thus localized “windows” of vulnerability exist. Based on this description, the aquifer generally has a low vulnerability to surface contamination with the potential for localized areas of high vulnerability. Overall the aquifer is assessed to have medium vulnerability to surface contamination.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels range from shallow (1 m) to deep (70 m). No provincial observation wells exist within the aquifer extents. There are seven wells with artesian conditions in the aquifer.

Static water levels in the well records suggest that the groundwater likely flows north and east toward Fraser Lake and Nechako River, respectively.

A.2.2 RECHARGE

Overburden appears patchy or absent over most of the bedrock aquifer (see Hinnell et al. 2020, Figure 4). Accordingly, recharge of the aquifer could occur via distributed infiltration of precipitation. Where the Stellako Unconsolidated Aquifer System (0668) overlies Aquifer 0673, the bedrock aquifer may be recharged from infiltration from the overlying aquifer.

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater is inferred to be hydraulically connected to Nechako River, Stellako River, and Fraser Lake. Well records indicate that the coarser-grained material may be confined to the eastern portion of the bedrock aquifer, and that clay or till directly overlie the central and western portion of the bedrock aquifer. If intervening low permeability units are absent, the aquifer may be in hydraulic connection with the overlying Stellako Unconsolidated Aquifer System (0668).

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

Well records do not comment on the quality of the groundwater produced. Stated yields in the well records range from less than 0.1 L/s to 6.3 L/s, with a geometric mean of 0.2 L/s, suggesting a low productivity aquifer.

Groundwater is used primarily for domestic purposes based on well records.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

No water availability or water budget studies have been completed in the area.

A.4 AQUIFER REFERENCES

ERDMER, P., AND CUI, Y. 2009. Geological Map of British Columbia. Ministry of Energy and Mines, BC Geological Survey, Geoscience Map 2009-1

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof and Houston Aquifer Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

MASSEY, N.W.D., MACINYRE, D.G., DESJARDINS, P.J. & COONEY, R.T. 2005. Geology of British Columbia. Ministry of Energy and Mines, BC Geological Survey, Geoscience Map 2005-3.

STRUIK, L.C., MACINTYRE, D.G. & WILLIAMS, S.P. 2007. Nechako NATMAP Project: A Digital Suite of Geoscience Information for Central British Columbia (NTS Map Sheets 093N, 093K, 093F, 093G/W, 093L/9,16, & 093M/1,2,7,8). Geological Survey of Canada, Open File 5623.

A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
20031229	1	Major	Initial Mapping of Aquifer	S. Kenny
20200324	2	Major	Remapping of Aquifer 672 and 673.	Andrew Hinnell, P.Geo., Sean Funk, and Tibor Lengyel

2003 mapping is assumed to be the initial mapping of the aquifer.

Aquifer Name: Barrett Hat Bedrock

Date of Mapping: October 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Sean Funk, Ph.D., and Tibor Lengyel, M.Sc.

A. AQUIFER DESCRIPTION FOR AQUIFER 0675

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The aquifer is located northwest of Mount Harry Davis between Fishpan Lake and Vallee Lake. The aquifer is interpreted to be connected with bedrock aquifers to the northwest (outside the study area for Hinnell et al. [2020]). The southeast boundaries of the aquifer have been assessed by Hinnell et al. (2020). Aquifer boundaries towards the north and the west are delineated based on well development and dry boreholes. The southern aquifer boundary is delineated based on an interpreted groundwater divide. The eastern boundary follows 900 m topographic elevation line.

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

Overlying materials consist of Quaternary unconsolidated sediment. Overlying sediments may be coarse grained (Fraser ice-advance glaciofluvial) or fine grained (pre-Fraser sediments, Fraser ice-advance glaciolacustrine or Fraser till). Much of the overlying material consists of finer-grained sediments. Well records also indicate that there are lenses of sand and gravel intermixed within the clay or till package.

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 6B FACTURED CRYSTALLINE ROCK

The bedrock aquifer consists of Eocene basaltic volcanic rocks of the Buck Creek Formation of the Endako Group and Jurassic calc-alkaline volcanic rocks of the Telkwa Formation of the Hazelton Group (Massey et al. 2005). Permeability is inferred to be associated with fractures.

A.1.4 VULNERABILITY - MEDIUM

Surficial geological mapping by Tipper (1976) indicates that most of the bedrock aquifer is covered by Quaternary sediments, which are interpreted to be fine grained (Fraser Glaciation till or Fraser ice advance and ice retreat glaciolacustrine sediments). Well records indicate that the thickness of the clay or till units is variable, ranging from approximately 20 m to over 90 m in some wells. Stumpf (2008) described the till in the area to contain vertical jointing and sub-horizontal fissility, which facilitates downward seepage of surface water to the aquifer. The vulnerability of the aquifer is classified as medium, where the bedrock is covered by Quaternary sediments and high where the aquifer outcrops at surface or is only covered by a thin veneer of overburden (in topographically elevated areas). Thus, the overall vulnerability of the bedrock aquifer to surface contamination is assessed as medium.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels range from shallow (5.1 m) to deep (30.5 m). No provincial observation wells exist within the aquifer extents. There are no springs or artesian wells within the footprint of the aquifer (see Hinnell et al., 2020 Figure 8B).

There are insufficient water levels in the well records to interpret the groundwater surface. However, based on the conceptual understanding of groundwater flow groundwater is interpreted to flow towards the northwest.

A.2.2 RECHARGE

Overburden cover is not continuous over the aquifer (see Tipper 1976). Where overburden is thin or absent, recharge of the aquifer could occur via distributed infiltration of precipitation. In the areas where overburden is present, the aquifer may be recharged by infiltration through fractures in the overlying fine-grained units.

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater is inferred to be hydraulically connected to Fishpan and Vallee Lakes.

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

There are no documented water quality concerns within this aquifer in well records. There was a well noted to be dry within the aquifer. Stated yields in the well records range from 0.12 L/s to 0.31 L/s, with geometric mean of 0.20 L/s indicating a poorly productive aquifer.

Groundwater is used primarily for domestic purposes based on well records.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

No water availability or water budget studies have been completed in the area.

A.4 AQUIFER REFERENCES

Geographic datasets from the BC Data Catalogue, accessed August 2020 https://data.gov.bc.ca/

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof Aquifer and Houston Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

MASSEY, N.W.D., MACINYRE, D.G., DESJARDINS, P.J. & COONEY, R.T. 2005. Geology of British Columbia. Ministry of Energy and Mines, BC Geological Survey, Geoscience Map 2005-3.

STUMPF, A. J. 2008. Till Geochemistry and Clast Lithology Studies of the Bulkley River Valley, West-Central British Columbia (parts of NTS 093L). Geoscience BC Report.

TIPPER, H. W. 1976. Geology of Smithers Map Area, British Columbia, 1:250000. Geological Survey of Canada, Open File 351.

A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
20031125	1	Major	Initial Mapping of Aquifer	W.S. Hodge
20201015	2	Minor	Adjusted aquifer extents to the south and east	Andrew Hinnell, P.Geo., Sean Funk, and Tibor Lengyel

Mapping by W.S. Hodge assumed to be initial mapping of aquifer.

Aquifer Name: North Houston Bedrock

Date of Mapping: September 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Sean Funk, Ph.D., and Tibor Lengyel, M.Sc.

A. AQUIFER DESCRIPTION FOR AQUIFER 0775

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The aquifer is located north of Houston, north of the Upper Bulkley and Bulkley rivers. The bedrock aquifer is bounded to the north by a groundwater divide and by the 900 m topographic elevation line, in the west and the south by the Bulkley and Upper Bulkley rivers, and in the east by faults, inferred to be impermeable, however this should be confirmed.

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

Overlying materials consist of Quaternary unconsolidated sediment. Overlying sediments may be coarse grained (Fraser ice-advance glaciofluvial) or fine grained (pre-Fraser sediments, Fraser ice-advance glaciolacustrine or Fraser till, see Hinnell et al., 2020 Figure 7B, 7C). Much of the overlying material consists of finer-grained sediments. Well records also indicate that there are lenses of sand and gravel intermixed within the clay or till package. At the surface, there is a veneer of post-glacial sediment localized within the valley bottom, composed of clean sand and gravel.

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 6B FACTURED CRYSTALLINE ROCK

The bedrock aquifer consists of blocks of Eocene basaltic volcanic rocks of the Buck Creek Formation and alkaline volcanic rocks of the Goosly Lake Formation, both within the Endako Group, and Jurassic calc-alkaline volcanic rocks of the Telkwa Formation of the Hazelton Group (Massey et al. 2005). Permeability is inferred to be associated with fractures.

A.1.4 VULNERABILITY - MEDIUM

Surficial geological mapping by Tipper (1976) indicates that most of the bedrock aquifer is covered by Quaternary sediments, which are interpreted to be fine grained (Fraser Glaciation till or Fraser ice advance and ice retreat glaciolacustrine sediments, see Hinnell et al., 2020 Figure 7B, 7C). Well records indicate that the thickness of the clay or till units is variable, ranging from a few metres to nearly 75 m in some wells. Stumpf (2008) described the till in the area to contain vertical jointing and sub-horizontal fissility, which facilitates downward seepage of surface water to the aquifer. The vulnerability of the aquifer is classified as medium, where the bedrock is covered by Quaternary sediments and high where the aquifer outcrops at surface or is only covered by a thin veneer of overburden (in topographically elevated areas). Thus, the overall vulnerability of the bedrock aquifer to surface contamination is assessed as medium.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels range from shallow (3.1 m) to deep (89.0 m). No provincial observation wells exist within the aquifer extents. There are two springs interpreted to be associated with the bedrock aquifer (see Hinnell et al., 2020 Figure 8B).

Static water levels in the well records suggest that the groundwater is a subdued representation of bedrock topography. Based on the conceptual understanding of groundwater flow and the observed springs groundwater is interpreted to flow towards the Upper Bulkley and Bulkley rivers with an upward seepage potential near the river.

A.2.2 RECHARGE

Overburden cover is not continuous over the aquifer (see Tipper 1976). Where overburden is thin or absent, recharge of the aquifer could occur via distributed infiltration of precipitation. In the areas where overburden is present, the aquifer may be recharged by infiltration from various overlying units, including the overlying Bulkley Buried Channel (0660).

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater is inferred to be hydraulically connected to Upper Bulkley and Bulkley Rivers. Groundwater in the bedrock may be hydraulically connected to the overlying Bulkley Buried Channel (0660) if fine-grained layers are not present between them. There are also several lakes that the bedrock aquifer may be hydraulically connected to, including Barrett, Dunalter, Mathews, and Vallee lakes.

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

There are no documented water quality concerns within this aquifer in well records. There were wells noted to be dry within the aquifer. Stated yields in the well records range from 0.03 L/s to 0.63 L/s, with geometric mean of 0.12 L/s indicating a poorly productive aquifer with localized regions of moderate productivity.

Groundwater is used primarily for domestic purposes based on well records.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

No water availability or water budget studies have been completed in the area.

A.4 AQUIFER REFERENCES

Geographic datasets from the BC Data Catalogue, accessed August 2020 https://data.gov.bc.ca/

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof Aquifer and Houston Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

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A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
20031126	1	Major	Initial Mapping of Aquifer	W.S. Hodge
20061117	2	N/A	N/A	A.P. Kohut
20200917	3	Major	Remapping of Aquifer	Andrew Hinnell, P.Geo., Sean Funk, and Tibor Lengyel

Mapping by W.S. Hodge assumed to be initial mapping of aquifer. N/A – The extent of revisions implemented by A.P. Kohut not documented.

Aquifer Name: West Cluculz Lake Bedrock Aquifer

Date of Mapping: March 2020

Authors: Andrew Hinnell, Ph.D., P.Geo., Sean Funk, Ph.D., and Tibor Lengyel, M.Sc.

A. AQUIFER DESCRIPTION FOR AQUIFER 1246

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The aquifer is located west of Cluculz Lake. The bedrock aquifer is bounded to the west and south by a series of faults, which are inferred to be low permeability zones. However, the hydraulic properties of the faults are speculative, and requires further investigation. The northern extent of Aquifer 1246 is bounded by the Nechako River, whereas the eastern extent is partially constrained by watershed boundaries and the shoreline of Cluculz Lake.

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

Overlying materials consist of Quaternary unconsolidated sediment. Immediately above the bedrock are Fraser glaciofluvial deposits of the South Vanderhoof Unconsolidated Aquifer (0246, see Hinnell et al. 2020, Figure 6H), followed by fine-grained sediments from the glaciolacustrine Fraser ice-advance, Fraser till, and glaciolacustrine Fraser ice-retreat deposits. A veneer of post-glacial sediment intermixed with organics are present at the surface. Well records also indicate that there are localized layers of sand and gravel intermixed within the clay or till package.

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 6B FRACTURED CRYSTALLINE ROCK

The bedrock aquifer consists of mostly Permian to Triassic basaltic rocks of the Cache Creek Complex, with some Oligocene to Pliocene sedimentary rocks (conglomerates and coarse-grained sandstone) of the Australian Creek and Fraser Bend formations (Logan et al. 2010). Permeability of the bedrock aquifer is inferred to be associated with fractures.

A.1.4 VULNERABILITY - LOW

Surficial geological mapping of the area by Clague (1998) indicates that much of the land surface is covered by Fraser till or fine-grained glaciolacustrine sediment. Well records indicate that the thickness of the clay or till units is relatively consistent, with an average thickness of 40 m. Based on surficial mapping (Clague 1998), the thickness of overlying lacustrine sediments is variable which may impact local vulnerability of the aquifer. The overall vulnerability of the aquifer to surface contamination is deemed low.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels range from shallow (5 m) to deep (50 m). Calculated groundwater surface elevations appear to generally decrease towards the north (i.e. towards the Nechako River). No provincial observation wells exist within the aquifer extents. There are seven wells with artesian conditions in the aquifer.

Groundwater is interpreted to flow to the north, discharging to the Nechako River.

A.2.2 RECHARGE

The southwestern extremity of the aquifer has been delineated in an area where overlying sediments are getting thin or are absent (see Hinnell et al. 2020, Figure 4). In this portion of the aquifer, recharge of the aquifer could occur via distributed infiltration of precipitation. Elsewhere, where thick packages of overlying sediments are present, the aquifer may be recharged from infiltration from various overlying units, including the overlying Sinkut Mountain North Surficial Aquifer (0240) and the South Vanderhoof Unconsolidated Aquifer (0246), if the intervening low permeability units are absent.

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater is inferred to be hydraulically connected to Nechako River. It is unclear whether the groundwater is hydraulically connected to Cluculz Lake as there are no wells screened in bedrock adjacent to the lake. Figure 6H (see Hinnell et al. 2020) illustrates that the intervening fine-grained pre-Fraser sediment may thin toward the west, and that the overlying Fraser glaciofluvial aquifer (South Vanderhoof Unconsolidated Aquifer [0246]) may be in geologic contact with the bedrock. It may be possible that the bedrock aquifer is hydraulically connected to the overlying unconsolidated aquifers (Sinkut Mountain North Surficial Aquifer [0240], and South Vanderhoof Unconsolidated Aquifer [0246]).

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

Well records do not comment on the quality of the groundwater produced. Stated yields in the well records range from 0.1 L/s to 2.5 L/s, with a geometric mean of 0.7 L/s indicating a moderately productive aquifer.

Groundwater is used primarily for domestic water supply, with only one well categorized as for commercial purposes (livestock watering), based on land use and well records for the region.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

No water availability or water budget studies have been completed in the area.

A.4 AQUIFER REFERENCES

CLAGUE, J. J. 1998. Surficial Geology, Cluculz Lake, British Columbia. Geological Survey of Canada, Open File 3638.

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof and Houston Aquifer Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

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A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
20200325	1	Major	Initial Mapping of Aquifer	Andrew Hinnell, P.Geo., Sean Funk, and Tibor Lengyel

Aquifer Name: Fort Fraser Alluvial Aquifer

Date of Mapping: March 2020

Authors: Andrew Hinnell, PhD, P.Geo., Tibor Lengyel, M.Sc. and Sean Funk, Ph.D.

A. AQUIFER DESCRIPTION FOR AQUIFER 1247

A.1 CONCEPTUAL UNDERSTANDING OF HYDROSTRATIGRAPHY

A.1.1 AQUIFER EXTENTS

The aquifer is located the eastern end of Fraser Lake along the Nechako River. The aquifer boundaries follow the mapped extents of the alluvial plain along the Nechako River (Plouffe, 1996, Plouffe et al. 2004, see Hinnell et al. 2020, Figure 5).

A.1.2 GEOLOGIC FORMATION (OVERLYING MATERIALS)

Aquifer 1247 is a surficial alluvial aquifer, and thus no overlying materials are present.

A.1.3 GEOLOGIC FORMATION (AQUIFER) – 1A UNCONFINED FLUVIAL

Aquifer 1247 is an alluvial aquifer along the Nechako River. Borehole descriptions indicate that the material can range from fine grained sediments (silts, fine sands) to coarse grained sediments (gravels).

A.1.4 VULNERABILITY - HIGH

The alluvial sands of the aquifer are exposed at surface, and thus the aquifer is deemed to have high vulnerability to surface contamination.

A.2 CONCEPTUAL UNDERSTANDING OF FLOW DYNAMICS

A.2.1 GROUNDWATER LEVELS AND FLOW DIRECTION

Static water levels range from shallow (2.4 m) to moderately deep (> 15 m). No provincial observation wells exist within the aquifer extents. There are no known wells with artesian conditions in the aquifer.

Calculated groundwater surface elevations are variable between Fraser Lake and Nechako River and show limited spatial patterns. South of Fraser Lake, groundwater levels closer to the flanks of the aquifer appear to have higher groundwater surface elevations than the river levels suggesting groundwater flows towards the Nechako River.

A.2.2 RECHARGE

Recharge of the aquifer could occur via distributed infiltration of precipitation. Based on water levels reported for wells located between Nechako River and Fraser Lake, it is possible that the aquifer is also seasonally recharged from either of these surface water features. However, further investigation of this is required.

A.2.3 POTENTIAL FOR HYDRAULIC CONNECTION

Groundwater is likely connected to surface water features, specifically the Nechako River and Fraser Lake. The aquifer may also be connected with the underlying unconsolidated confined aquifer (Nechako Buried Valley Aquifer [0242], see Hinnell et al., 2020, Figure 6A), where fine-grained sediments separating the aquifers is absent. The aquifer is also underlain by multiple bedrock aquifers (Fort Fraser Bedrock Aquifer [0239], South Nechako Terrace Bedrock Aquifer [0243], and South Fraser Lake Bedrock Aquifer [0673]). The aquifers may be connected where low conductivity sediments are absent. Such connections are especially likely closer to the edges of the alluvial plane, where the bedrock rises closer to the surface (see Hinnell et al. 2020, Figure 3). Further study is required to delineate locations for potential hydraulic connection

A.3 WATER MANAGEMENT

A.3.1 ADDITIONAL INFORMATION ON WATER USE AND MANAGEMENT

There were no water quality concerns recorded in the well records. One of the wells was dry upon installation. This well was installed close to the boundaries of the aquifer. Driller's well yield estimates range from 0.1 L/s to 3.2 L/s with a geometric average of 0.7 L/s suggesting a moderately productive aquifer. No other comments regarding water use were noted in the well records.

Where groundwater use records were available, the water wells were used for domestic water supply.

A.3.2 ADDITIONAL ASSESSMENTS OR MANAGEMENT ACTIONS

No water availability or water budget studies have been completed in the area.

A.4 AQUIFER REFERENCES

Geographic datasets from the BC Data Catalogue, accessed March 2020 https://data.gov.bc.ca/

HINNELL, A. C., LENGYEL, T., FUNK, S. P., CLAGUE, J. J. & HAMMOND, Z. M. 2020. Vanderhoof and Houston Aquifer Mapping and Hydrostratigraphic Characterization. Water Science Series. Victoria, B.C.

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A.5 REVISION HISTORY

Date	Version	Revision Class	Comments	Author
20200325	1	Major	Initial Mapping of Aquifer	Andrew Hinnell, P.Geo., Tibor Lengyel, and Sean Funk