

File: 1809191

January 29, 2019

CHZ International Investment Inc.
7029 Cariboo Highway
Clinton BC
V0K 1K0

Attention: CHZ International Investment Inc.

Re: Conceptual Characterization of Aquifer 921 at Clinton, British Columbia

As requested, the following assessment has been completed of Aquifer 921 at Clinton based on an examination of previous studies, available soils and geological reports, water well records and groundwater level data for the region.

Previous Studies

Aquifer 921 was previously mapped and classified for the Ministry of Environment by W.S. Hodge, P. Geo., in 2007. According to the aquifer classification work sheet, available at the *BC Water Resources Atlas* (Ministry of Environment, 2019a), the aquifer occupies an area of 4.6 km² and is classified as a IIC unconsolidated aquifer with a ranking value of 8. A IIC aquifer, indicates a low level of development and low level of vulnerability to sources of contamination at the land surface (Berardinucci and Ronneseth, 2002). In 2007, Hodge based his classification on consideration of only 4 well records. He also regarded the aquifer as being confined by clay or till over the entire aquifer. Aquifer boundaries were delineated by Hodge, based on well log lithology and topography, with a dashed line to indicate a low degree of certainty.

New Well Record Data

Currently there are now some 30 well records available in the vicinity of the Village of Clinton in the WELLS database (Ministry of Environment, 2019a) as indicated in Figure 1. It appears that the majority of these records were not available in 2007 for aquifer delineation at that time. Examination of 19 well records depicted in two geologic cross sections A-B (Figure 2) and C-D (Figure 3) indicates that significant areas of the southern portion of the mapped aquifer appear occupied by unconsolidated sand and gravel under unconfined conditions, while areas close to and along Cutoff Valley Creek appear occupied by interbedded sand and gravel deposits with lenses of till, silt and clay, under confined conditions.

Available mapping of soils and underlying parent deposits (Valentine and Schori, 1980), shows medium-textured fluvial deposits (sand and gravel) of the *Frances* soil association within a delta shaped area around Salt Lake and Duck Lakes (Figure 4).

Salt Lake, Duck Lakes and other nearby small lakes likely represent kettle depressions (United States Geological Survey, 2019) that formed after in-situ blocks of glacier ice melted within the glacial outwash delta. The fluvial deposits also occur within the valley to the south occupied by several lakes such as Three Mile Lake, and 4 Mile Lake, which are situated in a former glacial, lateral overflow channel, as described by Tipper (1971). This valley was also occupied by a Miocene (Tertiary) channel draining towards the north within the Chilcotin Group rocks (Read, 1989). Medium textured, gravelly colluvium including some bedrock soils, of the *Chasm* soil association, are found along Cutoff Valley Creek. During deglaciation of the region, Cutoff Valley Creek was occupied by a large meltwater channel (Tipper, 1971).

Data Compilation and Limitations

In preparing the geologic cross sections across Aquifer 921, the following information sources and data limitations are noted:

1. Well locations, construction records, elevations, lithologic and water level data were obtained from the Ministry of Environment (2019a) and previous reports and maps by: Yin (2013), Lowen (2015), Sarkor (2015a), Sarkor (2015b), and EHD Consulting Ltd. (2018).
2. Original well records, where available from the Ministry of Environment (2019b) were downloaded to verify and correct some of the data compiled under 1 above.
3. All well locations have not been independently confirmed.
4. Lithologic description of units in the cross sections and relationships have been simplified and interpreted for illustrative purposes by the author of this report and may not be entirely accurate in all aspects.
5. Ground elevations of well locations where not available from the above sources, were estimated from contour elevations (20 m interval) available from the Thompson-Nicola Regional District (2019).
6. Data for each well site incorporated in the geologic cross sections, is provided in Table 1 for reference.

Cross Section A-B

Cross section A-B (Figure 2), through the southern portion of the aquifer looks south westerly through the CHZ International Investment Inc., well field. Unconfined groundwater conditions appear to dominate the region around the CHZ well field. This would suggest that the recharge estimates, based on the WTF method, as described by Kohut (2018) would have some validity for this region of the aquifer. Observed water levels shown in the CHZ wells are close to the elevation of Duck Lake. On June 6, 2015 Sarkor (2015a) noted that the static water elevation at Well 41015 (WTN

109378) was higher than the surface water elevation at the Duck Lake staff gauge. This suggests that groundwater in this region is discharging upwards and then moving laterally towards the northwest. Part of this groundwater discharge may be originating from the underlying bedrock formations, based on groundwater quality considerations identified previously by Kohut (2018). The elevation of Salt Lake appears to lie several metres below the observed nearby groundwater levels.

Cross Section C-D

Cross section C-D (Figure 3), extends longitudinally along and across Cutoff Valley Creek, looking northerly. It shows a more complex unconsolidated aquifer system overlying relatively thick silts and clays (possibly lacustrine) to the west over bedrock. Groundwater appears to be moving laterally down gradient and discharging upwards towards Cutoff Valley Creek near elevation 890 m, where flowing artesian conditions are observed. Aquifer 921 then appears to extend a further 1000 m easterly along Cutoff Valley Creek from its currently mapped eastern boundary.

Conclusions

Based on this assessment the following conclusions are provided.

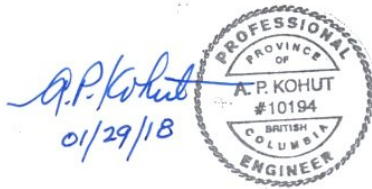
1. The initial mapping and classification of Aquifer 921 in 2007 as a IIC unconsolidated and confined sand and gravel aquifer, was based on only 4 well records, well log lithology and topographic considerations.
2. Currently there are now some 30 well records available in the vicinity of the Village of Clinton within the Ministry of Environment's WELLS database.
3. Geologic cross sections completed as part of this assessment, indicate that significant areas of the southern portion of the mapped aquifer appear occupied by unconsolidated sand and gravel under unconfined conditions, while areas close to and along Cutoff Valley Creek appear occupied by interbedded sand and gravel deposits with lenses of till, silt and clay, under confined conditions.
4. Recharge estimates, based on the WTF method, as described by Kohut (2018) would have some validity for the southern portion of the mapped aquifer where the CHZ International Investment Inc., well field is situated.
5. Comparison of water level elevation data for Duck Lakes and the CHZ wells indicates the upward movement of groundwater (groundwater discharge conditions) in the region of the CHZ well field. Part of this groundwater discharge may be originating from the underlying bedrock formations, based on groundwater quality considerations identified previously (Kohut, 2018).
6. Available well record information indicates that Aquifer 921 extends a further 1000 m easterly along Cutoff Valley Creek from its currently mapped eastern aquifer boundary.

7. Results of the above assessment, supports previous evidence presented by Kohut (2018) outlining the probable groundwater recharge and discharge relationships for Aquifer 921 and that there are likely significant groundwater outflow components from Aquifer 921 towards a currently unmapped and unclassified alluvial valley aquifer underlying the Cutoff Valley Creek – Clinton Creek drainage.

Closure

This report was prepared in accordance with generally accepted engineering, hydrogeological and consulting practices. It is intended for the prime use of CHZ International Investment Inc. This report is based on data and information available to the author from various sources at the time of its preparation and the findings of this report may therefore be subject to revision. Data and information supplied by others has not been independently confirmed or verified to be correct or accurate in all cases. Any errors, omissions or issues requiring clarification should be brought to the attention of the author. The author and Hy-Geo Consulting accepts no responsibility for damages suffered by any third party as a result of any unauthorized use of this report.

Respectfully submitted,



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Principal and Senior Hydrogeologist

HY-GEO CONSULTING

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Figure 1. Reported wells and location of cross sections A-B and C-D. Base map with 20 m contours adapted from Thompson-Nicola Regional District (2019).

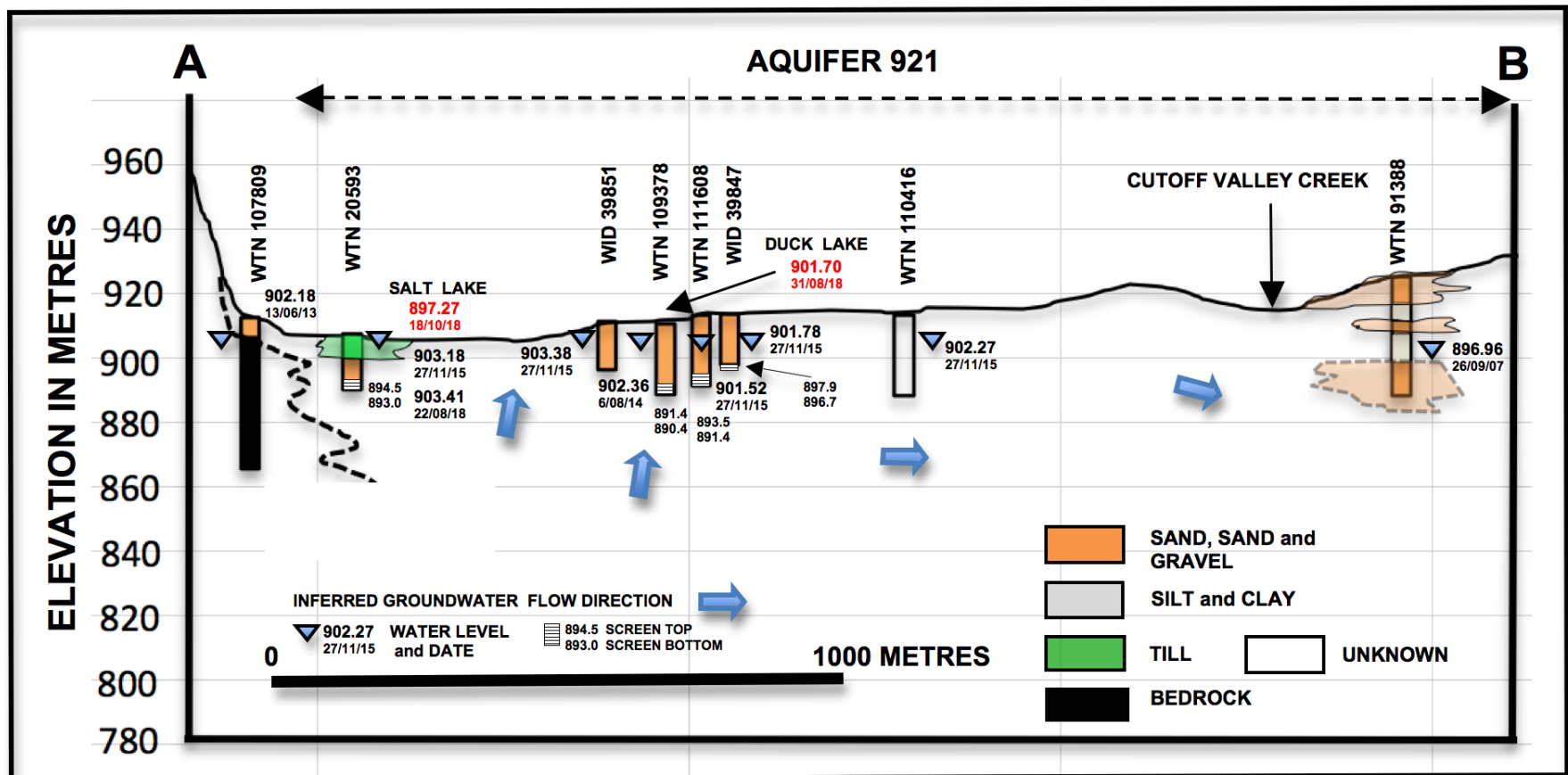


Figure 2. Schematic geologic cross section A-B looking south westerly.

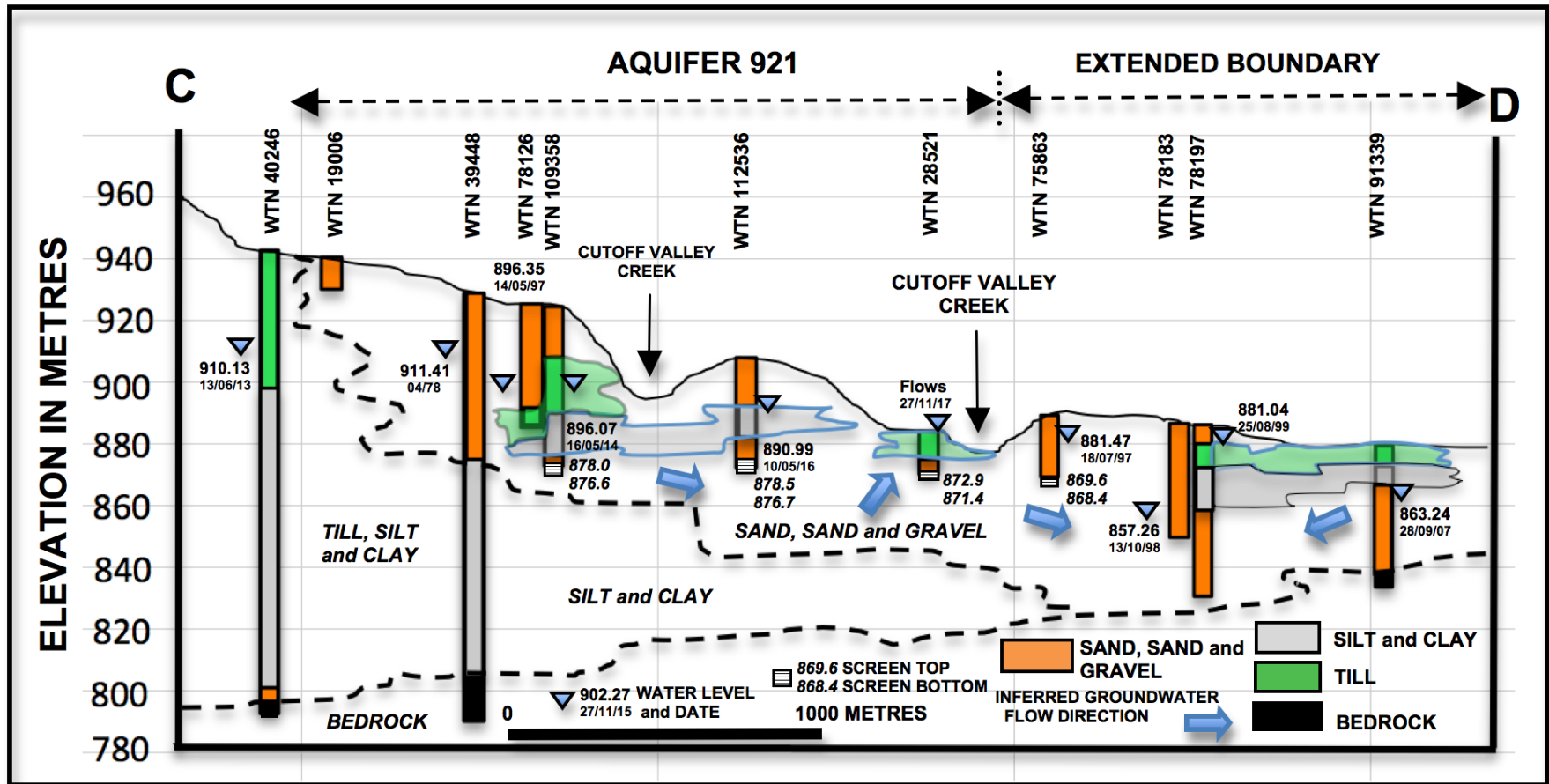


Figure 3. Schematic geologic cross section C-D looking northerly.

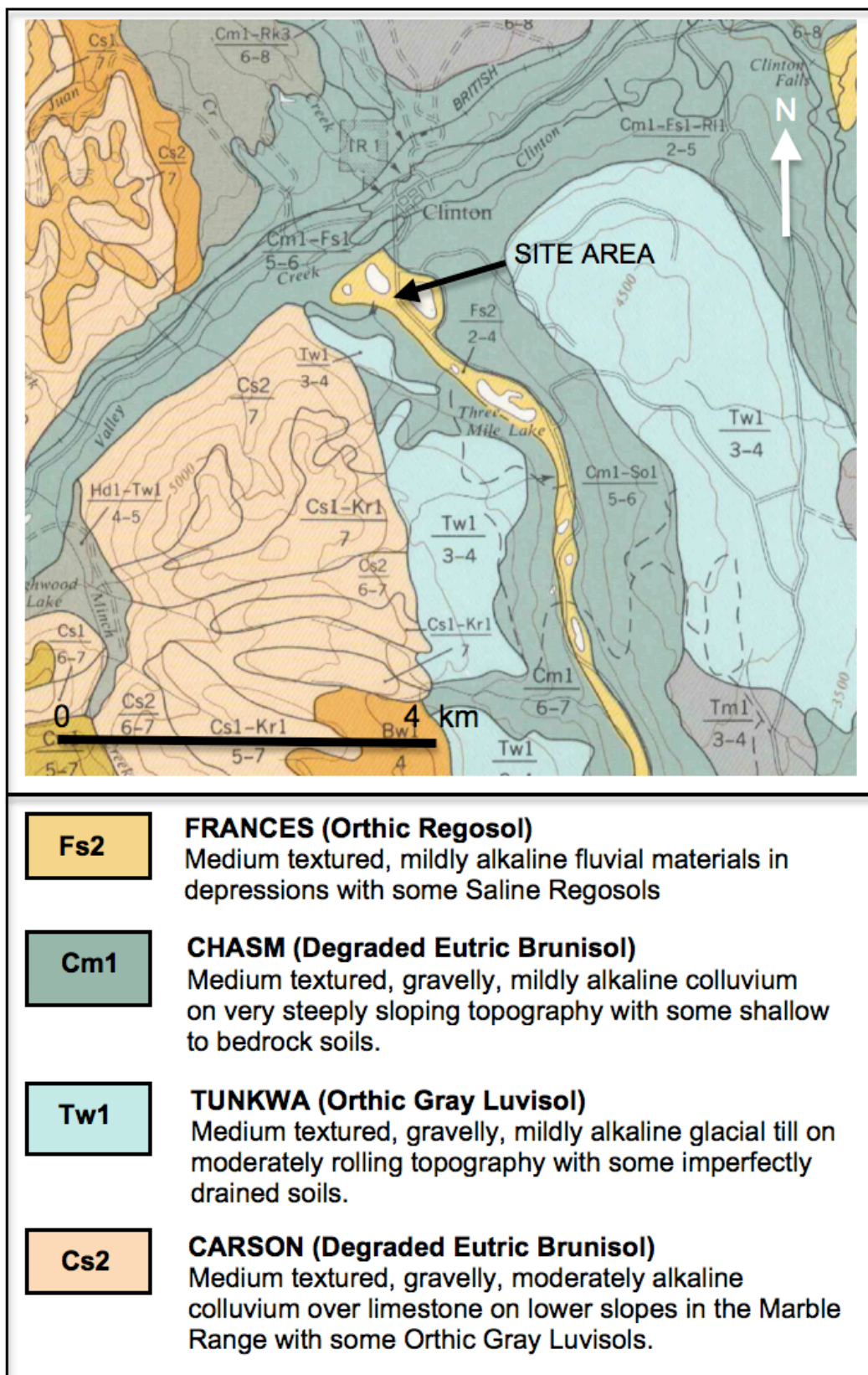


Figure 4. Soil associations in the vicinity of the Village of Clinton. Adapted from Valentine and Schori (1980).

Table 1. Summary of well data utilized in cross sections and well location plan.

Well Tag Number (WTN)	Well ID Plate (WID)	Northing	Easting	Interpreted Lithology	Thickness Feet	Thickness metres	Finished Well Depth (ft)	Finished Well Depth (m)	Top elevation (m)	Bottom elevation (m)	Top screen elevation (m)	Bottom screen elevation (m)	Depth to Water (ft)	Depth to Water (m)	Elevation Water Level (m)	Date Measured	Comments
28521		5660595	599024	till	22	6.706	30	9.144	880.52	873.81	872.90	871.38	Flows	Flows	Flows	27/11/17	GPS Wellhead elevation from EHD Consulting Ltd. (2018), 18/10/18.
				gravel	8	2.438			873.81	871.37							
40246		5660113	597163	till	133	40.538	469	142.951	940	899.46			98	29.870	910.130	13/06/13	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
				clay	313	95.402			899.46	804.06							
				gravel	7	2.134			804.06	801.93							
				bedrock	16	4.877			801.93	797.05							
19006		5660159	597346	gravel	30	9.144	30	9.144	940	930.86							Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
20593	12813	5658923	598981	till	20	6.096	50	15.240	908.21	902.11	894.49	892.97		5.027	903.183	27/11/15	GPS Wellhead elevation from EHD Consulting Ltd. (2018). 31/8/18
				sand	30	9.144			902.11	892.97				4.800	903.410	22/08/18	Water level from Ministry of Environment (2019c).
78197		5661134	599435	sand and gravel	10	3.048	183	55.778	885	881.95			13	3.962	881.038	25/08/99	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
				till	30	9.144			881.95	872.81							
				silt and clay	40	12.192			872.81	860.62							
				till with silty sand	99	30.1752			860.62	830.44							
				sand and gravel	4	1.2192			830.44	829.22							
78201		5661115	599492	sand	15	4.572	112	34.138	885	880.43			18	5.486	879.514	16/10/98	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
				till	80	24.384			880.43	856.05							
				bedrock	17	5.1816			856.05	850.87							
37750		5661132	600380	till	58	17.6784	165	50.292	875	857.32			41	12.497	862.503	25/07/77	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
				bedrock	107	32.6136			857.32	824.71							
75863		5660958	599082	silt and gravel	17	5.1816	71	21.641	890	884.82	869.58	868.35	28	8.534	881.466	18/07/97	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
				sand and gravel	54	16.4592			884.82	868.36							
82697		5661209	599842	gravel	15	4.572	77	23.470	880	875.43			26	7.925	872.075	17/05/04	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
				clay	40	12.192			875.43	863.24							

Well Tag Number (WTN)	Well ID Plate (WID)	Northing	Easting	Interpreted Lithology	Thickness Feet	Thickness metres	Finished Well Depth (ft)	Finished Well Depth (m)	Top elevation (m)	Bottom elevation (m)	Top screen elevation (m)	Bottom screen elevation (m)	Depth to Water (ft)	Depth to Water (m)	Elevation Water Level (m)	Date Measured	Comments
				gravel	22	6.7056			863.24	856.53							
39448		5660137	597792	sand and gravel	168	51.2064	460	140.208	930	878.79			61	18.593	911.407	04/78	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
				clay	243	74.0664			878.79	804.72							
				bedrock	49	14.9352			804.72	789.78							
78183		5661125	599456	sand and gravel	114	34.7472	114	34.747	885	850.25			91	27.737	857.263	13/10/98	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
78126		5660124	597962	sand and gravel	133	40.5384	134	40.843	925	884.46			94	28.651	896.349	14/05/97	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
				till	1	0.3048			884.46	884.16							
86455	11365	5659750	599246	sand and gravel	118	35.9664	118	35.966	950	914.03	915.26	914.19	63	19.202	930.798	6/6/06	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
91339	19281	5661489	599965	sandy clay (till?)	15	4.572	139	42.367	880	875.43			55	16.764	863.236	29/09/07	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
				silt	15	4.572			875.43	870.86							
				silty sand	107	32.6136			870.86	838.25							
				bedrock	2	0.6096			838.25	837.64							
91338	19280	5660024	597807	sand and gravel	25	7.62	122	37.186	925	917.38			92	28.042	896.958	26/09/07	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
				silt	25	7.62			917.38	909.76							
				gravel	10	3.048			909.76	906.71							
				clay	39	11.8872			906.71	894.82							
				gravel	23	7.0104			894.82	887.81							
95205	26355	5660688	599616	till	37	11.2776	127.25	38.786	890	878.72			72	21.946	868.054	16/10/08	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
				sand and gravel	90.25	27.5082			878.72	851.21							
103782	31322	5661240	600499	till	30	9.144	260	79.248	880	870.86			20	6.096	873.904	27/11/09	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
				gravel	32	9.7536			870.86	861.11							
				till	18	5.4864			861.11	855.62							
				bedrock	180	54.864			855.62	800.76							
103711	31336	5660872	599699	gravel	40	12.192	99	30.175	870	857.81	841.04	839.82	13	3.962	866.038	13/05/05	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.

Well Tag Number (WTN)	Well ID Plate (WID)	Northing	Easting	Interpreted Lithology	Thickness Feet	Thickness metres	Finished Well Depth (ft)	Finished Well Depth (m)	Top elevation (m)	Bottom elevation (m)	Top screen elevation (m)	Bottom screen elevation (m)	Depth to Water (ft)	Depth to Water (m)	Elevation Water Level (m)	Date Measured	Comments
				clay	12	3.6576			857.81	854.15							
				gravel	2	0.6096			854.15	853.54							
				clay	23	7.0104			853.54	846.53							
				gravel	3	0.9144			846.53	845.62							
				clay	14	4.2672			845.62	841.35							
				gravel	5	1.524			841.35	839.83							
107809	38346	5658773	598881	sand and gravel	10	3.048	160	48.768	912.99	909.94				10.71	902.280	13/06/13	GPS Wellhead elevation from EHD Consulting Ltd. (2018). 31/8/18. Water level from Yin (2013).
				bedrock	150	45.72			909.94	864.22							
109357	34089	5661453	600377	till	17	5.1816	198	60.350	860	854.82			12	3.658	856.342	12/5/14	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
				silt	141	42.9768			854.82	811.84							
				bedrock	40	12.192			811.84	799.65							
109358	34091	5660122	598007	gravel	60	18.288	156	47.549	924.11	905.82	877.99	876.56	92	28.042	896.070	16/05/14	GPS Wellhead elevation from EHD Consulting Ltd. (2018). 31/8/18
				till	60	18.288			905.82	887.53							
				sand and silt	30	9.144			887.53	878.39							
				clay	2	0.6096			878.39	877.78							
				gravel	4	1.2192			877.78	876.56							
109378	41015	5659284	598684	sand and gravel	70	21.336	70	21.336	911.76	890.42	891.84	890.42	31	9.4	902.360	6/8/14	CHZ Testwell. GPS Wellhead elevation from EHD Consulting Ltd, (2018). 31/8/18. Location coordinates and water level from Lowen (2015).
109412	34090	5661437	600815	till	50	15.24	299	91.135	865	849.76							Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
				bedrock	249	75.8952			849.76	773.86							
110416	48914	5659575	598700	unknown	75	22.86	75	22.860	913.39	890.53				11.12	902.270	27/11/15	GPS Wellhead elevation from EHD Consulting Ltd. (2018). 31/8/18. Water level from Lowen (2015).
110392	39263	5660339	599055	unknown	110	33.528	110	33.528	920	886.47							Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
110399	48287	5659610	596925	unknown	15	4.572	15	4.572	930	925.43			3	0.914	929.086	11/2/97	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.

Well Tag Number (WTN)	Well ID Plate (WID)	Northing	Easting	Interpreted Lithology	Thickness Feet	Thickness metres	Finished Well Depth (ft)	Finished Well Depth (m)	Top elevation (m)	Bottom elevation (m)	Top screen elevation (m)	Bottom screen elevation (m)	Depth to Water (ft)	Depth to Water (m)	Elevation Water Level (m)	Date Measured	Comments
111608	39845	5659289	598691	sand and gravel	68	20.7264	68	20.726	912.13	891.40	893.53	891.40	34.7	10.61	901.520	27/11/15	CHZ Production Well. GPS Wellhead elevation from EHD Consulting Ltd. (2018). 31/8/18. Location coordinates and water level from Lowen (2015).
110434	48905	5661067	599854	unknown	12	3.6576	12	3.658	875	871.34			10	3.048	871.952	1/7/93	Wellhead elevation estimated from Thompson-Nicola Regional District. 2019.
112536	41748	5660210	598620	sand	53	16.1544	100	30.480	907.14	890.99	878.49	876.66	53	16.154	890.990	10/5/16	GPS Wellhead elevation from EHD Consulting Ltd. (2018). 31/8/18.
				clay	27	8.2296			890.99	882.76							
				gravel	20	6.096			882.76	876.66							
	39851	5659215	598681	sand and gravel	58.5	17.8308	58.5	17.8	913.50	895.67				10.12	903.380	27/11/15	CHZ Tempoary Monitoring Well. Location coordinates and water level from Lowen (2015).
	39847	5659328	598717	sand and gravel	58	17.6784	58	17.7	914.40	896.72	897.90	896.70		12.62	901.780	27/11/15	CHZ Monitoring Well. Location coordinates and water level from Lowen (2015).

Note: Well site coordinates from Ministry of Environment (2019a) except where noted otherwise.

Water level data from Ministry of Environment (2019b) except where noted otherwise.

GPS Elevations reported for 31/8/18 are by Underhill Geomatics Ltd.

GPS Elevations reported for 18/10/18 are by EHD Consulting Ltd.