Phase I Groundwater Supply Assessment for Skeleton Lake Residential Subdivision

NW – 13 – 65 - 19W4
Athabasca County

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arletta water resources

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1. EXECUTIVE SUMMARY

A Phase I Groundwater Supply Assessment was undertaken for a proposed 70 - lot residential subdivision located within NW ¼ of Section 13 – 65 – 19W4 to better understand the quality and distribution of aquifer resources in the area as they relate to the future development of the property and its water requirements. Assuming a community water supply an annual yield of approximately 23,000 m^3 is required.

The uppermost stratum in the area consists of till deposits consisting largely of clay and silt. Minor gravels may be present in these deposits which can serve as marginal aquifers for water supply wells, but this unit generally serves as a confining layer for underlying aquifers. A continuous sandstone aquifer of the Brosseau Member of the Foremost Formation underlies the area and serves as the main aquifer supply for the area. This aquifer is found at depths of 40 – 60 metres below ground level. Underlying units consist of shale units of the lower Foremost Formation and are generally not as productive.

Wells producing from the Brosseau Member sandstones in the area have a 20 year safe yield estimated at 128 m^3/day (20 gallons per minute or 47,000 m^3/year) showing that a single well should be available to supply the development. A Water License through Alberta Environment and Protected Areas will need to be obtained for this water supply. The process for the Water License application will require installation of a production well and monitoring well with a long term pumping test undertaken. The observation well can serve as a secondary backup supply well for the project.

No adverse effects to existing groundwater users are anticipated due to production from the supply well for the site. Analysis of long term trends of water levels shows no declines in water levels from the aquifer and the aquifer supply appears sustainable.

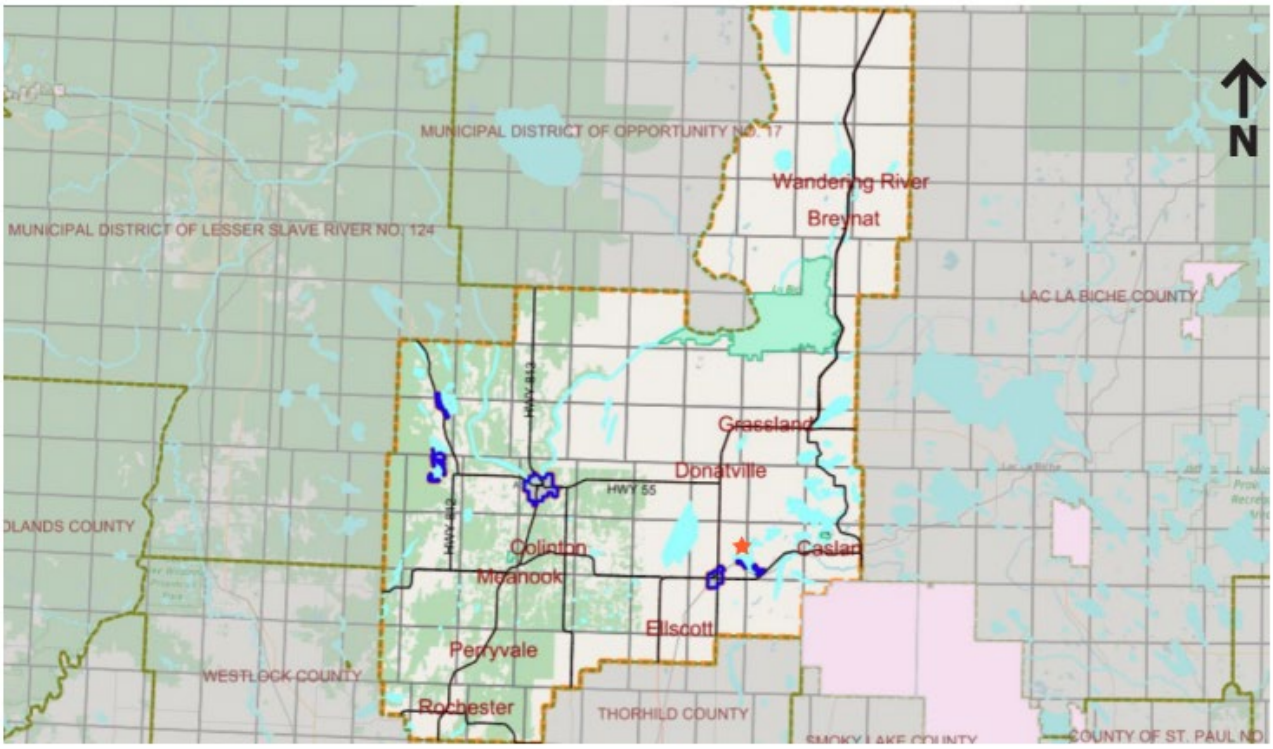
The water consists of a sodium – bicarbonate type of water with a moderate total dissolved solids content (714 mg/L). The water is generally acceptable as a drinking water source but some treatment for high iron may be required.

2. INTRODUCTION

Arletta Water Resources (Arletta) was retained by Protech Geo & Material Testing to complete a Phase I Groundwater Supply assessment for a proposed 70 lot residential subdivision within NW – 13 – 65 – 19W4 in the County of Athabasca. The assessment was undertaken to better understand the quality and distribution of aquifer resources in the area as they relate to the future development of the property and its water requirements.

The Site is in Atahabasca County along the north shore of Skeleton Lake, Alberta. The area is generally forested with numerous acreage developments in the area, including one immediately east of the proposed development. A portion of the Athabasca County map and subject Site quarter section location is shown in Figure 1.

Figure 1. Athabasca County map and subject site ¼ section location



Water is required to supply a new proposed 70 lot subdivision with parcels ranging in size from 1.5 to 0.52 ha. Given the size of the parcels a community well supply, if possible, is recommended for the development. A map showing the proposed subdivision is shown as follows.

Figure 2. Proposed subdivision conceptual site plan

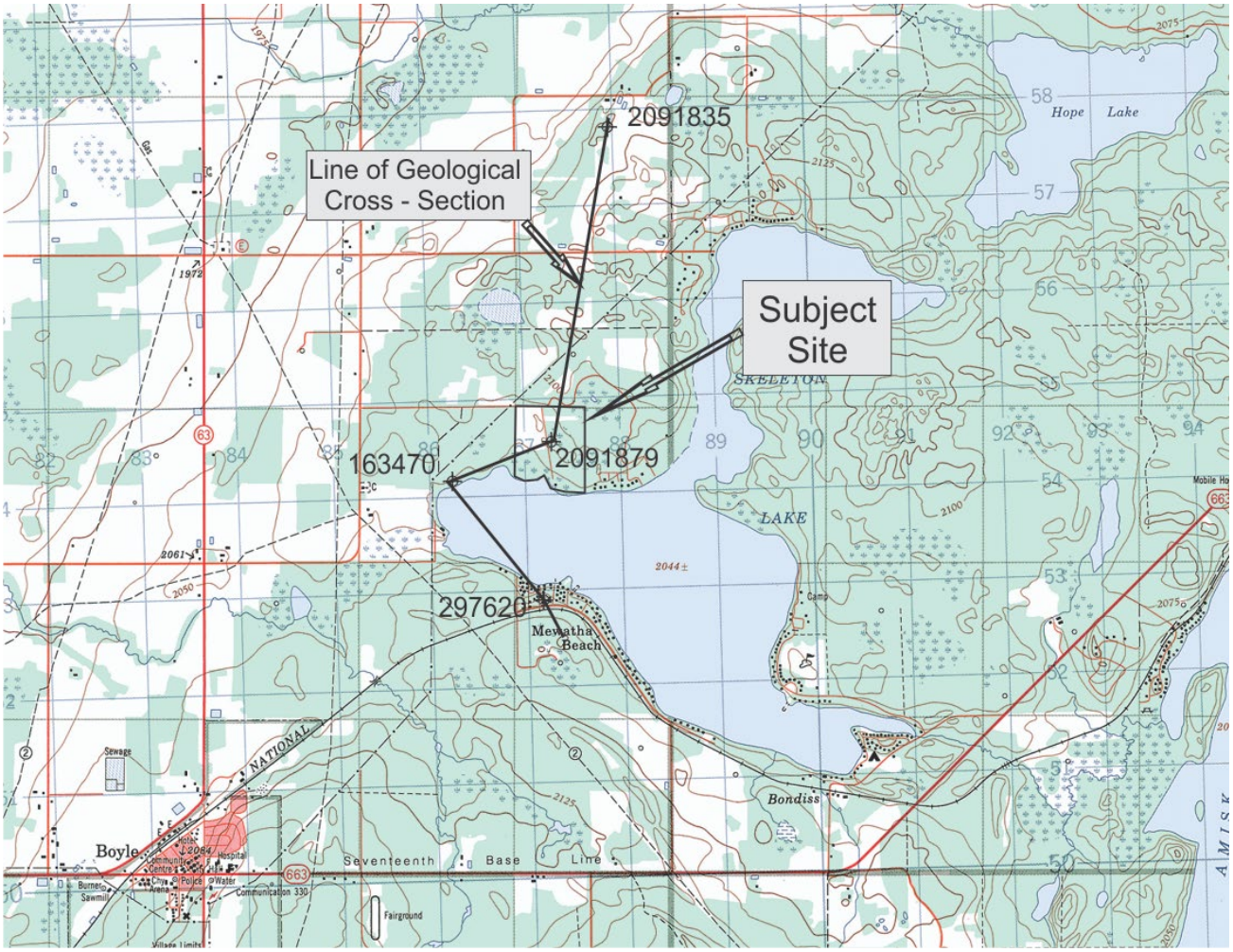
Assuming that each lot requires a water supply of 200 gallons per day a total water supply of approximately 10 gallons per minute or 23,000 cubic metres per year is required.

3. TOPOGRAPHY

The Site surface is in an area of rolling topography at an elevation averaging 2075 feet above sea level. Skeleton Lake, located on the south boundary of the site is located approximately 30 feet below the site at an elevation of 2044 feet above sea level.

Drainage to the site is towards Skeleton Lake with some wetlands on the site as indicated in Figure 2. A surface topography map showing surface drainage and the location of wells used in the geologic cross section is as follows:

Figure 3. Topographic map with cross section line A – A'



4. NATURE OF REGIONAL AQUIFERS

4.1. SURFICIAL GEOLOGY

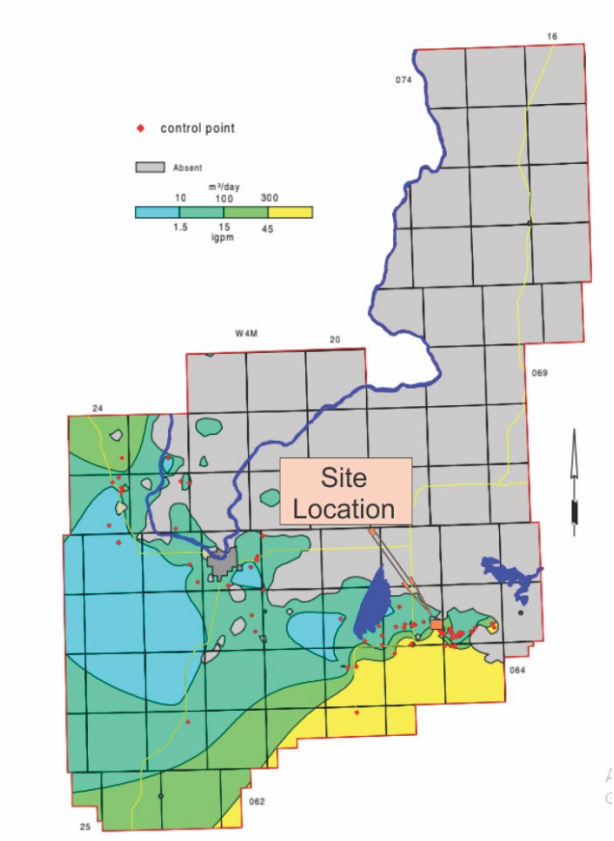
A geotechnical report undertaken for the site by Shelby Engineering in 2024 shows that the site is immediately underlain by at least 7 m of clay, silt and gravel which is interpreted to be a till deposit. The Water Well Drillers Reports indicate that this till can be over 25 m thick in the area.

No surficial gravel beds that could serve as aquifers were found in wells close to the Site. The presence of these tills is favourable in that they serve as confining layers to underlying aquifers and minimize the risk of contamination of these aquifers by surface sources such as septic field effluent.

4.2. BEDROCK GEOLOGY

The uppermost bedrock strata consist of the Cretaceous aged sandstones and shales of the Brosseau Member of the Foremost Formation. This member generally contains a productive aquifer, but is relatively thin in the area, having largely been removed by erosion prior to glaciation. This member appears to extend to a depth of approximately 60 m in the area, with less productive shales below. The Athabasca County Regional Groundwater Assessment has mapped the productivity of this aquifer as follows:

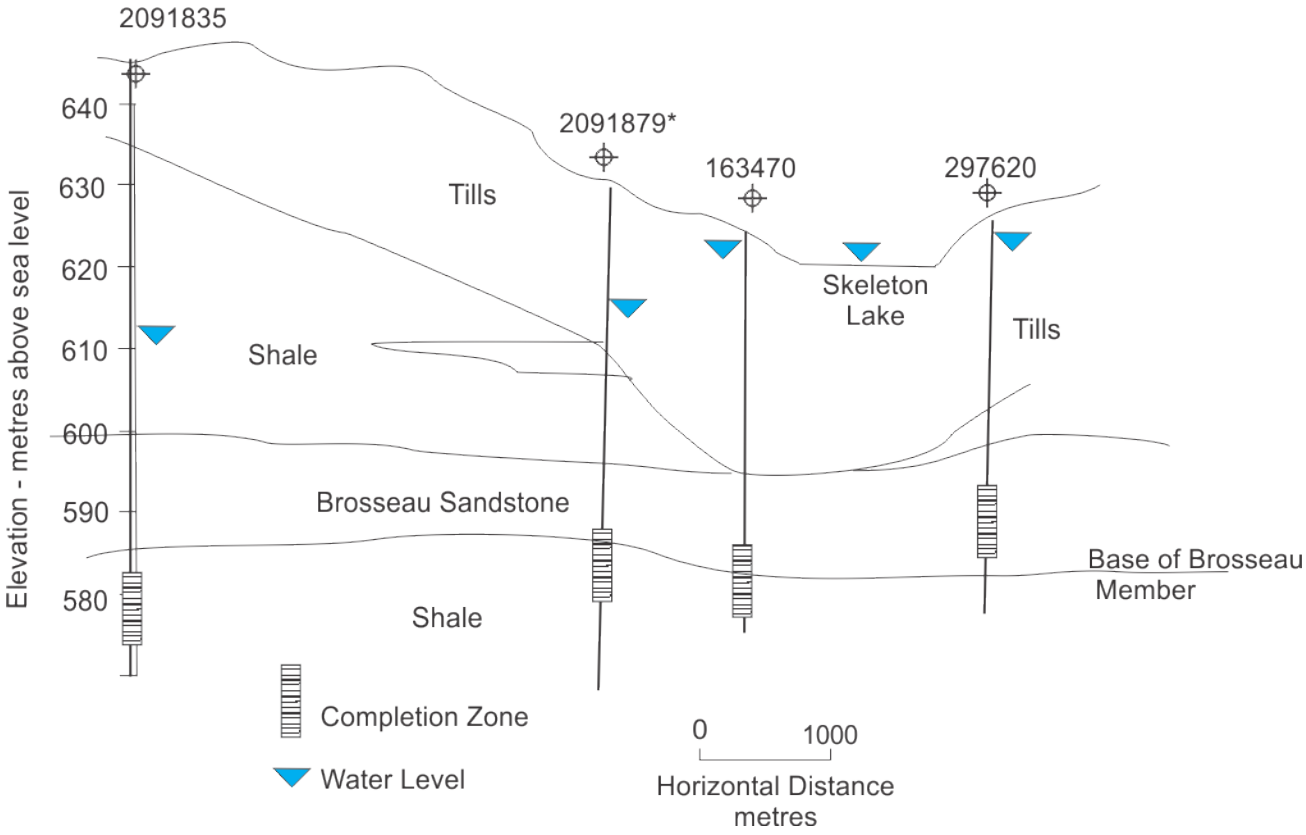
Figure 4 - Well yield map of Brosseau Member



Yields range from 100 – 300 m^3/day (350,000 – 900,000 m^3/year) indicating that a community well should be able to supply sufficient water for the development.

A cross-section showing the relationship between topography, target aquifers and static water levels is presented in Figure 5 with the line of section shown in Figure 3.

Figure 5. Geologic cross section A – A'



The cross section shows that the Brosseau Member sandstone is continuous across the area and most wells obtain water from this unit. Some earlier wells obtain water from scattered gravels in the upper tills. The water levels indicate that some wells close to the lake may be influenced by the lake level.

5. AREA GROUNDWATER USERS

5.1 WATER WELL USERS

A search of Alberta Environment and Parks water well data base of the wells within a 1.6 km (1-mile) radius of the Site was done to determine the number of water wells and their associated use in the area. The search shows a total of 75 groundwater wells within the area. Most of the wells are designated for domestic use. The wells were completed to depths of 11 – 79 metres and installed from the years of 1967 – 2020. Most wells are of depths from 40 – 60 metres. A summary of the well information from the AEP database is included in Appendix I.

5.2 LICENSED WATER USERS

A search of AEP's authorization viewer water license database was undertaken to determine if any groundwater licenses are present in the area. A search of licenses and registrations for the subject site and adjoining eight sections was undertaken. A summary of the groundwater licenses and registrations in the area is as follows:

Table 1: Area groundwater license and registration summary

Location	Licences/ Registration	Licensed Depth Interval (m)	Licensed Volume (m^3)	Licensee/*Registrant*
7 – 65 – 18W4	1/0	33.6 – 39.6	6818	Skeleton Lake Golf Couse
24 – 65 – 19W4	0/1	*?*	6250	Public Land Management

Licenses for surface water withdrawals were not included in the Table 1 summary. One license for groundwater extraction was found in the area along with one registration. Registrations may include surface water or groundwater diversions up to 6,250 m^3 per year. The groundwater use in the area can be described as moderate, consisting largely of unregistered domestic groundwater user with low licensed usage.

6 AREA AQUIFER PROPERTIES

Six Water Well Drilling Reports near the site had sufficient pumping test data to allow for aquifer interpretation. The Water Well Drilling Reports for these wells are included in Appendix 2. The pumping tests were analyzed with the aid of AQTESOLV software developed by Hydrosoft Inc. to estimate aquifer properties and a graph showing water displacement with time and calculated aquifer transmissivity for each of these wells is also included in Appendix 2. A summary of well yield and associated aquifer properties produced from this analysis are tabulated below.

Table 2. Area aquifer properties

GIC Well ID	Available Head	Depth to Top of Aquifer (m)	Aquifer Thickness (m)	Aquifer Type	Aquifer Transmissivity (m^2/day)	Safe Well Yield (Q_{20}) (m^3/day)
169561	26.9	29.9	1.8	Sandstone	32.7	251
214571	58	64.0	15	Sandstone	10.4	179
1130846	15.2	19.8	9.6	Sandstone	16.3	72
1131082	26.0	36.6	13.7	Sandstone	15.7	119
1889397	23.0	34.8	9.8	Sandstone	8.3	57
2091879	36.6	53.0	11.9	Shale	8.5	93

The twenty-year safe yield of the supply wells (Q_{20}) was calculated using the above data and the Cooper-Jacob Equation as follows:

$$Q_{20} = \frac{(0.7 \times T \times H_a)}{0.183\, x \log(2.25Tt/rw2S}$$

Where:

Q_{20}	-	Twenty Year Safe Yield (m^3/day)
H_a	-	Available Head (m)
T	-	Transmissivity
t	-	Time (20 years or 7305 days)
S	-	Aquifer Storativity (assume 5 x 10^{-5})
rw2	-	square of the well radius ($(0.0651m)^2$ = 0.00042 m^2)
0.7	-	Safety factor

Analysis of pumping test data from wells completed in confined bedrock aquifers near the Site produce a safe yield ranging from 57 – 251 m^3/day, and average 128 m^3/day. This value is within the range as shown in Figure 4. As a water supply of 23,000 m^3/year (63 m^3/day) is required for the development, the results indicate that one supply well should be sufficient for the development. An observation well will be required as part of the licensing process, which could serve as a backup supply well.

7 EFFECT ON EXISTING GROUNDWATER USERS

Using the Cooper-Jacob equation the expected drawdown through time can be calculated at various radial distances from the supply well as follows:

$$s = \frac{(0.183 \times Q)}{T} \quad \times \quad Log\left(\frac{2.25 \times T \times t}{r^2 \times S}\right)$$

Where:

s	-	Drawdown (m)
S	-	Storativity (S) (5.0 x 10^{-5})
Q	-	Pump rate (63 m^3/day)
T	-	Average Transmissivity* (15.3 m^2/day)
t	-	Time (days)
r	-	Radial distance from pumping well (m)

Water level drawdown at various distances from the pumping well are tabulated as a function of time in Table 3.

Table 3. Cooper-Jacob distance drawdown calculations

Distance (m)/ Time (days)	Well bore	*100 m*	*250 m*	*500 m*	*1000 m*	*1600 m*	*3000 m*
1	6.1	1.4	0.8	0.3	--	--	--
30	7.2	2.5	1.9	1.4	1.0	0.7	0.3
365	8.0	3.3	2.7	2.3	1.8	1.5	1.1
1826	8.5	3.8	3.2	2.8	2.3	2.0	1.6
3652	8.8	4.1	3.5	3.0	2.6	2.3	1.8
7305	9.0	4.3	3.7	3.2	2.8	2.5	2.1

A neighboring well approximately 500 metres from the supply well could experience around 3 m of additional drawdown over a 20-year (7305 day) pumping period due to pumping from a future community supply well on the site. As the total available drawdown is at least 20 m for a typical well the pumping from a new supply well for the development will not impact the ability of existing wells to provide water.

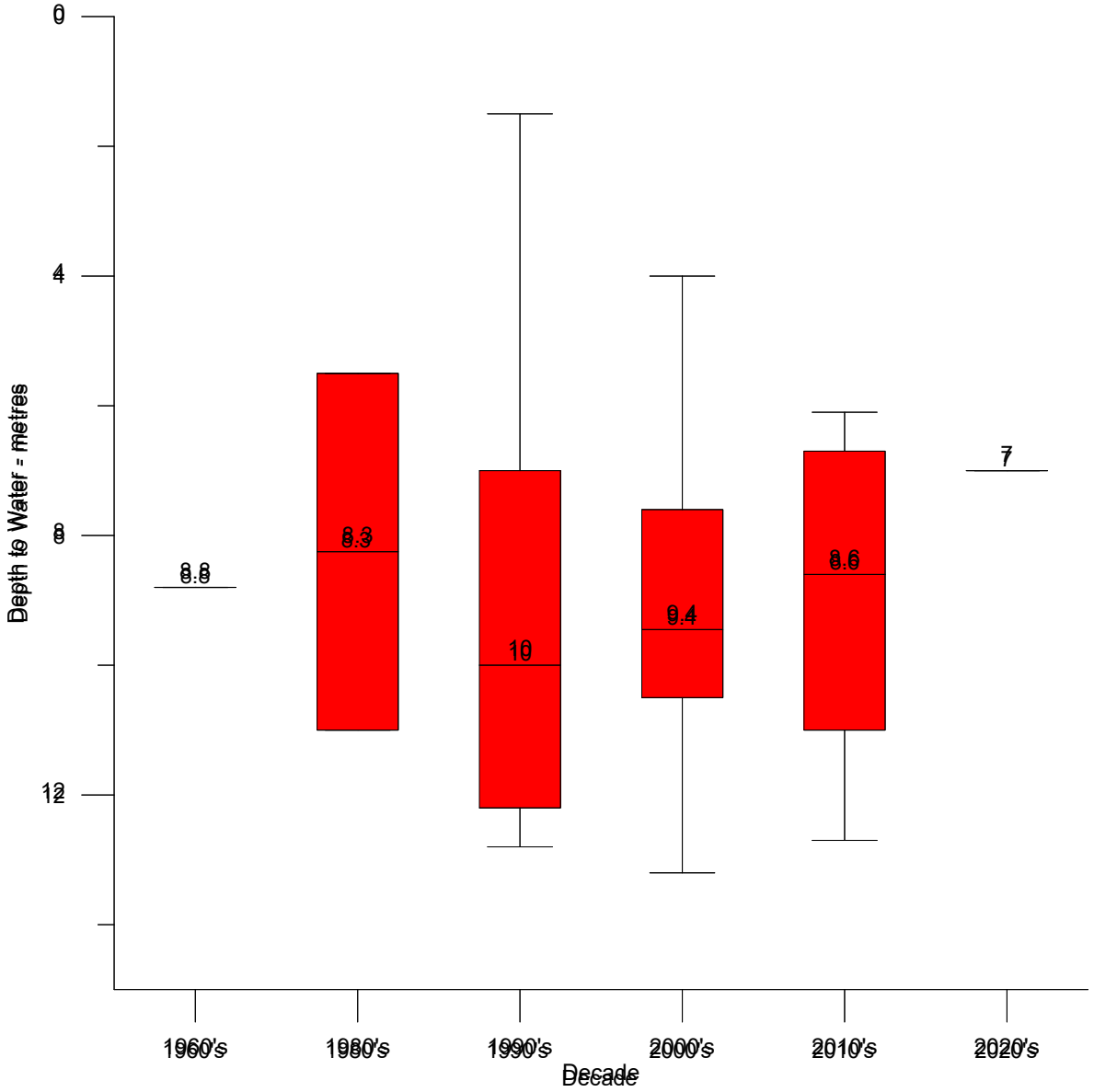
This calculation is likely conservative as recharge effects are not included.

8 CHANGES IN WATER LEVELS WITH TIME

Water levels from the Reconnaissance report were reviewed to determine whether indications of aquifer dewatering are occurring. Water levels were grouped by decade and water levels with wells over a depth range of 40 – 60 meters were examined to see if trends in water levels are apparent.

A whisker graph showing average water level and range of values (with the red bars showing 2/3 of the data) is as follows:

Figure 6. Changes in well static water levels when drilled



Water levels are observed to be constant with possibly a slight increase with time from the 1990's to the present. No indications of aquifer dewatering are present, and the aquifer supplies appear to be sustainable.

9 AREA WATER QUALITY

A water quality sample was collected from the Water Well database to illustrate the groundwater chemistry within the Brosseau Member of the Foremost Formation. The well is in 11 – 12 – 65 – 19W4 approximately 2 km south of the site and the well is reported to be 33.5 m deep with the sample collected in 1985 (Well Record 280679). The Chemical Analysis Report for this well is attached in Appendix 3. A summary of the results, with a comparison to Health Canada Guidelines for Canadian Drinking Water Quality (2024) is as follows:

Table 4. Area aquifer quality

Parameter	Units	Well ID 280679	CDWQ MAC/AO
Well depth	metres	33.5 m	
Date sampled	mm/dd/yyyy	1985-08-05	-
pH	pH	7.70	7.0 – 10.5
EC (@ 25˚C)	µS/cm	1149	--
Calcium	mg/L	98	--
Magnesium	mg/L	35	--
Sodium	mg/L	*127*	200
Potassium	mg/L	4.7	--
Chloride	mg/L	2	250
Nitrate	mg/L	< 0.05	**10**
Sulfate	mg/L	120	500
Manganese	mg/L	NA	**0.12**
Bicarbonate	mg/L	664	--
Iron	mg/L	3.41	0.3
Total Dissolved Solids	mg/L	*714*	500
Fluoride	mg/L	0.2	**1.5**
Total Alkalinity	mg/L	545	--

MAC – Maximum Allowable Concentration

AO – Aesthetic Objective

The water from the well exceeded aesthetic objectives set for the concentration of iron and total dissolved solids (TDS). No maximum allowable concentration (MAC) guidelines were exceeded. It is likely that the Total Dissolved Solids level will be acceptable for most users, but the iron concentration, if found in the well on the subject site, is of similarly high levels, treatment will be required. It is recommended that a sample from the future supply wells be collected and analyzed prior to long term use to ensure the water meets drinking water quality standards for long-term human consumption.

10 REFERENCES

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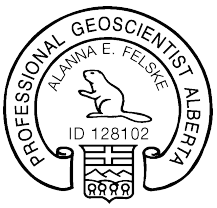

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APPENDICES

Appendix I:
Water Well Reconnaissance Report

Appendix 2:
Water Well Drillers Reports and AQTESOLV Plots

Appendix 3:
Water Quality Report