The Spider Lake region is an important source of groundwater for the surrounding communities of Parksville and Qualicum Beach. Much of their potable water comes from groundwater. The quality of the groundwater is dependent on the thickness and stratigraphy of the overlying material. The primary goal of this project is to develop a hydrostratigraphic framework focused on identifying aquifers and aquitards for the area around Spider Lake, BC.

Hydrostratigraphy Models

Based on the descriptions from the well log data (MapBC) five hydro-stratigraphic units were determined in the Spider Lake area by material type (3). There are two confined aquifers, two aquitards, and a layer of sediment with unconfined aquifer potential depending on water table levels. The two aquitards are composed of a silty diamicton which is defined as till due to knowledge of glaciation in the area. Unit 3 is only partially confined (leaky) as you can see in Figure 2 and 3. Unit 3 is the major aquifer in the area. There are clay lenses in this unit, but they are not large enough to impact on flow and therefore are not included in the cross sections or model. Unit 5 is not defined well in this study as there is not enough data from the well logs in the region. This unit is saturated with water and all wells reaching this depth stop almost immediately after hitting this aquifer, meaning it has enough water to be pumped when Unit 3 had insufficient supply.

Hydraulic Parameters

Hydraulic Conductivity (K)
The hydraulic conductivity of the hydro-stratigraphic units was calculated using the Haan Method:

\[ K = C D_{50} \]

\[ D_{50} = \text{effective grain size (cm)} \times 100 \text{% by weight} \]

This method is only applicable for the 10% finer (by weight) of sediment from 0.1 mm – 3 mm. Due to the minimal clay and fine silt content in this area this method can be applied.

Transmissivity (T)
The transmissivity of the hydro-stratigraphic units was calculated using the equation

\[ T = K b \]

\[ b = \text{depth of aquifer} \]

Transmissivity was calculated using average depth of each hydro-stratigraphic unit.

Flow Model

Unit 3: well sorted medium to coarse sand, not water bearing. Unit 2: first aquitard, composed of silty till. This unit is not present in the entire area and is pinched out into lens-like formations in some areas. Unit 3: main aquifer in this study as it is defined in nearly all of the well logs used for data, composed of well sorted medium sand, clay lenses present in some areas. This is a leaky aquifer. Unit 4: second aquitard, very similar to the first, composed of silty till. Unit 5: second aquitard, composed of well sorted gravel, saturated with water.

Figure 3. This model displays the equipotential and flow lines of the Spider Lake cross section (fig. 2A). Unit 1 (blue), Unit 2 (green), Unit 3 (blue), Unit 4 (yellow), Unit 5 (red). The depth and extent in Unit 5 is unknown as the well logs of the area displayed insufficient information on the unit. Bedrock is present on the left hand side of the model however, the program is only able to display five units. Model created using TopoDrive (4).

Conclusions and Recommendations

Aquitard Vulnerability

➢ The upper unconfined aquifer is not currently being utilised as a water source however, it has potential as one. Its capability as a aquifer is dependent on the water table and precipitation. It has potential to be one of the most vulnerable aquifers.

➢ The upper confined aquifer is leaky to the south and therefore the most vulnerable with a DRASTIC index of 180. The rest of the aquifer has an index of 149-159.

➢ The lower confined aquifer is the least vulnerable due to it being protected by two aquitards.

Future Work

➢ Identify the extent of the lower confined aquifer.

➢ Use geophysical data to better understand the contacts between the aquifers and aquitard (i.e. are aquifers communicating?)

➢ Develop further cross sections and flow models for the region.

➢ Pump/slug testing and sampling units to better constrain our hydraulic parameters.

References


(5) MapBC. 2008. Province of British Columbia

Figure 2. Hydro- lithostratigraphic cross sections around Spider Lake. Baseline is 95 m (300 ft) above sea level. Cross section A-A’ trends southwest-northeast and is 4.6 km long. Cross section B-B’ trends north-south and is 2 km long.

Unit 1: Upper unconfined aquifer
Unit 2: Upper confined aquifer (leaky)
Unit 3: Lower confined aquifer
Unit 4: Aquitard (most likely till)
Unit 5: Bedrock

Figure 2a Cross section B - B’ VE = 18.5 m

A' B' C' D' E'

Table 2. DRASTIC Method example matrix for the upper confined aquifer in B-B’.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
<th>Weight</th>
<th>Rating</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth to Water Table</td>
<td>5-30</td>
<td>5</td>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td>Net Recharge</td>
<td>4-7</td>
<td>4</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>Aquifer Media</td>
<td>Sand &amp; Gravel</td>
<td>3</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>Soil Media</td>
<td>Thin or Absent</td>
<td>2</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Topography</td>
<td>2-6</td>
<td>1</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Impact Vadose Zone</td>
<td>Sand &amp; Gravel w/ Significant Silt &amp; Clay</td>
<td>5</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>Hydraulic Conductivity</td>
<td>300-700</td>
<td>3</td>
<td>4</td>
<td>12</td>
</tr>
</tbody>
</table>

DRASTIC Index: 159

Table 3. Final DRASTIC indexes.

<table>
<thead>
<tr>
<th>Aquifer</th>
<th>A-A’</th>
<th>B-B’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Unconfined</td>
<td>179</td>
<td>179</td>
</tr>
<tr>
<td>Upper Confined (leaky)</td>
<td>149 (leaky)</td>
<td>159</td>
</tr>
<tr>
<td>Lower Confined</td>
<td>124</td>
<td>124</td>
</tr>
</tbody>
</table>

Table 1. Unit 5 had insufficient data on depth to calculate transmissivity. Transmissivity for Unit 4 is unrealistic as most drill hole data is not to the maximum extent of the unit.