Lower Englishman River Watershed

Groundwater and Surface Water

Interaction

For:

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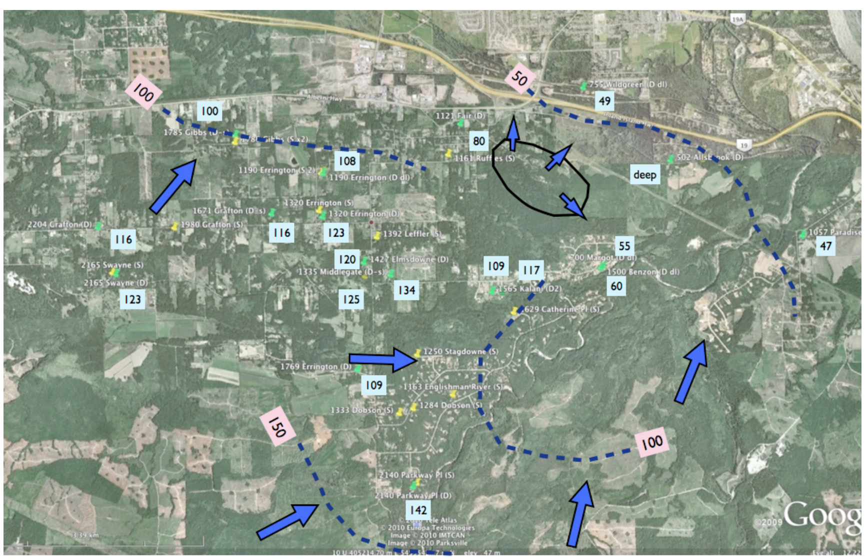

By:

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1 Introduction

This report describes a monitoring program and presents preliminary results of Phase 1 of a multi-phase community-based program to characterize and to understand the interaction between groundwater and surface water moving in the Englishman River (ER) Watershed.

A report titled *Englishman River (Background Information)* has been issued in August 2009. It has provided a summary of the background information available on the Englishman River watershed.

This work has been initiated by the Mid Vancouver Island Habitat Enhancement Society (MVIHES) and has been funded by the BC Real Estate Foundation, the Georgia Basin Vancouver Island Living Rivers, and the Regional District of Nanaimo. The BC Ministry of Environment (MOE) and GW Solutions have also supported the project through in-kind contributions.

2 Completed Work

The work was designed to collect information on the presence and behaviour of aquifers in the ER watershed, to define aquifers, to assess the elevation of the water table in the aquifers, to estimate the groundwater regime (groundwater flow path), and to start defining the interconnection between the aquifers and the ER.

The completed work has been community-based; well owners were invited to offer their wells for monitoring of the fluctuation of the water table. The following was completed:

- A total of 17 shallow dug wells were manually monitored; 10 wells we monitored every 2 weeks between June 2009 and January 2010; 7 wells were monitored in January 2010.
- A total of 19 drilled wells were monitored; electronic data logger were installed in 5 wells and data started being collected on August 17, 2009. The data gathering is on-going; 14 wells were monitored manually in January 2010.

The community was also involved in the gathering of information on the ER. The following was completed:

- 7 stations were monitored for temperature, pH, and electrical conductivity on August 30, 2009
- 20 stations were monitored for temperature, pH, and electrical conductivity on September 13, 2009
- 19 stations were monitored for temperature, pH, electrical conductivity, and total dissolved solids (TDS) on February 20, 2010.

Water samples were also collected on September 2, 2009 from 3 selected wells (2 dug wells and 1 drilled well) by BC MOE staff and submitted for chemical analyses.

3 Results

Figure 1 shows the locations of both the dug wells (yellow symbols) and the drilled wells (green symbols), and the locations of the cross sections, referred to in later sections of this report.

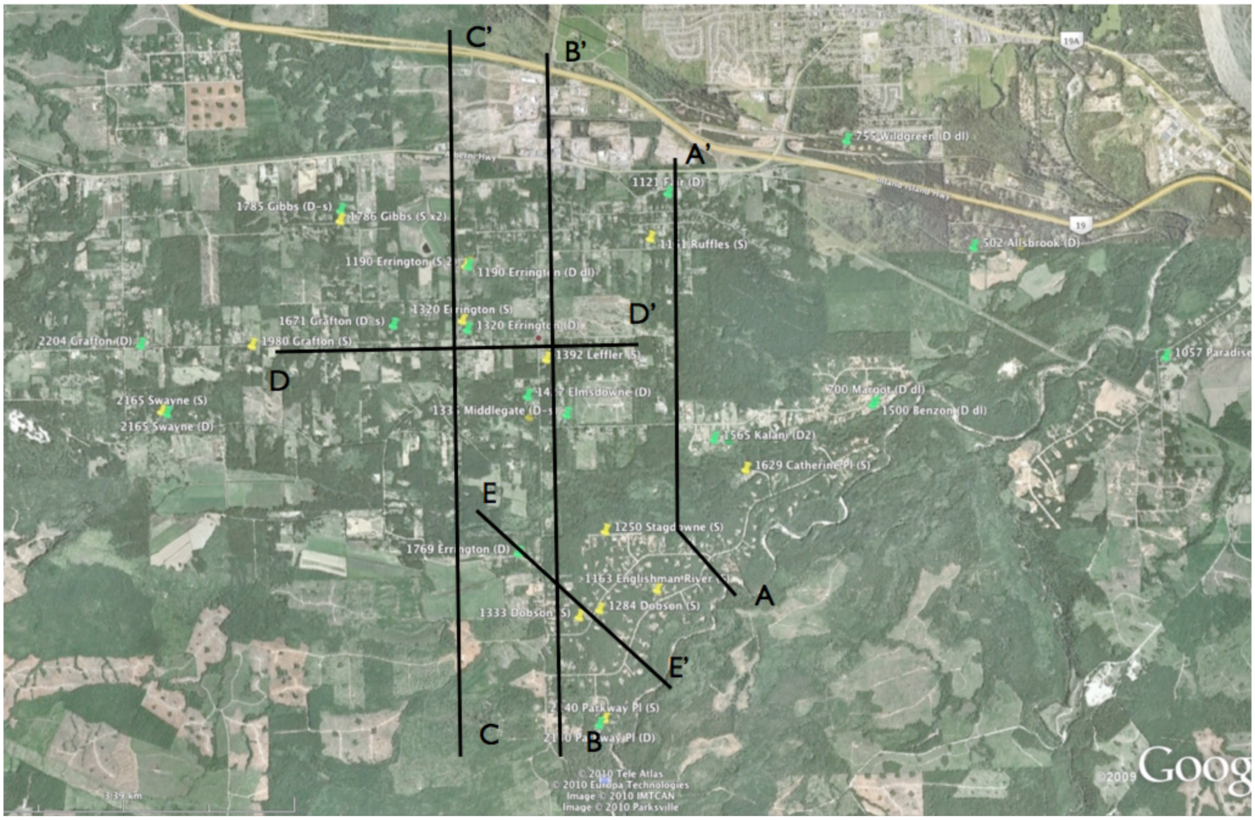

Figure 1: Studied area and location of cross-sections

3.1 Water table elevations

Figure 2 and Figure 3 show the approximate elevation of the water table measured in the dug wells on October 5 and December 15, 2009. These two dates have been selected because they represent the dates for which the lowest and highest elevations have been recorded. The elevations have been calculated based on the measurements of the depth to water provided by the well owners (measured from the top of the well casing) and the ground elevation obtained from Google Earth. Groundwater was measured in the dug well at depth between 2 and 6 m.

Piezometric (the term piezometric refers to the elevation of the water table) contours have been drawn in Figure 3. The data indicate that groundwater moves eastward, generally following topography. A topographic ridge also corresponds to a piezometric ridge. This results in part of the shallow groundwater flowing eastward and discharging to the ER. On the northern half of the studied area, groundwater flows with a northward component. The piezometric levels are typically between 140 m and 60 m.

Figure 2: Water table elevation on October 5, 2009 (m)

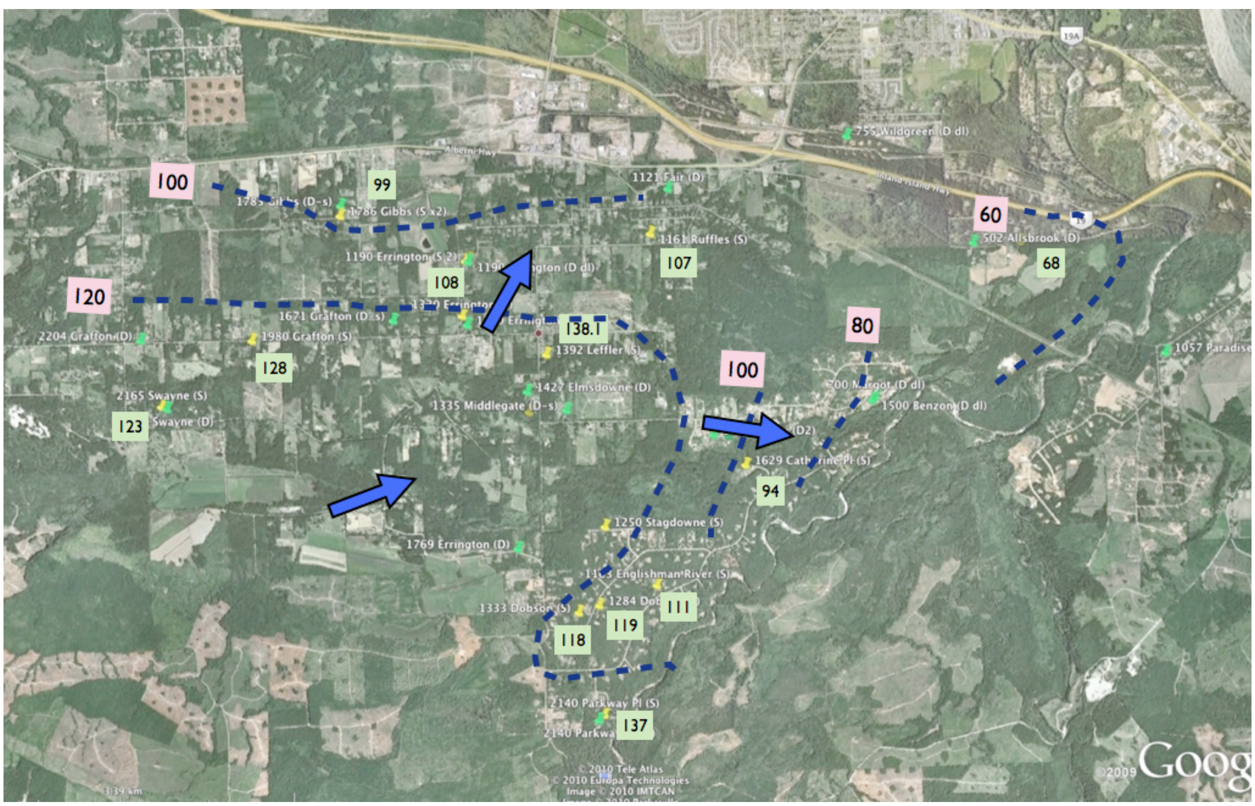

Figure 3: Water table elevation in dug wells on Dec 15, 2009 (m)

Figure 4 shows the piezometric elevations measured in the drilled wells on December 15, 2009. The estimated elevations are between 142 m and 47 m. The estimated piezometric contours also show the presence of a piezometric ridge. In the south part of the study area, piezometric contours converge towards the ER which acts generally as a drain. In the northern half of the study area, the groundwater moves northeast. The area of Little Mountain probably act as an area with higher piezometric conditions and therefore as a recharge zone.

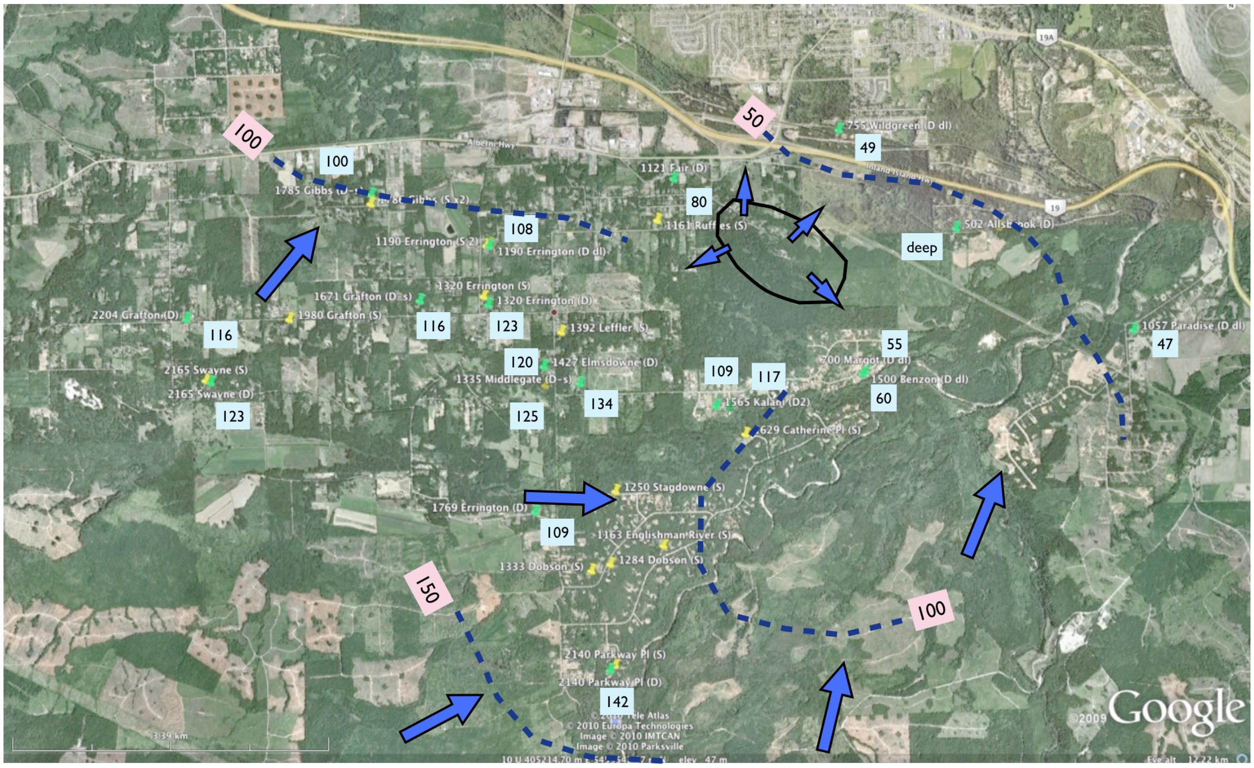

Figure 4: Water table elevation in drilled wells on Dec. 15, 2009

Figure 5: Water table rise between October and December 2009

Figure 5 shows the rise of the water table observed between October and December 2009, based on available data for both dug and drilled wells. The water table has risen in the order of 2 m to 3 m, except for the eastern part of the study area (circled with the dark dotted line) where no significant fluctuation of the water table was observed.

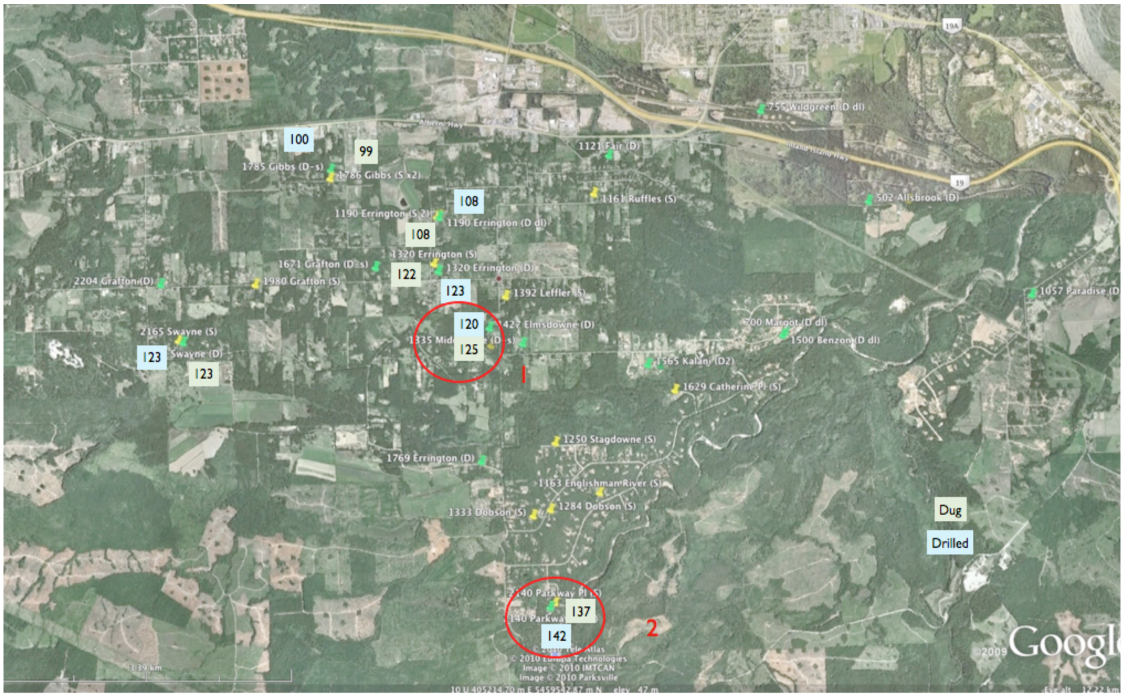

Figure 6: comparison of water table elevations in drilled and dug wells on Dec 15, 2009

Figure 6 allows the comparison between the piezometric levels measured on December 15, 2009 in drilled wells and in dug wells when both wells were present within close proximity. If the piezometric levels are similar, it means that both the dug well and the drilled well are completed in the same aquifer or the aquifers are closely connected. This appears to be the case in the central portion of the study area. At two locations, the piezometric levels were different: at location 1 (red circle 1), the piezometric elevation in the dug well is 5 m higher than measured in the drilled well, indicating a downward movement of the groundwater; at location 2, the piezometric elevation in the drilled well is 5 m higher than in the dug well, indicating an upward movement of the groundwater.

3.2 Continuous Piezometric Monitoring

Data loggers were installed in five drilled wells and the data gathering started in August 2009. The locations of the monitored wells and the hydrographs for each well are presented in Figure 7.

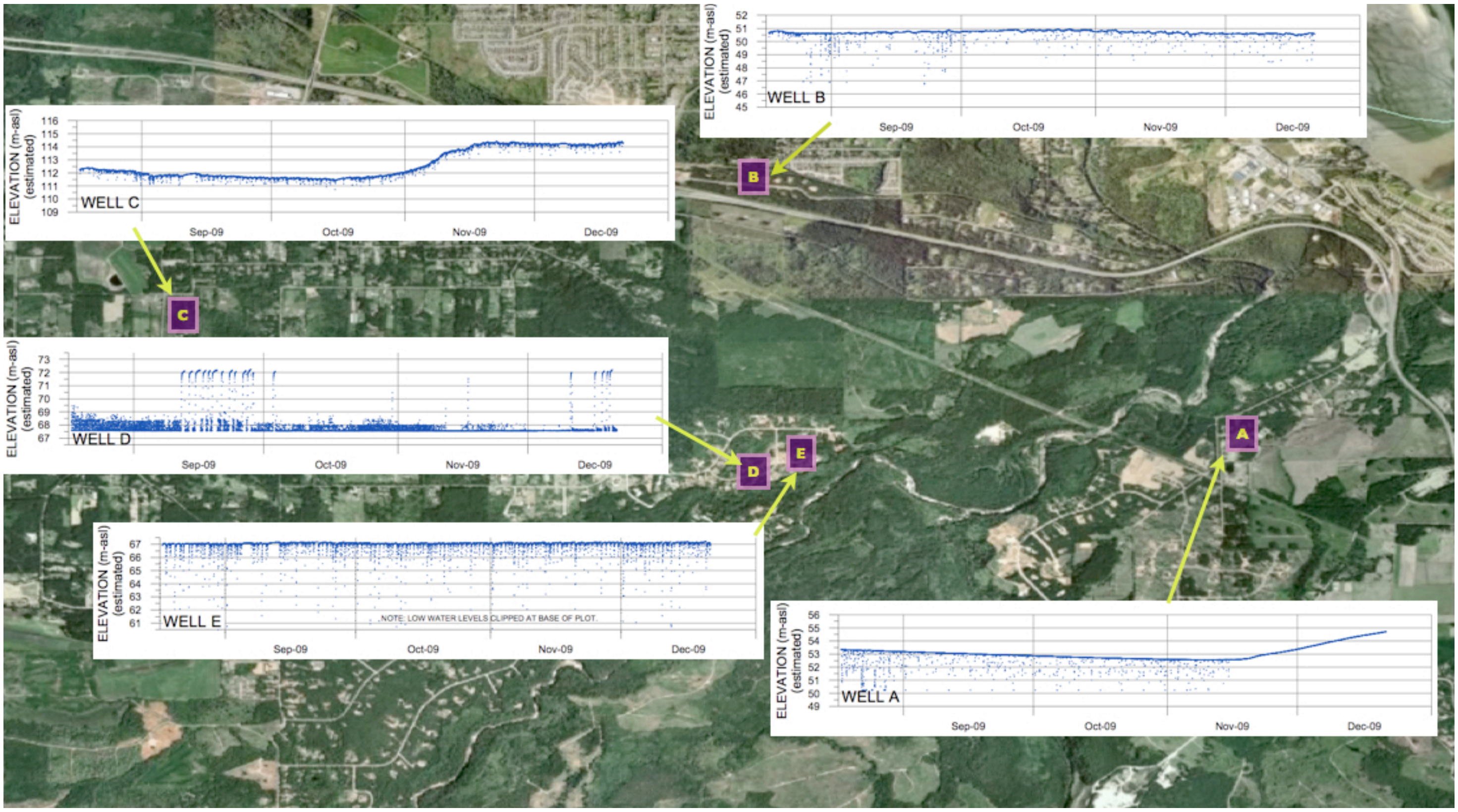

Figure 7: Continuous monitoring results in drilled wells between July and December 2009

Three types of hydrographs are observed:

- Well A shows a steady decline of approximately 1 m between August and mid November, followed by a regular rise until the end of December, where the water table rises by approximately 2 m. Pumping in this well creates a drawdown of approximately 3 m.
- Well C shows also a regular decline, but the amplitude of the decline is less than 1 m and the lowest level is observed in mid October. Then the water level rises by almost 3 m and then remains stable past November. Pumping in this well creates a drawdown of less than 1 m.
- Wells B, D and E show constant elevation of the water table. Pumping in Well B creates a drawdown of up to 4 m. In Wells D and E, the generated drawdown is greater than 5 m. Well D appears to operate under short pumping cycles because the well production is very low. This appears to create a constant drawdown with almost no recovery period.

4 Lithology and hydrogeology

The lithology described in the cross sections is based on the information and cross sections provided in HBT AGRA Ltd. report *Preliminary Assessment of Groundwater Resource and Soil Suitability in the Errington Area*, September 1993.

The shale bedrock unit constitutes the basal unit in all the cross sections. Generally, the overburden is thin in topographic heights. This can be seen in sections A through C where the topography of the bedrock presents a hump and on section DD' where the location of the cross-section corresponds to the top of the bedrock ridge.

Two main geological eras have shaped the region; the two most recent glaciations during which glaciers have shaped the terrain and deposited soils (till, sand and gravels associated with glacial outwash) and the time when sea levels reached an elevation of approximately 150 m and deposited sands and gravels.

The cross-sections clearly show the importance of the till, observed over the whole region. Till is a soil made of a wide range of particles, from very small particles the size of clay particles, to boulders. The resulting hydraulic conductivity of till is low. Till layers generally prevent the fast vertical percolation of groundwater and they also act as capping layers for deep sand and gravel aquifers.

The cross sections show the presence of marine sand and gravel deposits, at surface. These deposits generally consist of only a thin veneer and their lateral extent is limited. These deposits will therefore not contain or transfer large amounts of groundwater.

The following describes specific observations made on the cross sections:

- The lithology on the south half of cross section AA' shows shale and till being the main saturated units. A sand and gravel marine deposit is present at surface. Its thickness near the Englishman River is not well defined. Two sand and gravel units and a clay unit are present under the till on the northern side of the cross section.

- Cross section BB' shows the presence of a confined sand and gravel unit below the till, south of Swayne Creek. It also shows a more complex stratification at the northern end of the cross section with the presence of confined sand and gravel and a clay layer.

- Cross section CC' shows below and south of Swayne Creek the confined sand and gravel deposit. A sand and gravel unit is also present at the northern end of the cross section. It is unconfined.

- Cross section DD' is drawn perpendicular to sections AA' through CC'. It shows the shale bedrock present at shallow depth below a veneer of till and marine sand and gravels. The till may get thicker with a plunging bedrock at the western end of the cross-section, however more information is required to confirm this assumption.

- Cross section EE' shows a sand and gravel unit confined by the till deposit and possibly connected to the Englishman River.