Englishman River

Watershed

(Background Information)

For:

Mid Vancouver Island Habitat Enhancement Society
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By:

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August, 2009
09-04

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1 Introduction – Scope of the Study

This report provides background information on the Englishman River watershed and is the first step in the design and implementation of a community based watershed monitoring and protection plan. This work has been initiated by the Mid Vancouver Island Habitat Enhancement Society (MVIHES) and has been funded by the BC Real Estate Foundation and Georgia Basin Vancouver Island Living Rivers.

The Regional District of Nanaimo, the Ministry of Environment, Vancouver Island University, Vancouver Island Health Authorities, and GW Solutions have also supported the project through in-kind contributions.

2 ER Watershed - Settings

The ER watershed is located on the east coast of Vancouver Island between the Nanaimo River Watershed, the French Creek Watershed and the Little Qualicum Beach Watershed. Its approximate boundaries are shown in Figure 1 and 2.

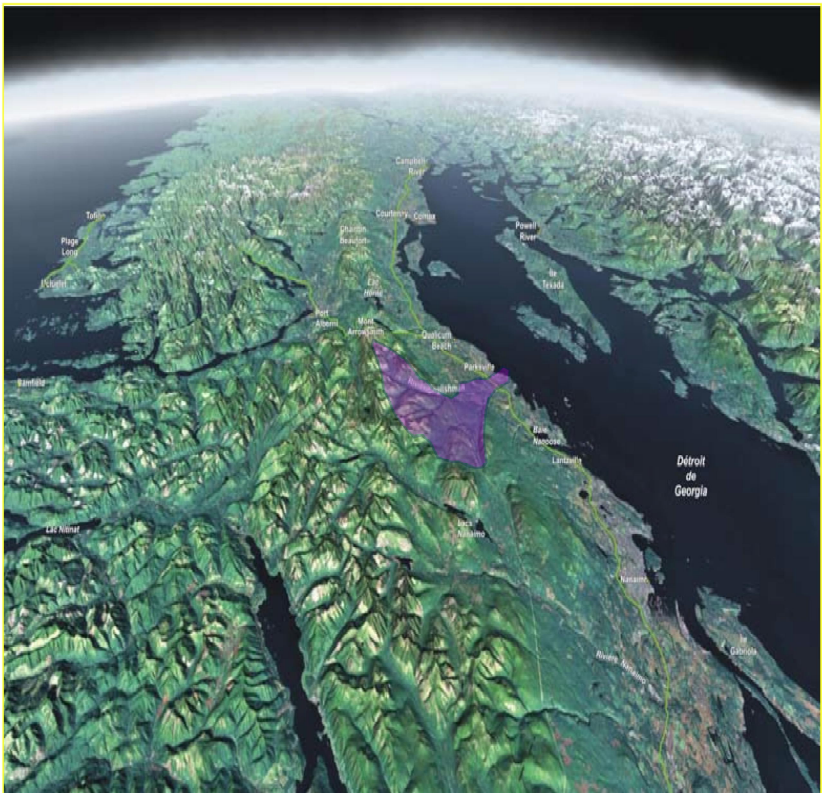


Figure 1: 3D Rendering - Englishman River Watershed (based on NRCan image)

It extends between the Mt Arrowsmith Ridge (elev. 1818 m) and the Strait of Georgia. It is inhabited principally in its flatter and lower section. Approximately 80% of the watershed is forested and the upper reach of the watershed consists of steep mountainous terrain.

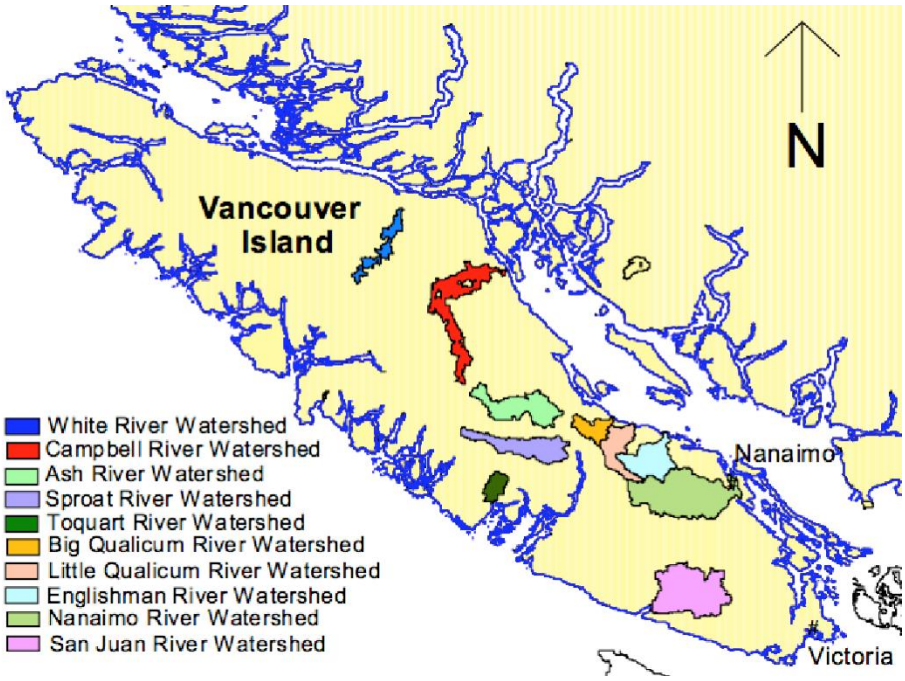


Figure 2: Some of the Main Watersheds on Vancouver Island

The Englishman River starts at the base of Mount Arrowsmith and receive flows from five main tributaries before reaching its estuary. These tributaries are:

- Morison Creek
- The South Englishman River
- Centre Creek
- Middle creek; and
- Moriarty Creek

Figure 3 shows the main drainage system in the ER.

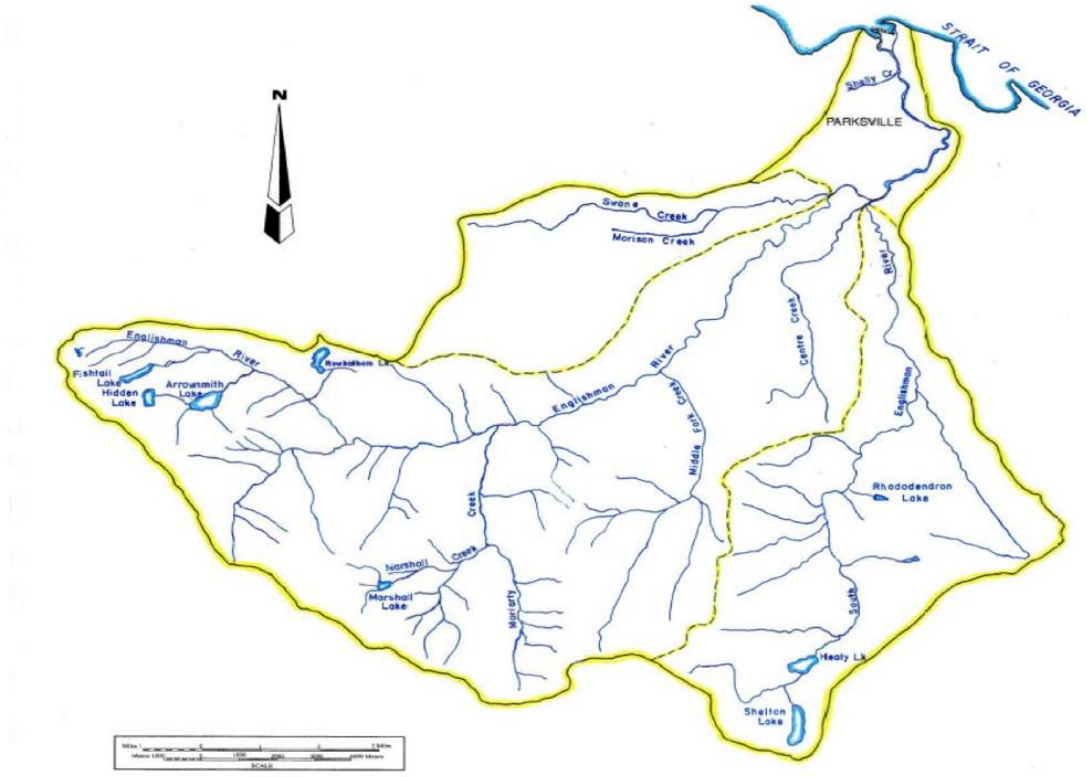


Figure 3: Englishman River Drainage System

3 Water Usage

3.1 Surface water

Figure 4 shows locations where extraction of surface water is authorized under licenses. Surface water extraction is predominantly taking place along the main stem and Morison Creek, and in the lower reach of the ER. The largest licenses correspond to the infiltration gallery operated by the City of Parksville (net extraction) and to the reservoirs located at the headwater of the watershed (storage and release).

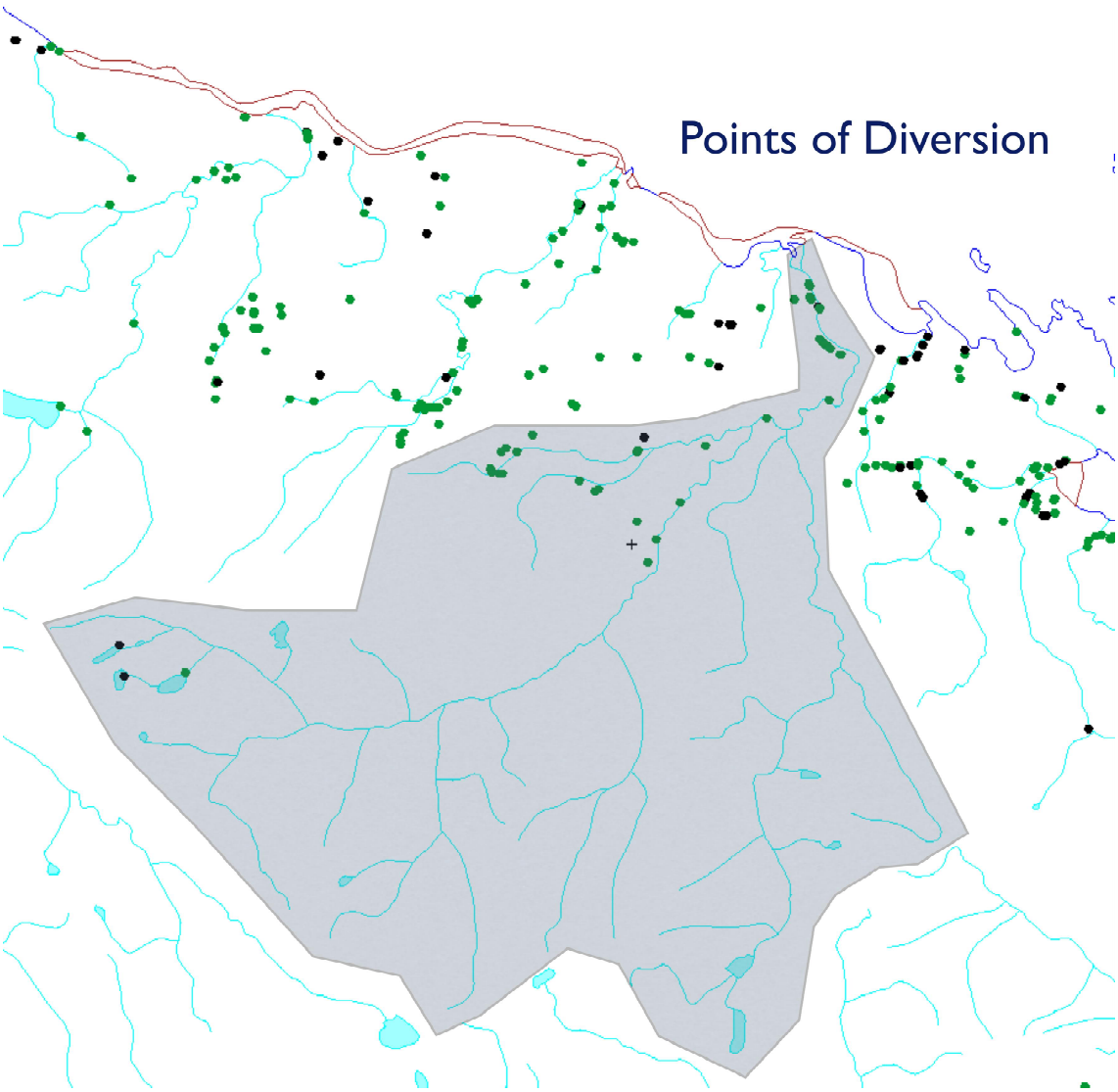


Figure 4: Surface Water Licenses (Points of Diversion)

3.2 Groundwater

The majority of the residents in the ER watershed rely on their own water supply consisting of shallow dug wells (typically less than 10 m depth) and drilled wells rarely exceeding a depth of 100 m. The only community system is the Englishman River Community Water Service Area, operated by the Regional District of Nanaimo (RDN).

Figure 5 shows the locations of the water wells, according to the information available in the well database of the BC Ministry of Environment (Water Atlas).

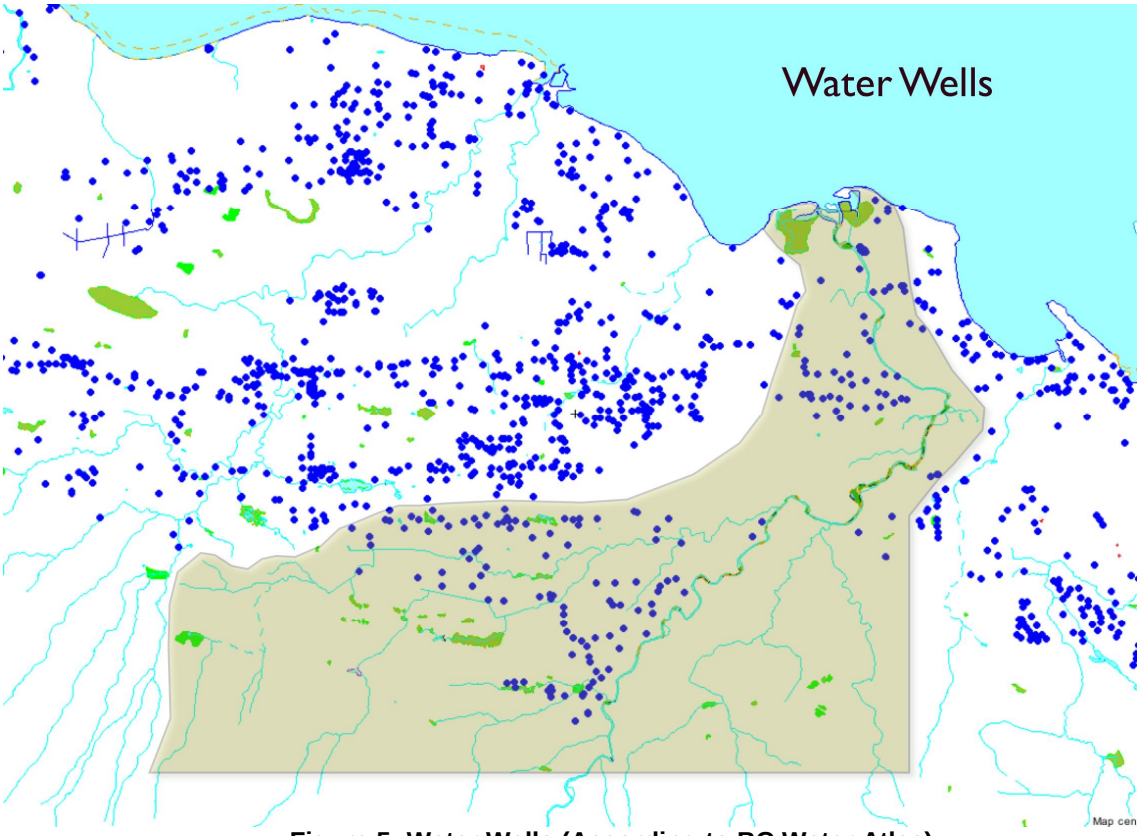


Figure 5: Water Wells (According to BC Water Atlas)

4 Groundwater and Surface Water Monitoring

4.1 Groundwater Monitoring

The BC Ministry of Environment (BC MOE) operates a network of monitoring wells in BC. However, as shown in Figure 6, there is no such monitoring well located in the ER watershed. Therefore, there are no historical records describing the seasonal fluctuations of the water table in the ER Watershed. The only location for which we have records is the Englishman River Community Water Service Area operated by the RDN. Two wells service this area and records are available starting in 2004.

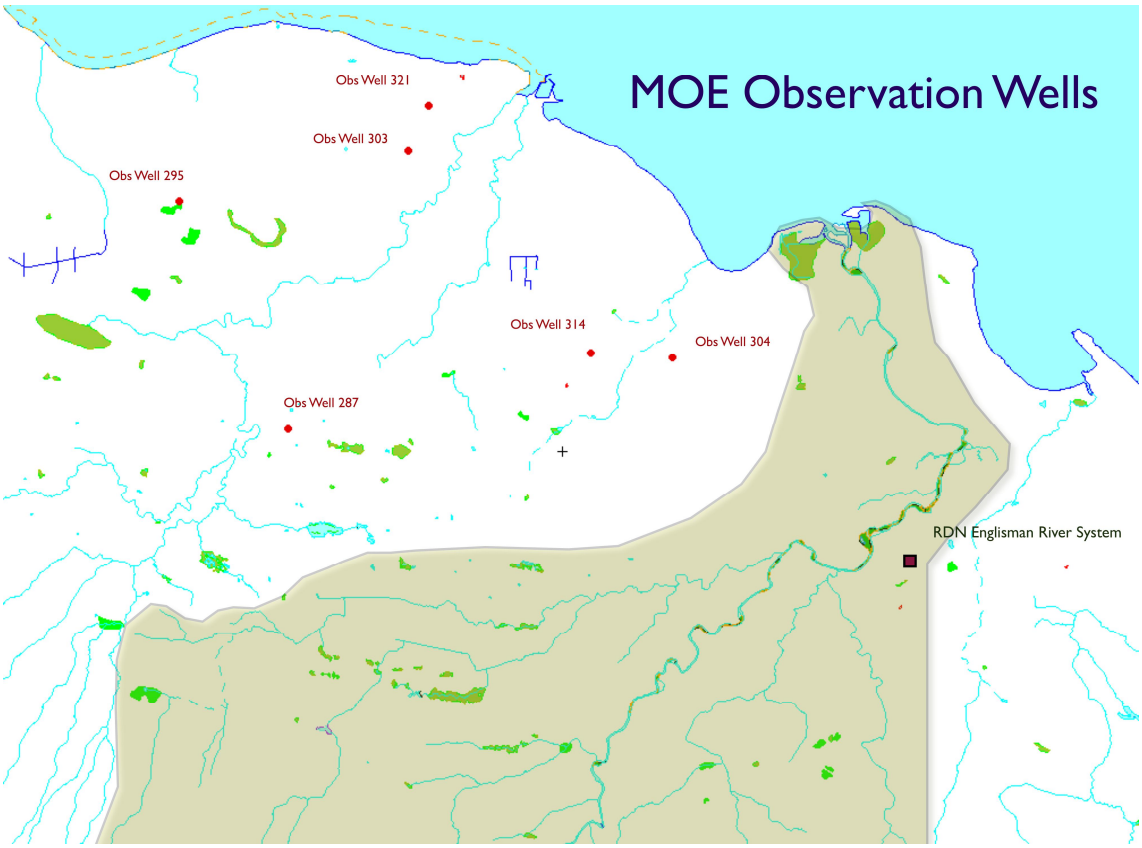


Figure 6: Observation Wells

4.2 Surface Water Monitoring

4.2.1 Federal Gauging Station

Environment Canada operates a gauging station near the estuary of the Englishman River (Station 08HB002). Interestingly, flow data dating back to the period 1913 to 1917 is available. Then starting in 1970, data has been manually recorded until an automatic recorder was installed in 1986. Information on water levels, discharge, electrical conductivity and turbidity data is available. The location of the station and an example of graphs that can be generated using the online information is shown in Figure 7.

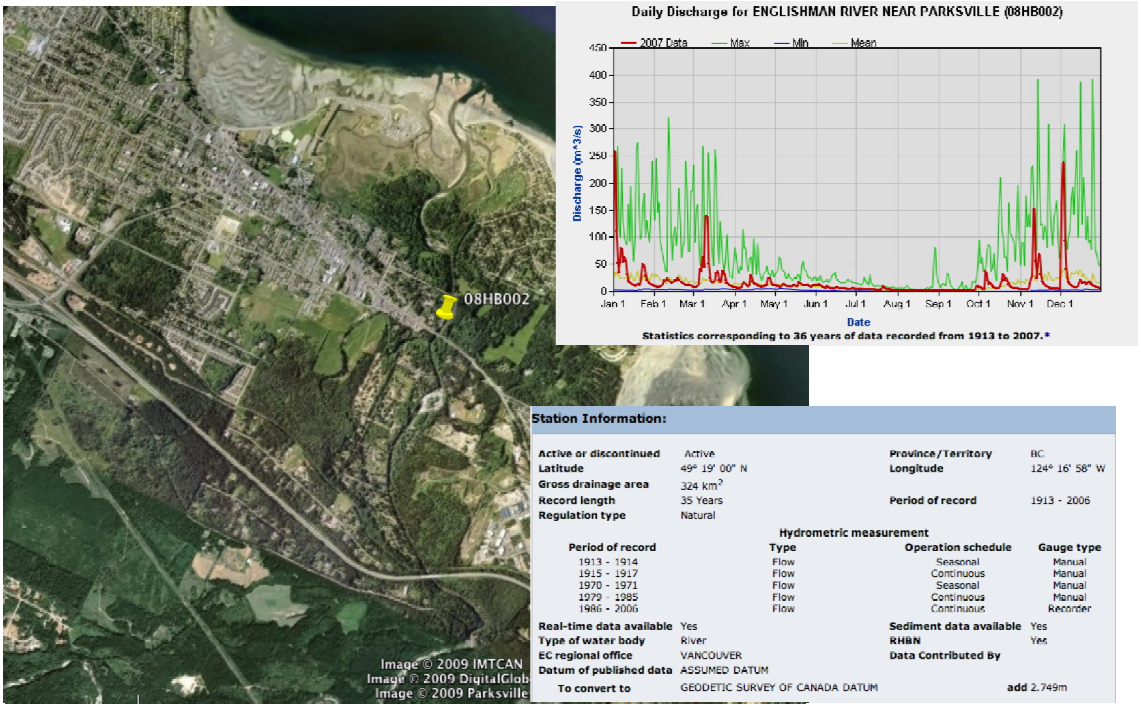


Figure 7: Environment Canada Gauging Station on ER

4.2.2 Monitoring completed by the province

BC MOE has operated five stations according to the schedule and for the parameters summarized in Table 1. The locations of the stations are presented in Fig 8.

Figure 8: BC MOE Gauging Stations on ER

Table 1: BC MOE Water Quality Monitoring Schedule

Site Number	Site Name Sampling Schedule*
E248836	South Englishman River U/S from Englishman River Monthly, August 2002 – August 2005, 5-in-30 samples summer and fall
E248835	Morison Creek U/S from Englishman River Monthly, August 2002 – June 2005, 5-in-30 samples summer and fall
E248834	Englishman River U/S from Morison Creek Monthly, August 2002 – June 2005, 5-in-30 samples summer and fall
E252010	Englishman River U/S from Allsbrook Canyon Monthly, May 2003 – June 2005, 5-in-30 samples summer and fall
0121580	Englishman River upstream from City of Parksville intake 3 samples early 1996; 1 sample in May 1998; 2 samples May – December 1999; 1 sample in November 2000 and November 2001; Monthly, April 2002 – October 2005, 5-in-30 samples summer and fall, 2002 – 2005. Continuous monitoring May 2003-March 2005

***5-in-30 sampling represents a minimum of five samples collected within a 30-day period.**

Five water quality monitoring sites were selected within the Englishman River watershed: EMS Site #E248834, Englishman River upstream from Morison Creek; Site #E248835, Morison Creek upstream from Englishman River; Site #E248836, South Englishman River upstream from the Englishman River; Site #E252010, Englishman River upstream from Allsbrook Canyon; and Site #0121580, Englishman River at Highway 1 (Figure 2).
An automated water quality/quantity monitoring station was also installed at Site 0121580 (at the City of Parksville intake), and programmed to log water temperature, turbidity, and specific conductivity at 15-minute intervals. The station has operated from May 2003 to the present.

Also, in 2007, a series of water and sediment samples was collected at the locations shown in Figure 9. This information is available at (http://www.env.gov.bc.ca/wsd/data_searches/wrbc/).

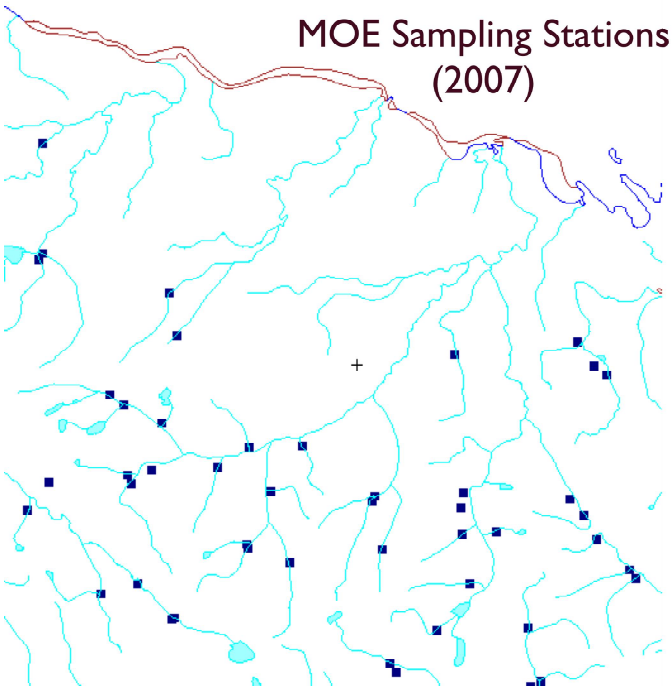


Figure 9: BC MOE Sampling Stations (2007)

A report (in preparation) will be released by BC MOE presenting and providing an interpretation of the water quality results.

4.2.3 Information collected by MVIHES

Water temperature and flow were monitored by MVIHES in 2006 and 2007 at the sites shown in Figure 10. Temperature loggers were installed in Centre Creek, 20 km bridge and lower ER in 2008. Flow monitoring continues below 19a bridge.

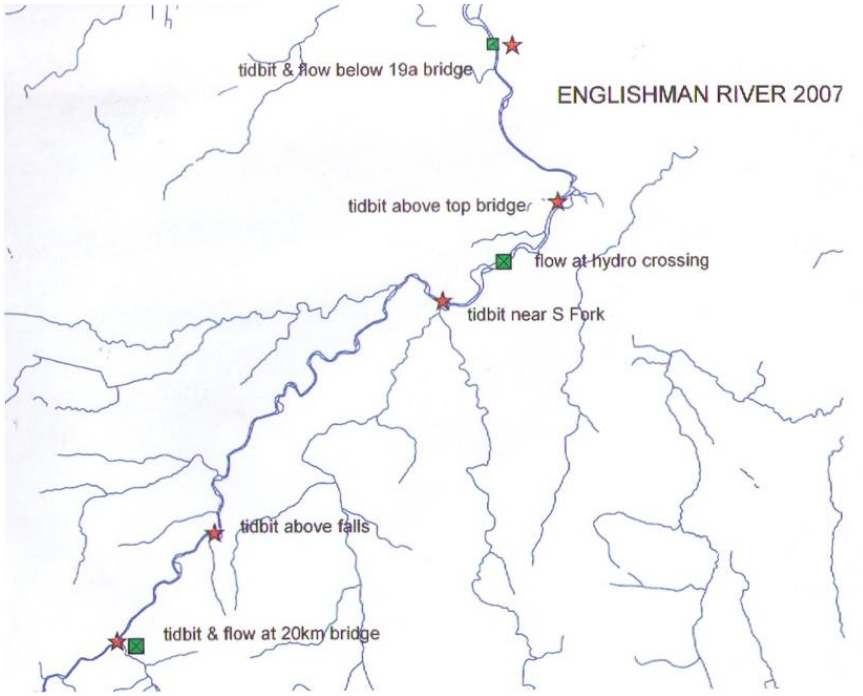


Figure 10: MVIHES Monitoring Stations

5 Lithology

5.1 Typical Setting

On the east coast of Vancouver Island, the hydrogeological conditions (type, geometry of the aquifers) are relatively complex because groundwater moves both in bedrock and in overburden aquifers. In addition, the overburden aquifers have a marine, glacial, glacio-fluvial, or fluvial origin, resulting in a large variety of geometry, size, thickness, and depth. The complexity of the aquifer sequence will increase with the thickness of the soil deposits and several aquifers can be superposed, sandwiched between low conductivity material (aquitards). Fig 11 is a artist rendering of the movement of groundwater on the East coast of Vancouver Island.

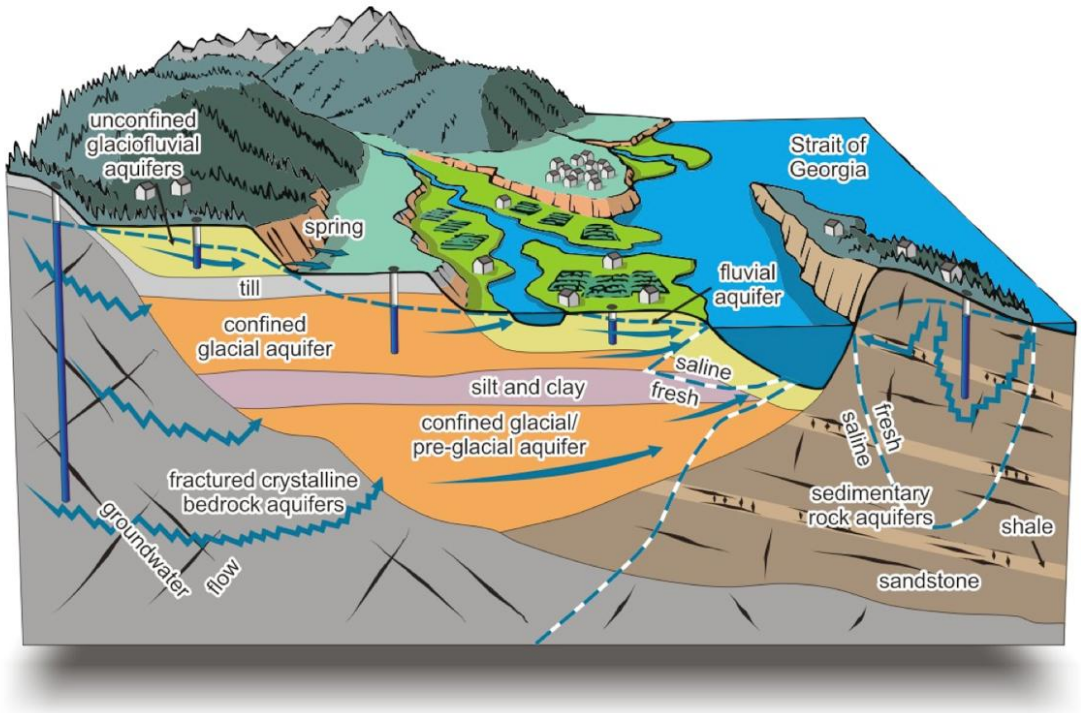


Figure 11: Illustration of Groundwater Regime
(Rivera, ed. in press - Geological Survey of Canada)

5.2 Regional Modeling

A study was completed in 2004, in partnership with the town of Qualicum Beach, the City of Parksville, the RDN, Breakwater, BC MOE and EBA Engineering consultants. It consisted of compiling available hydrogeological information (lithology, water table elevation) based on the BC MOE well database between the Little Qualicum River and the Englishman River and building a large grid numerical model simulating the groundwater regime in a steady state. Figure 12 shows the modeled area and the approximate extent of the lower section of the Englishman River watershed. Figures 13 and 14 show examples of the presence and locations of the various aquifers and aquitards with increasing depth. Based on interpreted data and a simple model, three types of aquifers are present (unconfined surficial, confined and deep confined aquifers).

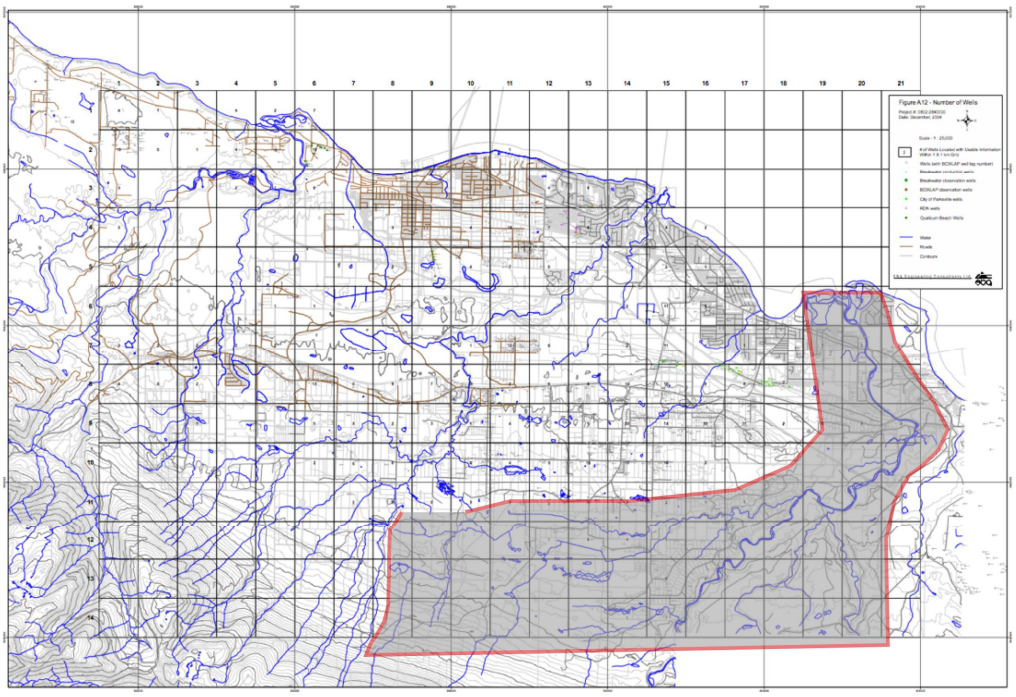


Figure 12: Area Covered by Numerical Modeling

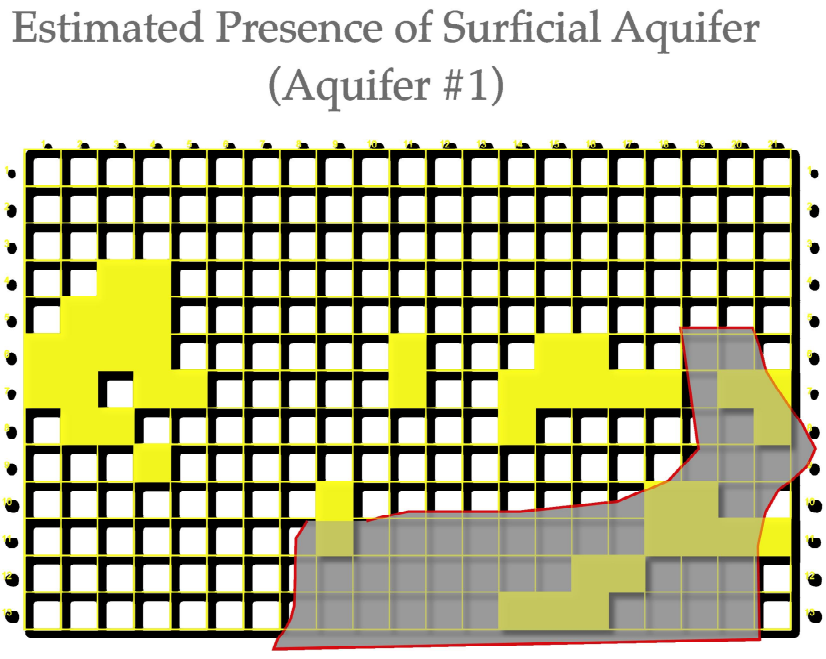


Figure 13: Estimated Location of Surficial Aquifer

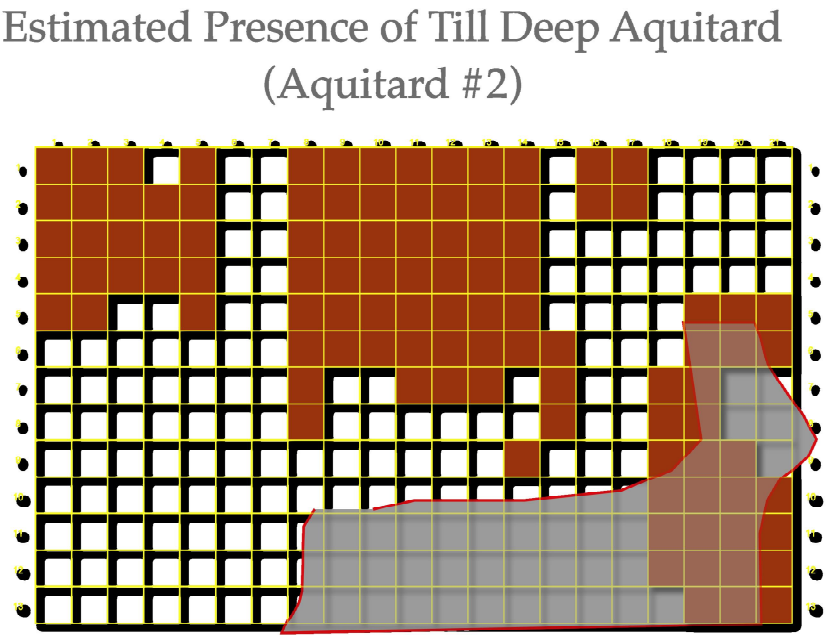


Figure 14: Estimated Location of Deep Aquitard

5.3 RDN – Industrial Area

A study was completed circa 2003 for the RDN to provide guidance on the vulnerability of aquifers to activities associated with potential change of land zoning. A map was generated showing the estimated thickness of low permeability soils (glacial till) overlaying the aquifers and also areas where artesian conditions had been reported (Figure 15).

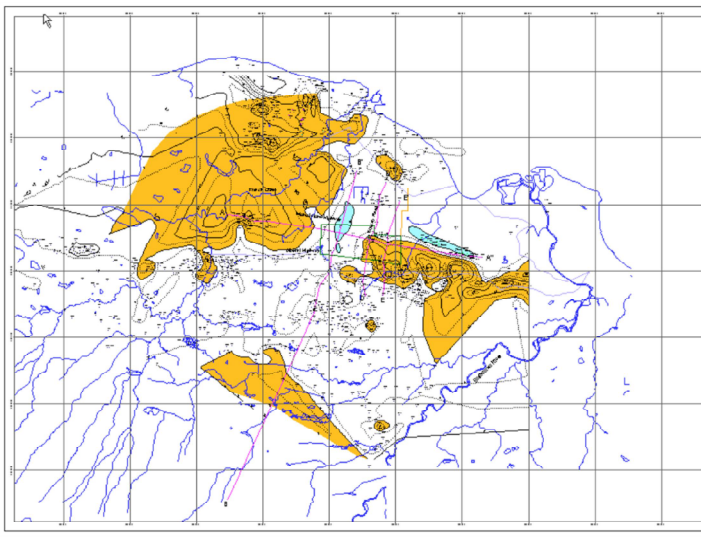


Figure 15: Estimated Location of Shallow Till and Reported Historical Artesian Conditions

5.4 River's Edge - Block 564

A hydrogeological study was completed in 2002 for the River's Edge development (Block 564). The local lithology was estimated and cross-sections drawn. They are presented in Figure 16 and 17 and show an upper (and partially confined) aquifer, and a lower confined aquifer. The upper aquifer appears to be discharging to the Englishman River. The lower aquifer is also most likely linked to the Englishman River with groundwater leaking through the confining aquitard.

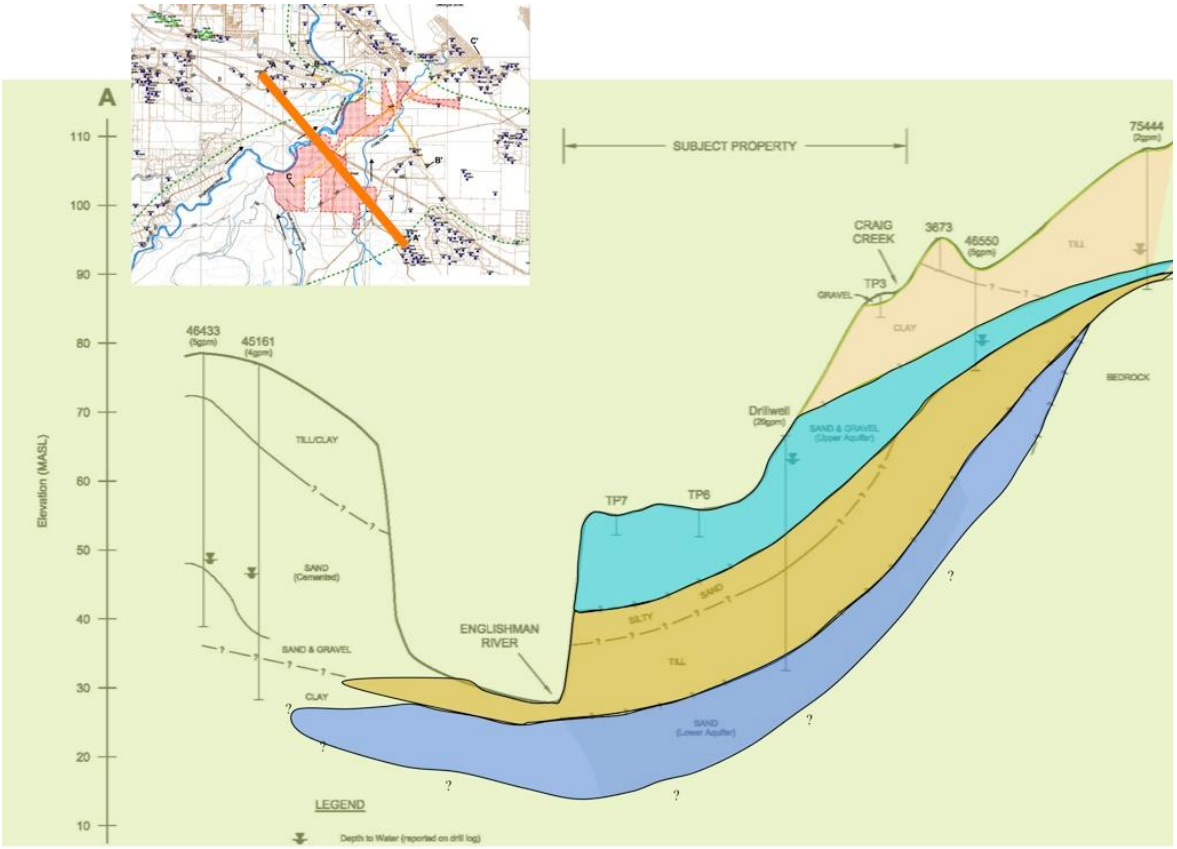


Figure 16: NW-SE Cross-Section Through River's Edge Subdivision

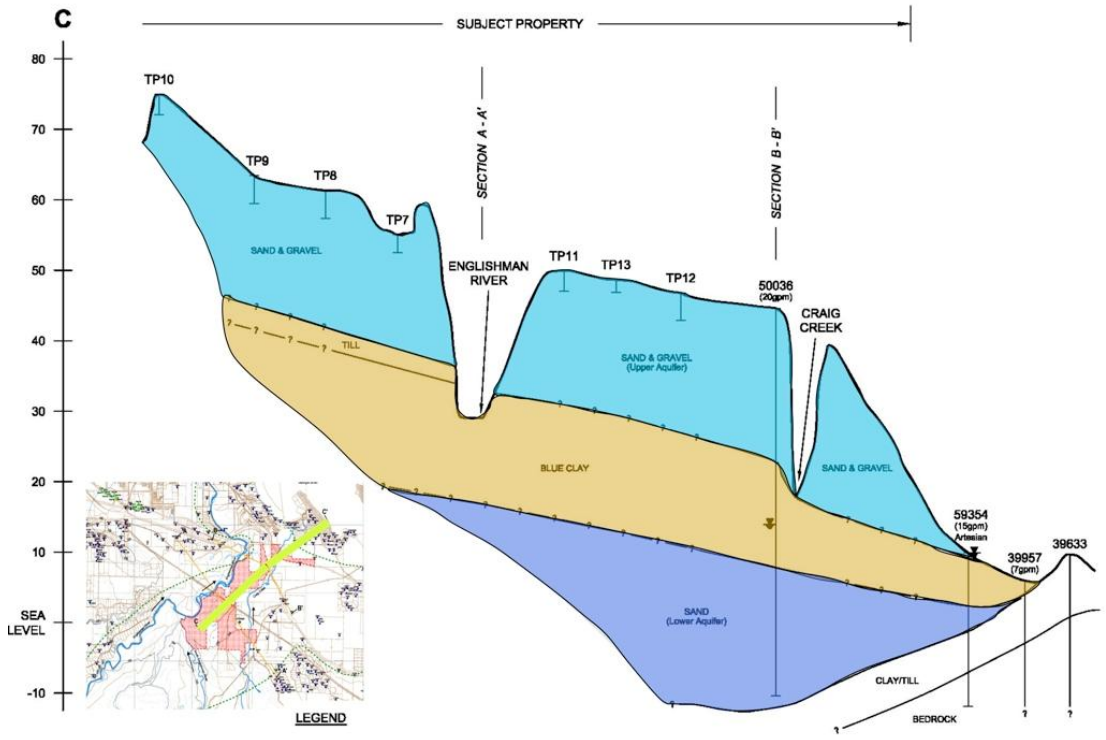


Figure 17: SW-NE Cross-Section Through River's Edge Subdivision

6 Other Studies

6.1 RDN Sustainability Study

The RDN has completed a sustainability report in 2005 where water quality and water quantity data were reviewed. In particular, comments were made on observed trends in the temperature of rivers, the rise or fall of water levels in monitoring wells, etc. An interesting aspect of the study was to estimate the percentage of impermeable surfaces on the land to identify areas where infiltration of rainwater was reduced due to coverage by impermeable surfaces. A portion of the map presenting such information for the lower section of the ER watershed is shown in Figure 18.

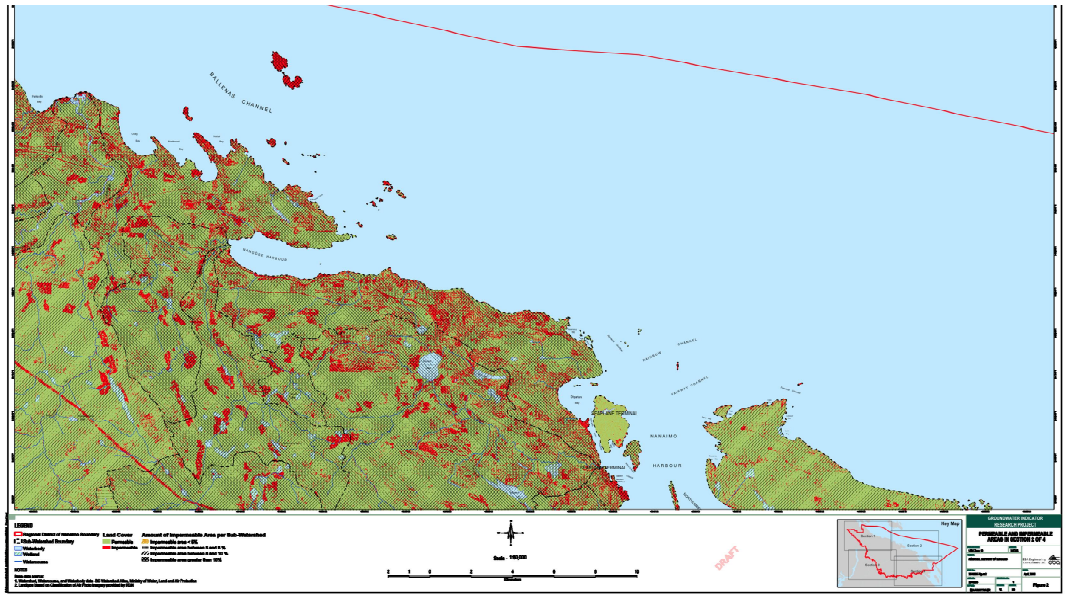


Figure 18: Estimated Location of Impermeable Areas

6.2 Water Source Vulnerability Mapping

The Vancouver Island Region Watershed Committee initiated a collaborative project between the Vancouver Island Health Authority, BC Ministry of Environment, Vancouver Island University and Natural Resources Canada to support the creation of a water resource assessment for Vancouver Island.

An existing aquifer vulnerability methodology developed by the US Environmental Protection Agency, termed DRASTIC, was employed in the assessment. DRASTIC is an acronym for the seven parameters that can influence the vulnerability of a groundwater resource: D - Depth to water, R - net Recharge, A - Aquifer medium, S - Soil medium, T - Topography, I - Impact of vadose zone and C - hydraulic Conductivity. These parameters are combined in an equation to represent one final map that highlights areas of higher and lower vulnerability.

Figure 19 shows a draft version of the vulnerability mapping for the lower section of the ER watershed. The colour coding indicates areas with estimated low vulnerability (in green) to areas of high vulnerability (in red). This map shows several areas in the lower ER watershed where the vulnerability is rated high.

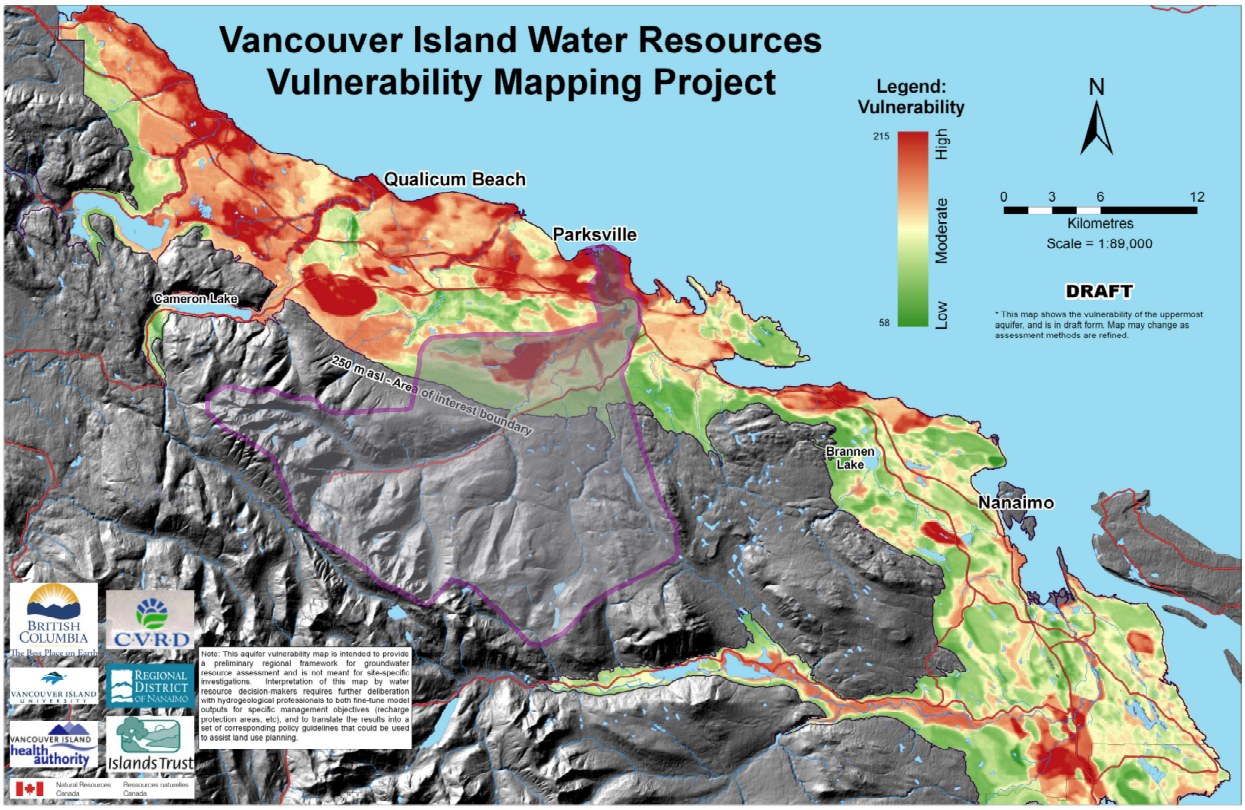


Figure 19: Water Resources Vulnerability Mapping

6.3 Fishery related projects

Many fishery habitat assessment and rehabilitation projects have been completed in the ER over time. Projects have focused on improving fish habitat through placement of large wood debris, and riffle enhancement. An illustration of such work is presented in Figure 20.

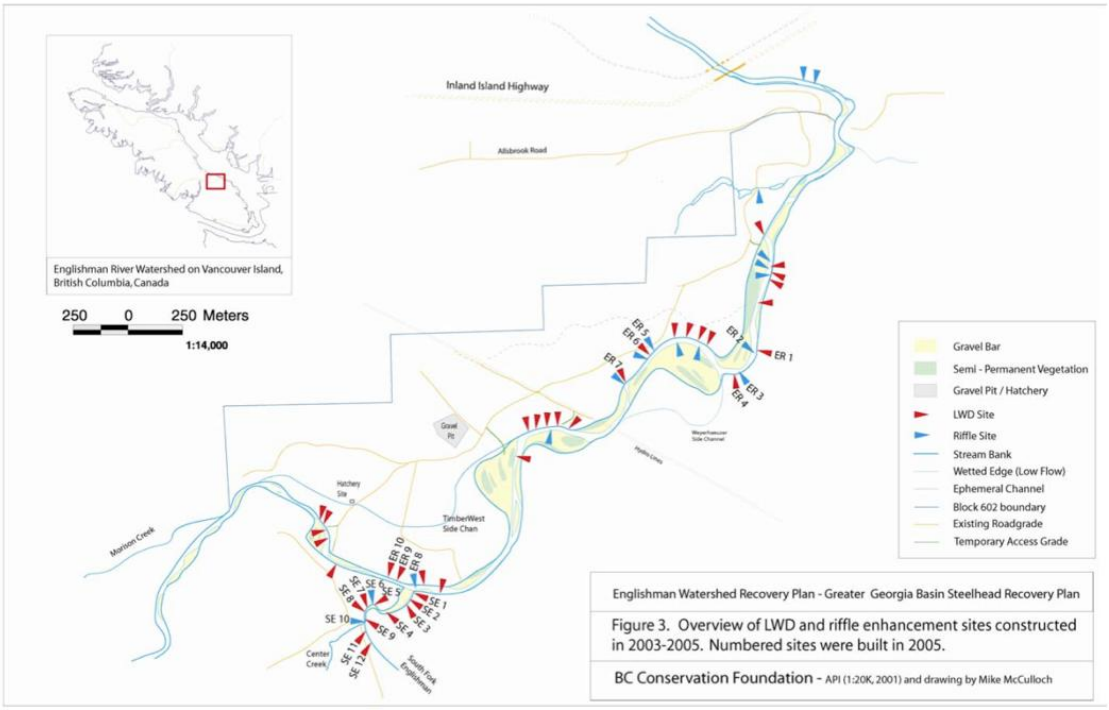


Figure 20: Example of Fish Habitat Enhancement Project

7 Proposed Work

The proposed work consists of collecting information on the presence and behaviour of aquifers in the ER, 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 proposed work is community-based; well owners will be invited to offer their wells for monitoring. Shallow dug wells will be monitored manually and electronic data logger will be installed in selected drilled wells. Such monitoring will allow the gathering of information on where groundwater is in the subsurface, the elevation of the water table, and how it fluctuates with the seasons.

Water samples will also be collected from selected wells and submitted for chemical analyses. Data on groundwater chemistry will be compared to historical data to assess whether the groundwater quality is changing. It will also be compared to available surface water quality information to estimate any correlation between surface water and groundwater chemistry.

8 Closure

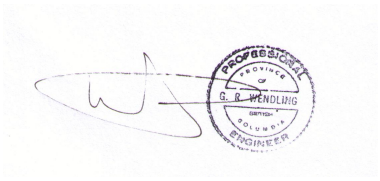
The information presented herein is based on information provided in part by others. The assessment has been carried out in accordance with generally accepted engineering practice. No other warranty is made, either expressed or implied.

This report was prepared by personnel with professional experience in hydrogeology. Reference should be made to the 'GW Solutions Inc. General Conditions and Limitations', attached in Appendix 1 that forms a part of this report.

GW Solutions was pleased to produce this document. If you have any questions, please do not hesitate to contact me.

Yours truly,

GW Solutions Inc.



Gilles Wendling, Ph.D., P.Eng.
President

Appendices

Appendix 1 – GW Solutions General Conditions and Limitations

Appendix 1

GW Solutions Inc.
General Conditions and Limitations

GW Solutions Inc. Reports – General Conditions

This report incorporates and is subject to these "General Conditions".

1.0 USE OF REPORT

This report pertains to a specific area, a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment. This report and the assessments and recommendations contained in it are intended for the sole use of GW SOLUTIONS's client. GW SOLUTIONS does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than GW SOLUTIONS's client unless otherwise authorized in writing by GW SOLUTIONS. Any unauthorized use of the report is at the sole risk of the user. This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of GW SOLUTIONS. Additional copies of the report, if required, may be obtained upon request.

2.0 LIMITATIONS OF REPORT

This report is based solely on the conditions which existed within the study area or on site at the time of GW SOLUTIONS's investigation. The client, and any other parties using this report with the express written consent of the client and GW SOLUTIONS, acknowledge that conditions affecting the environmental assessment of the site can vary with time and that the conclusions and recommendations set out in this report are time sensitive. The client, and any other party using this report with the express written consent of the client and GW SOLUTIONS, also acknowledge that the conclusions and recommendations set out in this report are based on limited observations and testing on the area or subject site and that conditions may vary across the site which, in turn, could affect the conclusions and recommendations made. The client acknowledges that GW SOLUTIONS is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the client.

2.1 Information Provided to GW SOLUTIONS by Others

During the performance of the work and the preparation of this report, GW SOLUTIONS may have relied on information provided by persons other than the client. While GW SOLUTIONS endeavours to verify the accuracy of such information when instructed to do so by the client, GW SOLUTIONS accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

3.0 LIMITATION OF LIABILITY

The client recognizes that property containing contaminants and hazardous wastes creates a high risk of claims brought by third parties arising out of the presence of those materials. In consideration of these risks, and in consideration of GW SOLUTIONS providing the services requested, the client agrees that GW SOLUTIONS's liability to the client, with respect to any issues relating to contaminants or other hazardous wastes located on the subject site shall be limited as follows:
(1) With respect to any claims brought against GW SOLUTIONS by the client arising out of the provision or failure to provide services hereunder shall be limited to the amount of fees paid by the client to GW SOLUTIONS under this Agreement, whether the action is based on breach of contract or tort;
(2) With respect to claims brought by third parties arising out of the presence of contaminants or hazardous wastes on the subject site, the client agrees to indemnify, defend and hold harmless GW SOLUTIONS from and against any and all claim or claims, action or actions, demands, damages, penalties, fines, losses, costs and expenses of every nature and kind whatsoever, including solicitor-client costs, arising or alleged to arise either in whole or part out of services provided by GW SOLUTIONS, whether the claim be brought against GW SOLUTIONS for breach of contract or tort.

4.0 JOB SITE SAFETY

GW SOLUTIONS is only responsible for the activities of its employees on the job site and is not

responsible for the supervision of any other persons whatsoever. The presence of GW SOLUTIONS personnel on site shall not be construed in any way to relieve the client or any other persons on site from their responsibility for job site safety.

5.0 DISCLOSURE OF INFORMATION BY CLIENT

The client agrees to fully cooperate with GW SOLUTIONS with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The client acknowledges that in order for GW SOLUTIONS to properly provide the service, GW SOLUTIONS is relying upon the full disclosure and accuracy of any such information.

6.0 STANDARD OF CARE

Services performed by GW SOLUTIONS for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Engineering judgement has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

7.0 EMERGENCY PROCEDURES

The client undertakes to inform GW SOLUTIONS of all hazardous conditions, or possible hazardous conditions which are known to it. The client recognizes that the activities of GW SOLUTIONS may uncover previously unknown hazardous materials or conditions and that such discovery may result in the necessity to undertake emergency procedures to protect GW SOLUTIONS employees, other persons and the environment. These procedures may involve additional costs outside of any budgets previously agreed upon. The client agrees to pay GW SOLUTIONS for any expenses incurred as a result of such discoveries and to compensate GW SOLUTIONS through payment of additional fees and expenses for time spent by GW SOLUTIONS to deal with the consequences of such discoveries.

8.0 NOTIFICATION OF AUTHORITIES

The client acknowledges that in certain instances the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by GW SOLUTIONS in its reasonably exercised discretion.

9.0 OWNERSHIP OF INSTRUMENTS OF SERVICE

The client acknowledges that all reports, plans, and data generated by GW SOLUTIONS during the performance of the work and other documents prepared by GW SOLUTIONS are considered its professional work product and shall remain the copyright property of GW SOLUTIONS.

10.0 ALTERNATE REPORT FORMAT

Where GW SOLUTIONS submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed GW SOLUTIONS's instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by GW SOLUTIONS shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by GW SOLUTIONS shall be deemed to be the overall original for the Project. The Client agrees that both electronic file and hard copy versions of GW SOLUTIONS's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except GW SOLUTIONS. The Client warrants that GW SOLUTIONS's instruments of professional service will be used only and exactly as submitted by GW SOLUTIONS. The Client recognizes and agrees that electronic files submitted by GW SOLUTIONS have been prepared and submitted using specific software and hardware systems. GW SOLUTIONS makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.