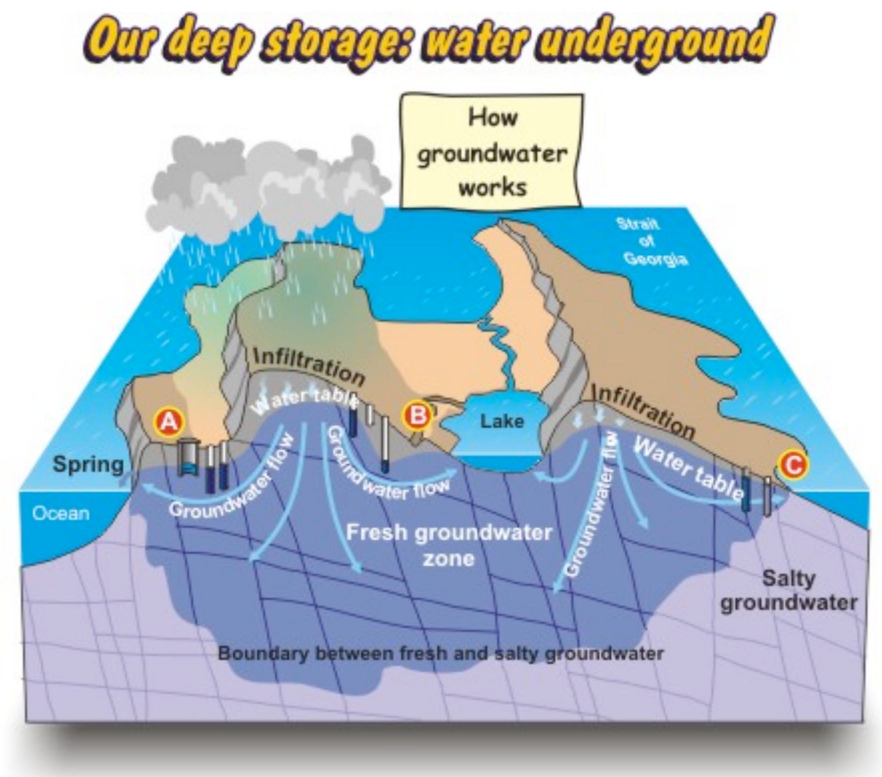
Salt Spring Island
WATER COUNCIL

SSI WATER COUNCIL
GROUNDWATER WORKSHOP

February 28, 2012



Waterscape Gulf Islands: Natural Resources Canada/Earth Sciences

FINAL REPORT

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SALT SPRING ISLAND WATER COUNCIL GROUNDWATER WORKSHOP REPORT

1. INTRODUCTION

The Salt Spring Water Council Society held this workshop to provide information on the island's groundwater sources, review current and proposed groundwater regulations, raise awareness of groundwater quality and quantity concerns and to identify steps to be taken to address any concerns.

The workshop was held on Tuesday February 28, 2012 at the Lions Hall on Salt Spring Island from 10 am to 4 pm. Admission was free. It was advertised through notices in the Gulf Islands Driftwood, Island Tides, Salt Spring exchange and the SSI Water Council website. Invitations to participate in the workshop were also sent to businesses associated with well drilling, well pump installations, water testing, hydrology and hydrogeology consulting, other water services and the BC Groundwater Association. Also invited were the locally elected Capital Regional District Director and both Islands Trust local trustees as well as staff at the CRD, Vancouver Island Health Authority and the SSI and Victoria planning offices of the Islands Trust. In addition to the six presenters, sixty-five people attended the workshop.

Those who registered in advance were e-mailed Background Briefing material (included as Attachment B) which included papers on:

- Goals for groundwater sustainability
- Salt Spring Island groundwater profile
- Background information for each presentation
- A list of further references

The workshop was organized by Water Council coordinator Peter Lamb and moderated by Water Council president George Ehring. The report was written by Murray Reiss.

The Salt Spring Water Council Society gratefully acknowledges funding from the Local Trust Committee of the Islands Trust which made this workshop possible.

2. PRESENTATIONS

"Salt Spring Groundwater, Wellhead Protection and the Water Sustainability Act"
Pat Lapcevic: Section Head, Water Protection, BC Ministry of Forests, Lands and Natural Resource Operations.

As background to her talk, Ms. Lapcevic pointed out:

- 45% of Salt Spring Island's residents get their water from wells
- Most wells extract groundwater from fractured rock aquifers
- Demand for groundwater will increase as surface water supplies reach capacity

She then presented one map showing the island's main fault lines superimposed on its geologic formations and another showing Salt Spring well sites and Community Water Systems. The Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) maintains two observation wells on Salt Spring, on Long Harbour Rd. and on Mt. Belcher Heights. Though data is limited, neither shows a trend towards depletion.

The first part of Ms. Lapcevic's talk focused on the Salt Spring Island Groundwater Chemistry Study that the Ministry carried out from 2007 to 2008. Its objectives were to:

- Collect baseline groundwater chemistry data to support decision making and future research
- Investigate the spatial distribution of chemical constituents
- Examine the relationships that may exist between ground water chemistry, fractures, and geology

146 wells were tested and their water analyzed for bacteria, metals and anions and cations. Analysis of the major ion chemistry showed fairly rapid groundwater recharge, with a subsurface flow of fairly fresh water. 14% of the samples collected had health-based chemical constituents above Health Canada guidelines:

- Arsenic: 9% of wells (Guideline: 10 μg/L)
- Fluoride: 6% of wells (Guideline: 1.5 mg/L)
- Boron: 5% of wells (Guideline: 5 mg/L)
- Nitrate: 1% of wells (Guideline: 10 mg/L)

25% of the samples showed arsenic at just under the guideline limits. It is important to note that these guidelines apply to treated water, while the study samples were untreated.

Arsenic:

Arsenic is a chemical element, naturally found in rock. Its occurrence, though difficult to predict, is common on the east coast of Vancouver Island. If used for drinking water or food preparation it can cause cancer. Exposure to high levels can cause short-term or acute symptoms, as well as long-term or chronic health effects. Recent research suggests that a safe level has yet to be definitively determined. It is known that long-term exposure (from years to decades) to even relatively low concentrations can increase the risk of developing certain cancers including skin, lung, kidney and bladder cancer. The concentration of arsenic in island wells was found to be higher in the summer than in winter.

Fluoride and Boron:

These chemical elements are also naturally found in rock. Low concentrations can reduce the risk of dental cavities but high concentrations of fluoride can cause dental fluorosis (discolouration of teeth, pitting and alteration of tooth enamel). An elevated intake for a long period of time can cause skeletal fluorosis (joint pain, restriction of mobility, bone fractures).

Boron is necessary for plants and thought to be an essential nutrient for humans. At high levels, however, boron can cause reproductive and developmental problems in mammals.

Nitrates are not naturally occurring; they are introduced to groundwater through land disturbance.

47% of samples had aesthetic-based chemical constituents above the guidelines. These included manganese, sodium, chloride, iron, aluminum and sulphate.

The study also sampled bacteria. The percentage above guidelines was:

- Total Coliform: 29% of wells (Guideline: <10 CFU/100 ml)
- Fecal Coliform: 10% of wells (Guideline: <1 CFU/1oo ml)
- E. Coli: 9% of wells (Guideline: <1 CFU/100 ml)

Summary:

1) Chemical Constituents:

- 86% of samples met the Guidelines for Canadian Drinking Water Quality for Health-Based chemical constituents.
- The potential for saltwater intrusion into fresh water aquifers exists and should be monitored/studied further.
- The presence of arsenic and fluoride are significant, but can be treated.

2) Bacteria

- Bacteria results suggest need for well maintenance and protection measures.

3) General

- Regular testing is important: bacteria (1-2 times per year) and chemical constituents (twice in the first year after a well is drilled and then once every 5 years).

The second part of Ms. Lapcevic's presentation dealt with ensuring a safe groundwater supply. There are four main actions to take:

- Contract only Qualified Well Drillers and Qualified Well Pump Installers registered with the Ministry
- Install wells away from potential sources of contamination
- Maintain well properly
- Decommission and close unused wells

Ms. Lapcevic's talk concluded with a look at proposed changes to the provincial Water Act. Commitments for 2012 to change the old Water Act to a Water Sustainability Act include proposals that will:

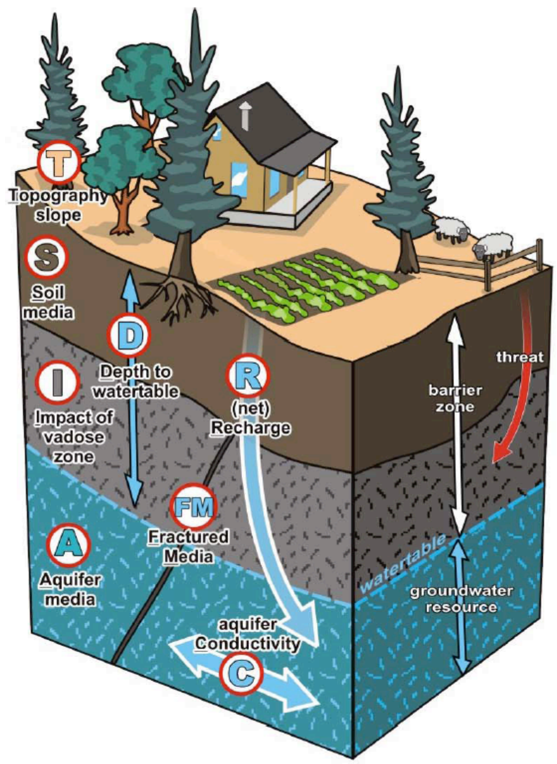
- Improve the protection of ecological values, provide for more community involvement and provide incentives for water efficiency
- Regulate groundwater use in priority areas and large groundwater withdrawals
- Recognize water flow requirements for ecosystems and species.

She cautioned that the details have yet to be worked out and that legislative changes can be very slow in coming.

"Vancouver Island Water Resource Vulnerability Mapping Project"

Dr. Alan Gilchrist: Professor, Department of Geography, Vancouver Island University.

The Vancouver Island Water Resource Vulnerability Mapping Project is an inter-disciplinary initiative aimed at developing a geographically based information system to characterize intrinsic groundwater vulnerability to pollution and contamination. This is a tool that can help anyone doing land use planning by providing a way of measuring any particular aquifer's intrinsic vulnerability to pollution. The data Dr. Gilchrist presented looks at all of Vancouver Island, including the Gulf Islands.



DRASTIC Method (Figure courtesy of Geological Survey of Canada)

There are two main types of aquifers in Vancouver Island and the Gulf islands: sand and gravel and fractured bedrock. The methodology used to measure their vulnerability is called DRASTIC, for the seven parameters it measures:

- **D**epth to water table
- **R**echarge rate
- **A**quifer media
- **S**oil media
- **T**opography steepness
- **I**mpact of vadose zone (the area from the top of the ground surface to the water table)
- **C**onductivity of aquifer

For the Gulf Islands, a further parameter can be added, **FM**, referring to the typically fractured media of our aquifers and looking for the presence of direct pathways in the bedrock due to these fractures.

The DRASTIC method results in an aquifer vulnerability map that shows areas of high, medium and low vulnerability, as well as delineating variability within a single aquifer.

High vulnerability areas feature low land, high water tables, are close to river systems, and are composed of unconfined sand and/or gravel.

Medium vulnerability areas have deeper groundwater and the aquifers themselves are less permeable, with more of a fractured bedrock composition.

Low vulnerability areas are further from the coast, on higher land, with deeper groundwater and unfractured bedrock.

Dr. Gilchrist stressed that the project's mapping provides a screening tool for the regional, but not local, level. A hydrogeological assessment would still be needed at the localized scale. Nor does the mapping reflect the presence or absence of sources of pollution. Compared to the BC Aquifer maps, which also document vulnerability, the DRASTIC maps show more spatial variability.

The Cowichan Valley Regional District has adopted this approach in their guidance document, "A Guide to the Use of Intrinsic Aquifer Vulnerability Mapping" (cvrd.bc.ca/DocumentView.aspx?DID=7838) to aid planners and others in protecting groundwater and informing land use decisions.

Dr Gilchrist then described a further step in enabling communities to protect their groundwater — the Community Groundwater Monitoring Network. This idea grew out of analyzing the "depth to water table" parameter in the DRASTIC model. CGMN offers communities a simple web application they can use to record water level and extraction data. The hope is that over time we will build up our knowledge (currently scanty) of how much groundwater is actually being extracted and have this information in one readily accessible location.

"Groundwater Monitoring: 2011 Summary and Reports of the Salt Spring Monitored Well Network"

Rick Gilleland: Retired Professional Engineer and operations adviser to Mt Belcher Improvement District.

This is a Salt Spring Water Council project to determine more about the condition of groundwater, on which about 45% of islanders rely for their potable water. Most people on their own private wells generally know if they have supply problems and self-regulate but they usually don't have data records. This project, funded by Water Council and BC Ministry of Forests, Lands and Natural Resource Operations , intends to expand a network of wells operated by both individuals and water districts to provide status and performance data on the water table on the island. Keeping it simple and affordable are the main drivers for the current first steps. The initial focus is the seasonal change of the static water table. Water quality testing is left to the individual operator/household and is encouraged at seasonal highs, lows and during recharge.

In order to determine the condition of the island's groundwater we need to know:

- Changes: a status baseline covering quantity, quality, performance and other issues will allow the detection of changes
- Use: how much is used and how much is available

- Source: how much rainfall and when
- Storage: how much is naturally stored in the ground
- Geology: capacity, vulnerability, chemistry
- Threats: rainfall/drought conditions, contamination, overuse, climate change, saltwater intrusion, well-to-well interference

In terms of monitoring individual and community system wells, the following parameters are either essential or desired:

- Essential: water table static level with no pumping
- Desirable: drawdown after/during pumping; recovery-time response of water table to return to static level; a record of pumping cycles over several days
- Later add-ons: water temperature at depth; pH or other water chemistry data

The advantages and disadvantages of several techniques to measure water depth were discussed, including:

- Wetted tape measure (requires cleaning)
- Air tube (limited to 200 feet of water column)
- Data logger (use of conduit adds to cost)
- Sonic water depth (can depend on how cluttered well is)

Mr. Gilleland concluded by presenting data from the existing network sites:

- MOE- Scott Point, Mt. Belcher- automated
- Mount Belcher- 2 wells, air tube
- Harbourview- 3 wells, wetted tape, many years
- Cedar Lane – 2 wells, air tube
- Mt. Erskine- 2 wells, air tube
- Scott Point- 3 wells, air tube
- Swan Point- 2 wells, wetted tape
- Reginald Hill – 1 well, air tube, second well in progress
- High Hill- 1 well, air tube
- Maracaibo- 2 or more wells, wetted tape, data collection in progress
- Mt. Tuam- 1 well, planned instrumentation by CRD, not yet completed

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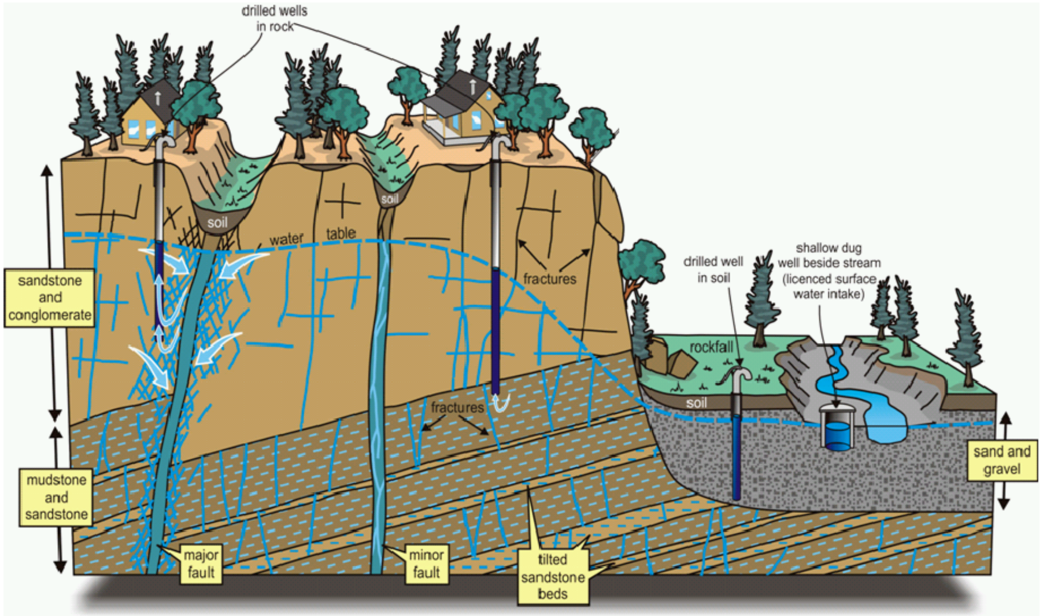
"Groundwater and Climate Change on the Gulf Islands"

Dr. Diana M. Allen: Professor, Department of Earth Sciences, Simon Fraser University.

Dr. Allen's talk looked at groundwater on the Gulf Islands through the lenses of hydrogeology, recharge and climate change. She emphasized that trying to work out ways to estimate recharge is "a very tricky business." This is made even more difficult on the Gulf Islands because of the fractured nature of bedrock with faults and fracture zones extending from one side of an island to the other.



The Conceptual Model (Figure courtesy of Geological Survey of Canada)

Dr. Allen and her students collected fracture data — including orientation, fracture surface roughness, an estimate of fracture aperture, fracture termination, fracture mineralization (if present) and fracture trace length — for over 10,300 fractures. These data were collected through four field seasons on eight islands.

There are three hydraulically distinct, hydrostructural domains on the Gulf Islands:

- "Highly" fractured, interbedded mudstone and sandstone (IBMS-SS)
- "Less" fractured sandstone (LFSS)
- Fault and fracture zones (FZ)

Statistical analysis revealed that fractures within the same hydrostructural domain tend to have similar fracture characteristics that are statistically different from those in other hydrostructural domains. Using a fracture modeling approach, the permeability of each hydrostructural domain was determined and found to be different, with the fault and fracture zone domain having the highest permeability, followed by the interbedded mudstone and sandstone, and then the less fracture sandstone. Dr. Allen noted that massive mudstone units do occur on some islands and that they likely have a low permeability. Fault zones seem to be likely zones of recharge, with an increased capacity to store and transmit water through the interconnected fracture network.

Despite our understanding of the nature of permeability on the Gulf Islands, there is no simple answer to how much groundwater is available. Geology is complex, as are fractures. Well yields can vary hugely within 5 metres of one another.

We do know that groundwater is recharged locally from precipitation, and that most recharge occurs in the late fall and winter months. The magnitude of the fluctuations in groundwater level is determined by a combination of geology and climate.

The key climatic factors for the Gulf islands are the variation in the amount of precipitation from year to year and the seasonal variations within the year. Our region is also subject to long-term climate variations over decades as a result of the Pacific Decadal Oscillation (PDO) and the El Nino Southern Oscillation (ENSO). Trends in groundwater level must be examined keeping these variations in mind. We need long-term records to show the longer term cycles so that we do not misinterpret natural long-term cycles as being due to more immediate factors.

Dr. Allen summed up the implications of geology and climate for recharge on the Gulf Islands as follows:

- The bedrock is variably fractured, with varying permeability;
- Zones of high fracture intensity with sub-vertical joins and fault zones may be primary sites for recharge;
- To model recharge, climate must be considered, as well as spatial variations in aquifer permeability, soil permeability, slope and water table depth.

This leads to what Dr. Allen calls "the crux of the matter" — recharge estimation. While recharge can be *estimated* using a variety of methods, all of them are highly uncertain and face a number of challenges. Among these are the lack of direct measurements of recharge, limited estimates of runoff, and the complex geology of fractured bedrock.

Based on a variety of methods, annual recharge on the Gulf Islands is estimated to be in the range of 8–20% of annual precipitation, but these estimates remain uncertain. Recharge on the Gulf Islands is not likely to change by very much on an annual basis as a result of projected changes in climate; however, the impact of more frequent intense rain events, which are projected for the future, on recharge has not yet been studied.

Dr. Allen's talk also covered the issue of saltwater intrusion in fractured aquifers. In the presence of these fractures, saltwater can enter through preferential pathways and wells can become salty right after they are drilled.

Finally, Dr. Allen considered how the system might change in the future. She introduced charts of global climate models for the last 100 years to illustrate how the different models variably reproduce past climate. She then showed the IPCC emissions scenarios, noting that we have already surpassed the most extreme scenario. Global climate models for this region indicate, generally, little change in annual and seasonal precipitation for the West Coast. This translates into little change in recharge, assuming the frequency of intense precipitation events does not significantly impact recharge. The sea level is also predicted to rise, with a predicted rise of from 30–100 cm for Fulford Harbour; however, this estimate is outdated and may in fact be higher. Dr. Allen surmises that the saltwater-freshwater interface will likely only shift a small amount due to sea level rise, except in low lying areas where the interface position is highly sensitive to changes in hydrology. She suggested that the low lying areas are particularly at risk, not only of seawater intrusion, but of land inundation and storm surges. The greater risk, though, is from unsustainable groundwater extraction due to over-pumping, especially along the coast.

"Groundwater and Health Considerations"

Erwin Dyck: South Island Supervisor, Vancouver Island Health authority

Mr. Dyck told us he was drawing most of the material for his presentation from the "wellSMART" part of the Regional District of Nanaimo's "Drinking Water and Watershed Protection Program."

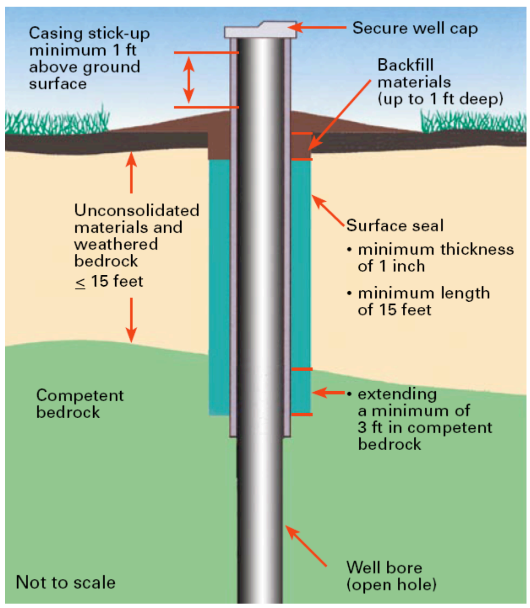
The quality of water in aquifers is influenced by nature and by how one looks after one's well. Generally, water gets cleaned of bacteria as it infiltrates the ground after a rainfall, but there are natural influences, such as:

- The kind of rock around your well can add minerals to the water (i.e., iron, manganese, fluoride, arsenic, sulphur, calcium, etc.)
- Bacteria from wildlife
- Human activities that lead to contamination

Fecal matter can introduce bacteria (eg., *E. coli, fecal coliforms, total coliforms*), viruses (eg., *Norovirus*), and parasites (eg., *Gardia lamblia*). Human activities can introduce chemicals like nitrates, pesticides, hydrocarbons and pharmaceuticals.

To protect your well, you need to understand the factors that affect the safety of your water source:

- Location
- Construction and setup
- Maintenance
- Proper Closure
- Aquifer characteristics



Well Head Protection — Drilled Wells

(From Regional District of Nanaimo wellSMART program)

Wells should be located 30 m (or 100 ft) away from potential sources of contamination (excess surface runoff is a major neglected source) and ideally at a high elevation in a secure, dry area free of contamination. All drilled wells *must* be constructed by a provincially registered well driller. All pumps *must* be installed by a provincially registered pump installer. Wells must have a water-tight, vermin-proof cap and a surface seal that prevents contaminants entering from along the outside of the casing.

Good maintenance includes:

- Inspecting the wellhead
- Properly maintaining the septic system
- Testing water quality on a regular basis
- Keeping wellhead and pumphouse in good repair and free of contaminants

- Disinfecting the well and water system if:
    - work is done on the well
    - water testing indicates bacterial contamination
    - flooding caused surface water to enter the well

<u>Water Quality Testing</u>

Well water may taste and look fine but still contain harmful substances. Some chemical contaminants sometimes found in well water can cause long-term health problems which develop over years. Water from private wells must be regularly tested by a laboratory to ensure that it is safe.

Test for bacteria 3 times a year and after any major plumbing work. Test for chemicals and other parameters twice in the first year of the well's operation and every 3–5 years after that. Early spring is a good time to test for bacteria. Another is after a heavy rainfall.

<u>Treatment</u>

No one treatment method will solve all problems. *Bacteria* can be treated by chlorinators, UV, distillers and ozonators but not by Brita filters, charcoal or ion exchange. *Chemical contamination* can be treated by reverse osmosis, activated charcoal filters and ion exchange but not by UV or chlorine shock.

"A Hydrogeology Study for Salt Spring"

Dr. Hugh Greenwood: Former Head, Department of Geology and Geological Engineering, University of British Columbia.

The availability of a new geological map of Salt Spring Island (prepared over several years by Dr. Greenwood), coupled with data from the BC government's archives of water well records, provides an opportunity to assess the degree to which the different rock types on Salt Spring affect the quantity and quality of groundwater. This brief report outlines the result of a preliminary study made in order to judge if there would be value in making a thorough analysis.

The proposed analysis would attempt to fill in gaps in our current knowledge:

- Is poor production related to rock type?
- Is bad chemistry related to rock type?
- Are there areas with inadequate water?
- Are there areas where water is abundant?
- Should we regulate groundwater?
    - near shorelines
    - the extraction rate
    - sources of contamination

The preliminary study checked 1,880 wells for their yield rate and examined 160 well logs in detail for their depth to production rate, rock type, flow rate, quality and proximity to faults and the shoreline. 160 wells constitute a small fraction of the Salt Spring wells in the provincial database. Much may be learned by making a complete analysis. What follows is a summary of preliminary findings, along with a few remarks.

Of these 160 wells, 80 produced less than 12 GPM, 60 produced 1.0 GPM or less, and 10 were essentially dry. Twelve wells report flows of more than 20 GPM; five of them are near mapped fault lines. The water is produced from granite, Haslam Shale, Pender Shale, DeCourcey and Geoffrey sandstones.

Most of the high-producing wells (more than 10 to 15 GPM) are close to known faults, particularly St. Mary Lake and Fulford Valley faults. However, a number of strong producers have no obvious relation to faulting. It is difficult to argue that certain rocks are usually big producers. More data may resolve this uncertainty.

One interesting observation may be made in relation to faulting: one well producing from the Northumberland Formation near the shoreline of St. Mary Lake has salty water. This well is very close to the east branch of the St. Mary Lake fault. The same fault passes close to the Salty Springs Resort, suggesting sea water access along the fault. It seems likely that fresh groundwater from the surrounding hills is forcing salty water, presumably from the sea and filling the fault zone, up into the St. Mary Lake well and into the Salty Springs area.

The lowest producing wells (<0.5 GPM–1.0 GPM) were found in the Ganges, Haslam and Northumberland shale and Protection, Cedar District and DeCourcey sandstone formations. Wells that are either dry or dry in the summer were found in the DeCourcey sandstone, Northumberland shale, Geoffrey formation and Spray formation. In general, shale units tend to have poor chemistry, a strong sulfur odour, and low productivity.

Summary:

The productivity of Salt Spring wells is controlled by a combination of rock type and faulting and fracturing, and the quality of the water is directly related to the chemistry of the rock from which the water is produced. There appear to some problems with well production, both in terms of quality and quantity. Correlations can be made much sharper and more precise by accumulating more data of this kind.

Proper management of groundwater requires information. We have some preliminary data but much more is needed for decision making. Dr. Greenwood proposes an integrated hydrogeology study to come up with the necessary data. The most cost-effective way would probably be as a supervised graduate thesis, which could cost around $40,000 over two years.

3. SPEAKER PANEL SESSION

Presentations were followed by a **question and answer session** in which the six speakers answered questions from the audience. A number of concerns were raised, of which the following present a sample.

Question:
How can land use mitigate water problems?
Responses:
It's not clear that removing trees leads to more or less recharge. This changes with time. You have to look at the overall water budget. With forests that have been hit by pine beetles, or heavily logged, it's hard to say how the water budget changes. Trees, after all, use a lot of water. But the early stages of logging, roadbuilding, etc., disrupt the land surface. It depends how it's done. It is important to understand local land use to manage groundwater.
Question:
What about well drillers who claim they can improve your well's flow?
Responses:
One well driller responded that he has been doing hydro—fracturing of low performance water wells on Salt Spring Island for ten years. Sometimes it is successful, although less so in shale and mudstone, more so in metamorphic rock. The process does not use chemicals or horizontal drilling and is in no way the same as natural gas and shale oil hydro-fracking. What's involved is "hydraulically fracturing" rocks — opening up existing fractures to provide a path of less resistance for water to enter the well. It can only build up enough pressure to be effective on wells that produce less than 1.0 GPM. Hydrofracking can influence neighbouring wells, as can drilling a new well.

Question:
How can small water systems promote conservation and the POLIS soft path? There seems to be a conflict with the requirement for proof of 1600 liters/day for a building permit.
Responses:
Conservation plans require ongoing management and cooperation between all the water systems. We need to find ways to control the uses of high quality water. One approach would be for the community system to provide the amount of potable water per unit required by local regulations with water for all other uses provided by the homeowner.
There is a need to keep the proof of water high or else developers will put in one well for 20 lots, promise more, and then skip out.

Question:
Will water governance be in the new Water Act?
Responses:
The Act will enable changes down the road but not immediate changes to the province's right to allocate water. We have no details yet. Will it devolve regulation to community groups? Regional Districts? Not in the immediate future. Tools will be put in place to regulate water use in drought conditions.

Question:

Why not insist on flow meters on all new wells installed? Let people know how much water they use.
Responses:
Yes, water system operators will tell you that as soon as you put meters in, use drops by as much as half. Very few people on wells know how much water they're using.

Question:
A huge amount of water is lost in runoff? What can we do? Ponds? How much influence would they have?

Responses:
Anything you do to the land surface alters the natural hydrology. We don't know enough — the results could be catastrophic. Redirecting runoff away from the oceans could have consequences for marine ecosystems. It's better to reduce your impact and consumption, especially in sensitive areas like the Gulf Islands.

Question:
What about desalinization?
Responses:
The power input required makes it hugely costly, if not ecologically damaging. Besides, what would you desalinate? Say it's a well: if you start pumping that salty well, you could contaminate other wells.
The Water Act currently prohibits the pumping of saline wells.

Question:
What about rainwater harvesting?
Responses:
A lot of new construction has some form of that. On Gabriola, there hasn't been a new house go in without some form of water catchment.
There are health implications. If you rely totally on rainwater harvesting, you have to be careful about how you size the system to get through the dry months. The roof composition, vegetation around the roof and storage — all affect the quality. You definitely need to treat that water. It is not safe otherwise.

4. SMALL GROUP FEEDBACK ON LOCAL CONCERNS

The workshop concluded with participants forming into five smaller groups for **discussion of priority issues and actions** for Salt Spring's groundwater. The groups were asked to address two questions:

1) Based on your understanding of our groundwater resource and what you have heard today, what is your priority concern about groundwater on Salt Spring?
2) What action or actions should be taken to address these concerns?

A number of the groups came up with similar concerns and suggested actions.

<u>Concerns</u>:

- Not enough data on the quantity, distribution and recharge rate of island's groundwater
- Dry wells, unpalatable wells and interference with neighbouring wells
- Overuse of groundwater
- Possibility of over-regulation
- Need for sustainable use of groundwater

<u>Actions</u>:

- Introduction of water metering as a general practice
- Require flow meter installation by certified well pump installers on all new construction
- Expand groundwater monitoring; more monitor wells
- Research size and distribution of groundwater resource
- Come up with more good data and use it to raise awareness
- Emphasize areas at higher risk
- Facilitate water reclamation, re-use and rainwater collection through changes to bylaws, building and plumbing codes, etc.
- Develop Best Practices Manual including information on:
    - basic hydrogeology
    - self-metering
    - double plumbing
    - rainwater capture
    - home estimation of yield rate
    - seasonal water storage
    - POLIS approach
- Use this as basis for community workshops
- Develop Community Based Social Marketing campaigns, using tools like positive peer pressure

ATTACHMENT A

SPEAKER PROFILES

Dr. Diana Allen

A Professor in the Department of Earth Sciences, Simon Fraser University, Dr. Allen graduated from Carleton University with Bachelor and Master degrees and a Ph.D. Her primary research interests are in groundwater resources in mountainous and coastal regions, groundwater resources assessment under the pressures of humanity and climate change, aquifer thermal energy storage and aquifer vulnerability and land use impacts.

Erwin Dyck

Mr. Dyck is the South Island Supervisor for the Vancouver Island Health Authority. He has been an Environmental Health Officer for almost 32 years and has been employed with CRD Health/VIHA for the last 25 years. He covered Salt Spring Island from 1989–1996.
For many years, Mr. Dyck worked as a Land-use/Drinking-Water Specialist and for the last three years has been the Supervisor of Health Protection for the South Island.

Dr. Alan Gilchrist

A Professor in the Department of Geography, Vancouver Island University (VIU), Dr. Gilchrist was educated in the UK, with a Bachelor degree in Geology from the University of St. Andrews, and a Doctorate in Earth Sciences from the University of Liverpool. He teaches courses in environmental geography, geomorphology, hydrology, geographical information systems, and natural resource management in VIU's Bachelor of Arts and Science programs as well as being active in research. Dr Gilchrist is currently the Chair of VIU's Geography Department.

Rick Gilleland

Rick Gilleland is a Water Council Society member and leads its Well Monitoring Network Project. He is an operations advisor (and past trustee and operator) of the Mount Belcher Improvement District on Salt Spring. Mr. Gilleland is a former Aerospace Industry Executive, Ministry of Transport senior engineer and RCAF engineering officer. He is currently a member of the Islands Trust Advisory Planning Commission.

Dr. Hugh Greenwood

Dr. Greenwood is the former head of the Department of Geology and Geological Engineering at UBC and a retired Professional Engineer. Dr. Greenwood participated in the Potable Water Focus group for the 2008 OCP Review, contributing to a comprehensive report on groundwater with Rick Gilleland. A member of the Water Council Society, Dr. Greenwood is actively promoting the need for a comprehensive hydrogeology study of Salt Spring Island.

Pat Lapcevic

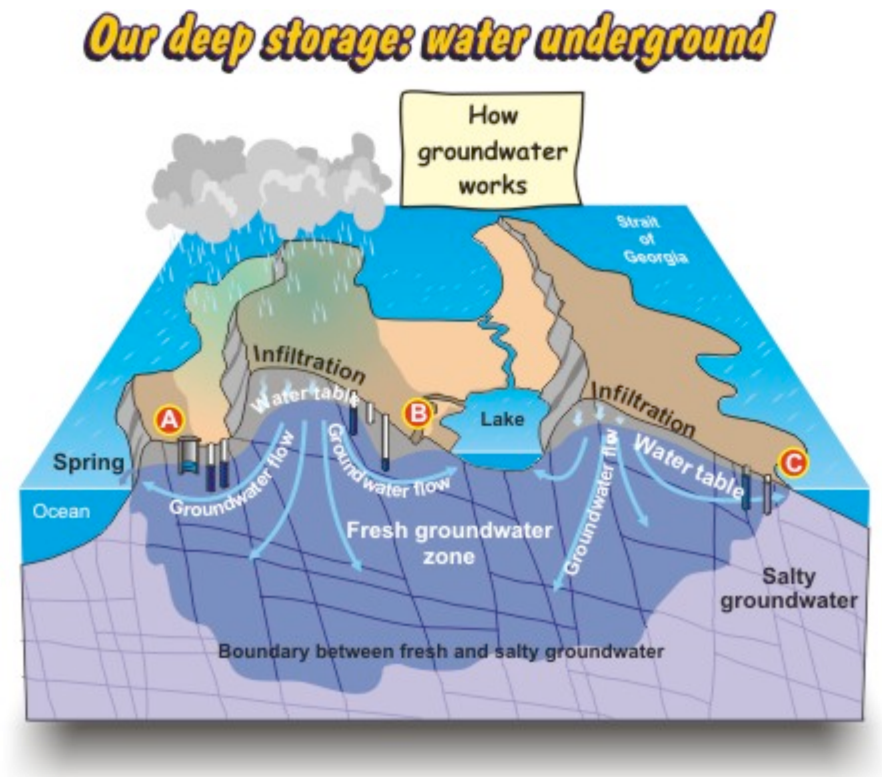
Pat Lapcevic is a professional hydrogeologist with over 25 years work experience. Currently, she holds the position of Section Head, Water Protection, in the Ministry of Forests, Lands and Natural Resource Operations, based in Nanaimo. Ms. Lapcevic leads a small team that maintains a network of dedicated observation wells, ensures compliance with provincial regulations, responds to complaints and inquiries from the public and carries out studies to better understand and protect groundwater resources in this region. Ms. Lapcevic has been a frequent participant at SSI Water Council meetings.

ATTACHMENT B

Salt Spring Island
WATER COUNCIL

SSI WATER COUNCIL GROUNDWATER WORKSHOP

February 28, 2012



Waterscape Gulf Islands: Natural Resources Canada/Earth Sciences

BACKGROUND BRIEFING PAPERS

FUNDING FOR THIS WORKSHOP PROVIDED BY THE ISLANDS TRUST, SSI LOCAL TRUST COMMITTEE

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A. GOALS FOR GROUNDWATER SUSTAINABILITY

1. **Protection of groundwater supplies from depletion:**
   Sustainability requires that withdrawals can be maintained indefinitely without creating significant long-term declines in regional water levels.
2. **Protection of groundwater quality from contamination:**
   Sustainability requires that groundwater quality is not compromised by significant degradation of its chemical or biological character.
3. **Protection of ecosystem viability:**
   Sustainability requires that withdrawals do not significantly impinge on the contribution of groundwater to surface water supplies and the support of ecosystems. Human users will inevitably have some impact on pristine ecosystems.
4. **Achievement of economic and social well-being:**
   Sustainability requires that allocation of groundwater maximises its potential contribution to social well-being (interpreted to reflect both economic and non-economic values).
5. **Application of good governance:**
   Sustainability requires that decisions as to groundwater use are made transparently through informed public participation and with full account taken of ecosystem needs, intergenerational equity, and the precautionary principle.

Source:
Report in Focus: The Sustainable Management of Groundwater in Canada; Council of Canadian Academies; 2009. http://www.scienceadvice.ca/en/assessments/completed/groundwater.asp

B. SALT SPRING ISLAND GROUNDWATER

1. Groundwater on Salt Spring Island is contained mainly in fractures both in the sedimentary rocks of the Nanaimo Group and the metamorphic igneous rocks of the Sicker Group at the south end. The effective porosity or capacity to contain water is very low, approximately 0.01% percent of the rock volume, but a reliable quantitative estimate is impossible without an extensive field study of the hydrology by means of well pumping and monitoring.
2. All the fresh water on the island arrives in the form of precipitation, most of which either runs off into the sea or evaporates. The water that eventually enters the groundwater system represents, out of the annual precipitation of about 900 millimetres, somewhere between 150 millimetres and 25 millimetres. It appears that this is enough to annually recharge the groundwater system in some places but not in others. Once the fractures are filled any further precipitation leaves as runoff.
3. Groundwater systems that are dominantly based on fractures are more vulnerable to contamination than those that are based on homogenous porous media such as sand.
4. Groundwater is a community resource and must be shared and conserved. Individual property owners and users must realize that although they have the right use the groundwater under their property they do not have the right to exploit it at the expense of neighbouring users of the same aquifer. (*Water Act- RSBC 1996, Chapter 483 Part 5- Wells and Ground Water protection, Well Operation page 41.)* They have instead an obligation to use it wisely, conservatively, and to refrain from depleting it at the expense of others.
5. The amount of rainfall that can annually reach the water table is not great and consequently the area from which each well draws must be large enough to capture the required amount of water. This implies that a minimum average lot size should be established where the water is derived from wells.
6. Global climate change presents a challenge to water-planners in that precipitation and drought events must be considered. The annual precipitation may well increase but it will occur mainly during the winter, and as the aquifer appears to be already recharged by existing rainfall, any excess will only add to runoff. Further, extreme weather events such as droughts are likely to become twice as frequent with the result that drought events that are now considered to occur only once every 50 years could recur as often as every 25 years. Any planning for future water management must adopt a stance that will deal with this ‘worst scenario’ which is ever more likely to occur.
7. Some of our groundwater areas are already stressed beyond their capability to supply current demand.
8. The foregoing indicates we must adopt management strategies that will protect our groundwater resource and that we can no longer allow access to it without applying constraints to development, subdivision, well-drilling, and rates of water withdrawal. Some of these constraints may be applied by the Islands Trust but others will need outside cooperation and cooperation by all our users.

Source: Appendix 4. *Potable Water Focus Group Report to the Salt Spring Island Local Trust Committee*; March 13, 2007. Hugh J. Greenwood, P.Eng (ret.) and Rick J. Gilleland, P.Eng.

C. BACKGROUND INFORMATION FOR PRESENTATIONS

1. PROPOSED LEGISLATION/REGULATIONS

Living Water Smart: B.C.'s Water Plan commits to change the way water is governed and managed in B.C. Through *Living Water Smart,* the provincial government has committed that by 2012:

- Water laws will improve the protection of ecological values, provide for more community involvement, and provide incentives to be water efficient;
- Legislation will recognize water flow requirements for ecosystems and species;
- New approaches to water management will address the impacts from a changing water cycle, increased drought risk and other impacts on water caused by climate change; and,
- Government will regulate groundwater use in priority areas and large groundwater withdrawals.

Modernization of the *Water Act* is seen by the provincial government, and others, as an essential part of delivering the *Living Water Smart* vision. It is about making our water laws simpler to understand, communicate, administer and enforce as we respond to current and future challenges.

The four goals of *Water Act* Modernization are to:

- Protect stream health and aquatic environments
- Improve water governance arrangements
- Introduce more flexibility and efficiency in the water allocation system
- Regulate ground water use in priority areas and for large withdrawals

Source:
http://www.livingwatersmart.ca/water-act/ ; 2011

2. WELL PROTECTION AND GROUNDWATER CHEMISTRY

The province's Ground Water Protection Regulation establishes standards to protect ground water supplies by requiring all water wells in British Columbia to be properly constructed, maintained, and, at the end of their service, properly deactivated and ultimately closed.

This means that new drilled and dug water supply wells must have a:

- ♦ Surface Seal
- ♦ Secure Well Cap
- ♦ Well Casing Stick-up
- ♦ Wellhead Graded
- ♦ Well Identification (ID) Plate
- ♦ Controlled or Stopped Artesian Flow

A private well owner must:

- Deactivate or close a well no longer in use.
- Cap the well.
- Maintain the well identification plate.
- Protect the well.

Source:

B.C. Water Stewardship Information Series: B.C.'s Ground Water Protection Regulation: *What Private Well Owners Should Know.*
http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/gw_regulation/GWPR_private_well_owners.pdf

Groundwater Chemistry Study

Like most of the Gulf Islands and parts of Vancouver Island, groundwater from the Upper Cretaceous Nanaimo Group of sandstone, conglomerate and shale formations is a primary source of potable water for thousands of residents on Salt Spring Island. While the ambient quality of the groundwater from Nanaimo Group sediments is generally acceptable when compared to the Guidelines for Canadian Drinking Water Quality (GCDWQ), several studies have detected higher than acceptable levels of arsenic, fluoride, boron, iron and manganese.

In this study, the geochemistry of the groundwater in fractured rock aquifers was examined by obtaining samples from 146 private wells on the island. Preliminary results indicate that 9% of the samples showed dissolved arsenic concentrations greater than the GCDWQ standard of 10 micrograms/L and in 25% of all samples arsenic concentrations over 1 microgram/L were detected. The occurrence of arsenic in the groundwater appears to be geologically controlled and can vary seasonally due to changes in contributing fractures. Bacterial analyses indicated greater than 10 total coliform CFU/100 mL in about 29% of all samples. Greater than 1 fecal coliform (CFU/100 mL) and Escherichia coli (E .coli), were noted in 10% and 9% of samples respectively.

These results suggest that in addition to natural geologic and climatic conditions, well siting, construction practices, and proximity of wells to potential contamination sources may also be impacting the potability of the groundwater resource.

Source:

Presented at GéoEdmonton 2008: Lapcevic, Kingerlee, Bickerton and Carmichael.

3. CLIMATE CHANGE IMPACTS ON GROUNDWATER SYSTEMS

This research aims to address the following knowledge gaps:

1. The vulnerability of water (specifically groundwater) resources to climate change, specifically, by undertaking a quantitative assessment of the direct impact of seasonal variations in recharge and river stage on groundwater levels under different climate change scenarios.
2. The impacts of climate change on socio-economic aspects of water resource management, specifically related to irrigation practices, potential user conflict and resource sustainability.
3. Developing methods for enhancing adaptive capacity of water resource planning and management to the impacts of climate change, specifically, by implementing predictive methodologies (modelling) to identify potential impacts on groundwater resources.
4. Increasing public awareness of groundwater resources, and vulnerability and sustainability of groundwater resources under both current and climate change scenarios.

Lower flows and extended low flow periods during the late summer and early autumn are of particular concern as they threaten not only water supplies, but also the health of wetlands and aquatic habitats. Combined with an increasing water demand due to a rapidly growing population, this is a cause of concern, particularly for the southern part of BC. With extended low flow periods, streams may be more strongly influenced by interaction with groundwater. In a Climate Change Action Fund (CCAF) project, Moore et al. (2007) undertook an analysis of provincial observation well records considered un-affected by anthropogenic factors, and determined that overall, summer groundwater levels appear to have lowered across the province. However, due to the limited availability of long observation well records near gauged streams, the attribution of whether and how these changes have affected summer low flows proved difficult.

Source:

Climate Change Impacts on Groundwater Systems, Dr. Diana Allen; SFU
www.sfu.ca/personal/dallen/Climate.html

4. VANCOUVER ISLAND WATER RESOURCE VULNERABILITY MAPPING PROJECT

Increasing development on Vancouver Island, together with existing industrial and commercial land use practices may have impacts on the quality of ground and surface water supplies. The Vancouver Island Water Resource Vulnerability Mapping Project is an inter-disciplinary initiative aimed at developing a geographically-based information system to characterize intrinsic water resource vulnerability.

Combining existing data on the properties of the surficial and bedrock aquifers of Vancouver Island with parameters such as the depth to the water table, topography and recharge rates, this methodology delineates regions of Vancouver Island into classes of susceptibility ranging from low to high. The resulting vulnerability maps and databases provide a screening tool for local government decision makers to help guide land use decisions.

In addition to the Intrinsic vulnerability aquifer mapping, classifying aquifers, mapping new ones and the need to develop a more comprehensive database on groundwater levels are also being worked on.

Source:
http://web.viu.ca/groundwater; Dr. Alan Gilchrist; VIU

5. GROUNDWATER HEALTH CONSIDERATIONS

All water suppliers in British Columbia are required to monitor water that reaches consumers for total coliform bacteria and Escherichia coli (E.coli) regularly. The monitoring is one part of a comprehensive approach to safe drinking water.

- The presence of E. coli in a water sample indicates that bacteria capable of causing illness may be present in the water system.
- The presence of total coliform bacteria may indicate a breakdown in the treatment process, or growth in the distribution system.

The following results are considered acceptable for drinking water:
E. Coli

- No E. Coli detectable per 100 ml of each water sample.

Coliform

- If only one sample is taken in a 30-day period:
- No detectable Coliform per 100 ml of water
- If more than one sample is taken in a 30-day period:
- At least 90% of samples will have no detectable Coliform per 100 ml of water, and
- No sample has more than 10 total Coliform per 100ml of water

Source:
http://www.healthspace.com/Clients/VIHA/VIHA_Website.nsf
http://www.health.gov.bc.ca/protect/dw_index.html

6. SALT SPRING WELL MONITORING PROJECT TO ESTABLISH GROUNDWATER-WATER TABLE DATA

Since about 45 percent of the people on Salt Spring rely on groundwater, the Water Council has begun a project to determine more about the condition of groundwater. It aims to help start a network of both individuals and water districts to provide status and performance data on the water table on the island.

The project's overall objectives are to:

- Improve groundwater information for all of Salt Spring Island
- Establish a database representative of the whole island
- Identify trends in usage/supply (Changes from baselines)
- Help support, confirm, improve related geological information
- Identify areas of concern regarding water quantity and poor water chemistry where possible
- Improve the capability to assess well interference
- Better support land use decisions

This can be achieved by first establishing a status baseline including quantity, quality, performance and issues/concerns. We can then gather data on use, storage, geology and threats.

Source:
Rick Gilleland: 2011

7. SALTSPRING GROUNDWATER: THE NEED FOR A SSI HYDROGEOLOGY STUDY

There is evidence that the supply of groundwater on Salt Spring is not unlimited. Some of the signs are purely anecdotal but it is possible to make a preliminary quantitative analysis. There are about 3000 water wells on the island and a preliminary analysis of 160 of them from the BC Government WELLS database coupled with island geology yields the following results.

Of 160 wells, 37 per cent produce less than 1.0 gpm, 20 per cent produce less than 0.5 gpm and 6 per cent produce nothing. The 26 per cent of poor producers are dominantly in the De Courcey sandstone. There are at least 36 households that have to make bulk water purchases to make up for wells that are either totally dry or that are dry in the summer. There also are a number of households that rely entirely on capture of rainwater.

It may be necessary in the future to consider regulating the use of groundwater, and for that reason alone it will be necessary to have a much fuller understanding of our groundwater. We need to answer questions such as: What rock units produce little water or sub-standard water? Is fracking a suitable solution? Are there areas with abundant groundwater? What is the best way to 'prove' the adequacy of a new well?

A preliminary analysis does not meet these needs. A thorough study is required.

Source:
Dr. Hugh Greenwood: October, 2011

D. FURTHER REFERENCES

1. SALT SPRING ISLAND OFFICIAL COMMUNITY PLAN BYLAW #434— GROUNDWATER POLICIES

C.3.3 Private Surface Water and Groundwater Supplies

C.3. 3.1 OBJECTIVES

C.3. 3.1.1 To avoid zoning changes that result in the depletion of existing wells or springs or water bodies used as water supplies.

C.3. 3.1.2 To preserve known groundwater recharge areas.

C.3. 3.2 POLICIES

C.3. 3.2.1 To protect groundwater recharge areas, zones in the upland areas of the island will continue to allow only a low density of development. The Local Trust Committee may consider undertaking or supporting further analysis of groundwater recharge areas on the island , including the creation of a groundwater conservation strategy. The transfer of development potential to other parts of the island will be encouraged.

C.3. 3.2.2 When considering rezoning applications, the Local Trust Committee should consider the impacts of the proposed new use on existing wells, springs, or other water supplies. If the proposed use is expected to need more water than the uses already allowed on the property, then the Committee should ask for evidence that wells or other water supplies in the neighbourhood would not be depleted. The Committee should also consider whether water use would affect agricultural activities or deplete any springs necessary to maintain fish habitat. Should a zoning change be proposed where groundwater supplies are not adequate, the applicant could be encouraged to find other means of supplying water. Rainwater catchment or a water conservation program could be considered.

C.3. 3.2.3 The Local Trust Committee should continue to require proof of adequate potable water supply for each new lot created by subdivision.

C.3. 3.2.4 The Local Trust Committee could establish an advisory group to provide advice regarding local groundwater topics

C.3.3.2.5 The Local Trust Committee should not support rezoning applications that depend on the import of water from off the island.

C.3.3.2.6 The Local Trust Committee should consider working with other agencies and stakeholders to development a groundwater conservation strategy for Salt Spring Island. The strategy would combine educational efforts with the creation of demand management measures.

Others are encouraged to help achieve the objectives of this Section as follows:

C.3. 3.2.7 The Ministry of Environment–Water Management Division is strongly urged to develop a groundwater licensing program for individual wells that would protect existing wells from depletion.

C.3. 3.2.8 All users that rely on groundwater are encouraged to conserve water.

http://www.islandstrust.bc.ca/ltc/ss/pdf/ssbylbaseocp434vol1.pdf Adopted October 2, 2008

2. SALT SPRING ISLAND LAND USE BYLAW #355

5.5 POTABLE WATER (Extract)

5.5.1 Each *lot* in a proposed *subdivision* must be supplied with *potable* water in accordance with the *service* levels specified in Part 9 of this Bylaw.

5.5.2 Each *lot* in a proposed *subdivision* must be supplied with sufficient water to supply all *uses*, *building*s and *structures* permitted on the *lot* by this Bylaw according to the standards set out in Table 1. Where more than one *use* is permitted on a *lot*, the amount of water to be supplied is the sum of the amounts required for each permitted *use*, calculated separately.

5.5.5 Where water is to be supplied by groundwater, the applicant for subdivision must provide written certification under seal of an engineer with experience in groundwater hydrology that there is sufficient available groundwater to provide the required amount of potable water on a continuous basis, and that the extraction from the groundwater table of that amount of water is not reasonably expected to adversely affect the quantity or quality of water obtainable from any existing well or surface water that is used as a source of potable water.

TABLE 1
POTABLE WATER SUPPLY STANDARDS FOR SUBDIVISION

USE	VOLUME (litres per day per lot)
Dwelling unit	1600
Seasonal cottage	680
Bed and breakfast home-based business	225/bedroom
Commercial or *Industrial use*	900
Community hall or *church*	1590
School	50/classroom
Commercial guest accommodation units	450/unit
Campground	225/*campsite*

5.5.8 Where the water supply is provided through a groundwater well or through a private surface water license, an engineer must also provide a water quality analysis that demonstrates that the surf ace water or the groundwater from each proposed water supply source or well is potable or can be made potable with a treatment system that is customarily used in a single-family dwelling. The certificate must include a plan of the proposed subdivision indicating each well location

Where a water sample was taken, and a statement that the water samples upon which the water quality analysis was performed were unadulterated samples taken from the locations indicated on the plan. If the water to be supplied is not potable, but can be made potable with a treatment system that is customarily used in a single-family dwelling, then the Approving Officer may nonetheless approve the subdivision if the applicant grants a covenant under the Land Title Act to the Salt Spring Island Local Trust Committee that requires on-going treatment of the water to ensure that it is potable before it is used as drinking water.

Source:
http://www.islandstrust.bc.ca/ltc/ss/pdf/ssbylbaselu0355.pdf Adopted June 28, 2001

TABLE 2: Land Use Bylaw 355: SCHEDULE "H"
POTABLE WATER QUALITY STANDARDS

WATER QUALITY PARAMETER	STANDARD (LESS THAN THE FOLLOWING UNLESS OTHERWISE INDICATED)
ARSENIC	0.025 mg/L
CHLORIDE	250 mg/L
FECAL COLIFORM	1/100 mL
FLUORIDE	1.5 mg/L
HARDNESS (AS $CaCO_3$)	80-100 mg/L
IRON	0.3 mg/L
MANGANESE	0.05 mg/L
NITRATE	45 mg/L
pH	6.5-8.5
RESIDUAL CHLORINE	0 mg/L
SODIUM	200 mg/L
SULPHATE	500 mg/L
TOTAL COLIFORM	0/100 mL
TOTAL DISSOLVED SOLIDS	500 mg/ L
TURBIDITY	1 NTU
OTHER PARAMETERS AS RECOMMENDED FOR A PARTICULAR SITE BY A PROFESSIONAL ENGINEER	STANDARD SET BY THE GUIDELINES FOR CANADIAN DRINKING WATER QUALITY

TABLE 3: SALT SPRING ISLAND GROUNDWATER-BASED COMMUNITY WATER SYSTEMS

Community Water System	**Number of Connections**	
	Existing	***Potential***
Cedar Lane Waterworks District (CRD/)	44	46
Cedars of Tuam Water District (CRD)	16	16
Erskine Water Society	31	40
Harbour View Improvement District	21	22
High Hill Water System	7	9
Maracaibo Estates	73	91
Mount Belcher Improvement District	45	55
Reginald Hill Water System	20	24
Scott Point Waterworks District	60	62
Swan Point Waterworks	4	5
Total number	321	370