Gabriola Streamkeepers—Water Quality testing

Preliminary report of water quality of Dick Brook, Gabriola Island, January 7, 2015.

Background

Dick Brook has the most interesting profile of all the creeks on Gabriola Island.[1] Its source, originally described as a "spring", is the gravel pit (Somerset Pit) owned by Nelder Boulton and operated by Mark and Jeff Pound. The lower pit has been exhausted and is now landscaped as a lake. The upper pit is still being worked. The lower stratum in this pit is a glaciomarine deposit of shell-rich blue-grey silt containing very little clay. Above this is a thick layer of stone-free glaciofluvial sand that radiocarbon dating has established was deposited by meltwater from ice caps on the surrounding higher ground during a warming period not long after the Strait of Georgia (Salish Sea) became ice free at the end of the last ice age.[2] On leaving the pit, the brook enters pastoral farmland used for haying, raising cattle, etc., originally described as "a great swamp" and known as "Dick's swamp". The fields there flood in winter and are a refuge for wild geese and ducks. On leaving the swamp, the brook passes through the usual mixed-conifer (mostly Douglas fir) and deciduous woodland down to Peterson Bay at the end of Dragons Lane. The water source since development of the pits has become a mix of surface runoff from the surrounding forested high ground and groundwater seepage ("spring water").

Observations

Measured where pH, temperature, dissolved oxygen content (DO), and turbidity at three locations.

The locations were:

Location 1: Somerset Pit on the upstream side of the culvert at the top end of the lower pit lake. The water was flowing freely and looked clear. 49º08.644′N 123º44.427′W. This location is private land and should not be accessed when the pit is being worked and without permission.

Location 2: Peterson Road on the upstream side of the culvert. This culvert joins the outflow of the "great swamp" with a much smaller Atkinson Swamp wetland from which it becomes a "normal" creek. The water here is dark brown. In winter there is a steady but not vigorous flow, but in summer the flow from the great swamp becomes very sluggish and may cease altogether. 49º09.160′N 123º43.705′W. The banks here are steep and, in winter, muddy. A small bucket on a rope is a useful sampling tool.

Location 3: North Road on the upstream side of the culvert underneath the road. In the wet season, the flow here is very strong and turbulent. The water is yellowish brown, distinctly lighter than at Location 2, but not as clear as at Location 1. The flow to and from here is through mainly forest. 49º09.278′N 123º42.681′W. Access from North Road is easy.

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[1] See Maps 3.1 and 3.2 in Doe, N.A., *Locations and names of wetlands and waterways on Gabriola,* < www.nickdoe.ca/pdfs/Webp661.pdf >

[2] For a full geological description see Site 12 in Doe, N.A., *Gabriola's glacial drift—13. Ice-age fossil sites on Gabriola, SILT* 8-13, 2014. < www.nickdoe.ca/pdfs/Webp533.pdf >

Weather (January 7, 2015) was overcast and calm. Air temperature 8 ºC. In the week or two previously it had been somewhat cooler interspersed with lots of rain. Atmospheric pressure has been higher than it usually is in winter.

Results

	pH	temp ºC	DO mg/L	turbidity JTU	colour
Location 1	6.5	7.5	3	10	fairly clear
Location 2	6.5	6.0	4 and 5	20	dark brown
Location 3	6.5	8.0	7	12	yellowish brown

Discussion and field notes—pH

In any other water course, the pH readings would be unremarkable. Just mildly acidic consistent with passage through, and over organic-rich soil. However, in the past, I have measured extraordinarily high pH values around Location 1, and a significant part of the current exercise was to see how effectively the swamp acidified this alkaline source water. My notes on this phenomenon are as follows.

In July 2008, I measured the following using a Hanna pH meter. The meter was originally calibrated using a pH7 solution, but because of the very high readings at the Somerset Pit, I re-calibrated the meter using a pH10 solution and returned to the pit the next day. The second-day readings were completely consistent with those made on the first day.

Commons: 7.1 (lake)
7.4 (water filled pit at south end)
5.9 (augured hole into clay at south end)

Good Earth: 7.6 (irrigation channel)

Somerset Pit: 9.6 (lower pit lake)
8.0 (feeder stream between lower and upper—Location 1)
7.4 and 7.7 (water filled hollows at the surface in the upper pit)
9.5 (15-foot hole dug into the glaciomarine layer by Jeff Pound).

The extraordinarily high pH of water in the Somerset Pit has always led me to believe that this area is the source of very alkaline water, but the Location 1 measurement reported here shows this not always to be the case. Possible reasons are (a) in winter the feeder stream is predominately fresh surface runoff; (b) operations at the upper pit have changed the properties of the water—it is currently being dug for glaciofluvial sand rather than glaciomarine silt; and (c) the pH is locally very variable.

High pH groundwater is usually associated with high sodium/low calcium water, the sodium having displaced calcium exchangeable cations leaving higher concentrations of HCO_3^- and CO_3^{2-} ions in solution due to the much higher solubility of the sodium salts. Another contributor may be groundwater reaching the surface with a heavy concentration of CO_2. Venting this to the atmosphere reduces the concentration of carbonate ions in the water potentially leaving behind OH^- ions that effectively mop up any H^+ ions around. Sodium is to be expected in a glaciomarine layer; it being a remnant of the seawater that it was immersed in during the ice age. Heavy concentrations of CO_2 might be a consequence of breakdown of shells in an environment not open to the atmosphere.

Whatever the explanation, further research, from a hydrogeological point-of-view, would be, I think, very interesting, although admittedly probably less so from the Gabriola Streamkeepers' perspective.

Discussion and field notes—temperature

There is a hint in the results that the swamp acts as a thermal reservoir but that the creek quickly assumes the current air temperature as it progresses through the forest. This would need to be checked though—temperature may be a function of where in the creek the sample is taken.

Discussion and field notes—DO

DO levels were low. Starting from a low base, typical of groundwater, it is not much improved by passage through the swamp in spite of its shallowness, presumably because of the high demand for microbial decomposition in the swamp. Salinity also depresses DO content, but I really don't know if this is a factor in this case. At a guess, DO is normal by the time the brook reaches the sea and has run over several dams and through riffles downstream of Location 3.

It would be interesting to compare DO levels upstream and downstream of a culvert. I took measurements upstream to get the worst case scenario.

I found a serious flaw in my measurements of DO. Because readings were low, I also measured the DO using the technique of reducing the BOD bottle content to 30 mL and adding drops at 0.2 mg/L DO per drop. All readings taken using this method were significantly higher than the standard readings—Location 1 became 5.5 mg/L instead of 3 mg/L; Location 2 became 9.4 mg/L instead of 5 mg/L (first attempt) and then about ≈10 mg/L instead of 4 mg/L (second attempt). I don't trust this low-DO method until this is sorted out. Possibly I was not ensuring that the BOD solution was thoroughly mixed before discarding most of it.

Discussion and field notes—turbidity

The turbidity measurements reflect what can readily be seen with the eye. The water from the swamp is murky—the bottom of the creek cannot be seen, but it clears on its way to the sea. The suspended particles are fine, even at Location 2 (mud?), and even finer at Location 3 where turbidity is as much as anything a coloration (tannins?).

Other remarks

The Water Quality kit #1, which I used, had not been dried out before being sealed and stored. There was mold visible on one container and the instruction sheet in it was still damp.

Conclusions

A good start, but as with all good science projects, as many questions posed as answered. ◊