Hydrogeology of Coats Marsh, Gabriola Island

Coats Marsh on Gabriola Island is within the boundaries of a park administered by the Regional District of Nanaimo (RDN); their management plan for the park was published on August 29, 2011.

The park is about 100 acres in area, and has a longish history of being used for logging and farming, but its dominant feature is the marsh itself at the south end of the park. This is a shallow palustrine basin that retains open-water year round, fringed with riparian vegetation and forest that is rapidly re-gaining its natural state. Beavers are active in the marsh.

The marsh is about 100 metres above sea level and its bedrock is Gabriola Formation (Nanaimo Group) sandstone. The bedrock slopes only slightly westward and, if it were visible, would probably exhibit the gently undulating character of the numerous tree-less sandstone plains, sometimes with petroglyphs, that exist in the highlands of Gabriola. These plains were scoured by a combination of ice movement and subglacial meltwater flowing under high hydraulic pressure. Auger holes at the east end of the marsh outside the park boundary showed the bedrock to be buried under only nine inches of Saturna soil. This contained stones that were mainly channery fragments of sandstone, which is the result of modern (Holocene) surficial weathering of the bedrock.

Judging solely by what can be seen on these soil-less plains elsewhere, the bedrock beneath Coats Marsh is fractured, but the long linear fractures common on such plains would be widely spaced and easily clogged with sediment making leakage of water into the ground rather slow, but not slow enough to prevent complete drainage in a season without the additional impervious cover provided by lake-bottom sediments.

As recorded in an earlier report on ice-age sites on Gabriola,[1] this sediment is primarily gleysol, which in places is almost a metre thick, and is silt (rock flour) originally deposited by glacial meltwater and that has since had its plagioclase feldspar content (*albite—andesine* range) weathered to smectite clay (*montmorillonite*).

Water outflow from the marsh, and hence the level of the lake, is controlled by a dam. According to the RDN Management Plan, two “springs” at the east end of the wetland were identified by planning consultants Bufo Inc. in 2010 and are shown on plan maps (Figure 2.1 and 3.2). However, as noted in Appendix A page 6 of the final RDN RP Management Plan, further information about these springs was not found by the Foul Bay Ecological Research consultants, nor could they locate these springs.

My own research in early May 2015 also failed to locate any flowing water at these sites, and an auger test in the southeast section, some thirty metres inland from the present-day lake edge, suggested that these watercourses are in fact incised drainage channels maintained on or near the surface by a more-than-a metre thick layer of clay that was formed from glacial silt when the lake level was significantly higher than it is now. That the bedrock is fractured sandstone with no near-by shale contact, and that there is no significant high ground near-by, also suggests that a deep and distant groundwater source for flows into the lake is unlikely.

[1] Doe, N.A., *Gabriola’s glacial drift*—13. *Ice-age fossil sites on Gabriola*, *SILT* 8-13, p.10, 2014. Coats Marsh is Site 5 in this report.

Watercourse at the southeast end of the marsh, about 20 metres from open water (early May 2015). There was no discernible flow in this and other similar channels, indicating that despite their distance from open water, they were just flooded.

In the wet season, they probably are drainage channels for water collected in adjacent inland areas that were formerly below the lake high-water level.

There was no suggestion in this area that the water in these channels was sourced from groundwater springs.

Gleysol underlying the marsh retrieved from the southeast end of the marsh beyond the park boundary about 30 metres from open water.

The gleysol is predominately anaerobic (grey-blue) at depth, and dry, despite being below the surface water level.

Similar material retrieved from McGuffies Swamp on Gabriola has been radiocarbon dated to 11530 BC at the very end of the Pleistocene (ice age).

An old rectangular concrete storage cistern near the water's edge, possibly used back in the 1930s when the marsh was dry in summer. It may be the origin of the use of the word "spring", which in the old days commonly meant any damp depression in the landscape. There is an old barbed wire fence (for cattle?) along here too. There was no water flowing from this cistern when observed in May 2015—it was just flooded.

49º09.115'N, 123º48.570'W. Located with help of John Peirce.

Although Gabriola receives on average about 900 mm of precipitation a year, evaporation from the surfaces of open water is very high;[2] one estimate puts this loss at 730 mm (81%).[3] With a net recharge of only 170 mm a year, the marsh would, in theory, have a hard time in dry years maintaining its water, especially if you allow for losses due to runoff through the weir.

It does nevertheless retain water year-round, even though the depth of the lake drops from around an observed winter maximum of 1640 mm to a conjectured summer maximum of less than 1200 mm, which is the point at which weir discharge ceases. This only modest drop is partially the result of the marsh being so uniformly shallow—the seasonal loss in volume results in a significant reduction in open-water around the fringes of the marsh rather than a dramatic decrease in the summer lake-wide average depth. This seasonal loss of open water also mitigates the loss in the basin due to evaporation. The remainder of the drop can reasonably be accounted for by supposing that the catchment area—defined by the former lake level with its assumed completely impermeable clay layer—is about 21% bigger than the winter open-water area, and that the evapotranspiration loss in this additional area is the same as that in the littoral zone at around 450 mm (50%). The net annual recharge over the winter open-water area would then be around a half metre, which is easily enough to account for the observed weir discharge in winter, and does not require the supposition that there is groundwater flowing into the marsh.

Coats Marsh is thus an interesting example of a "perched aquifer" that happens to be at the surface. Additional notes are in File 673. ◊

[2] Doe, N.A., *Groundwater budgets*, *SHALE* 14, pp.18–32, September 2006.

[3] In Aug. 2015, about 60% covered with water-lily pads, which must reduce evaporation when levels are very low.