BC Aquifer Stress Tool

Method not applicable

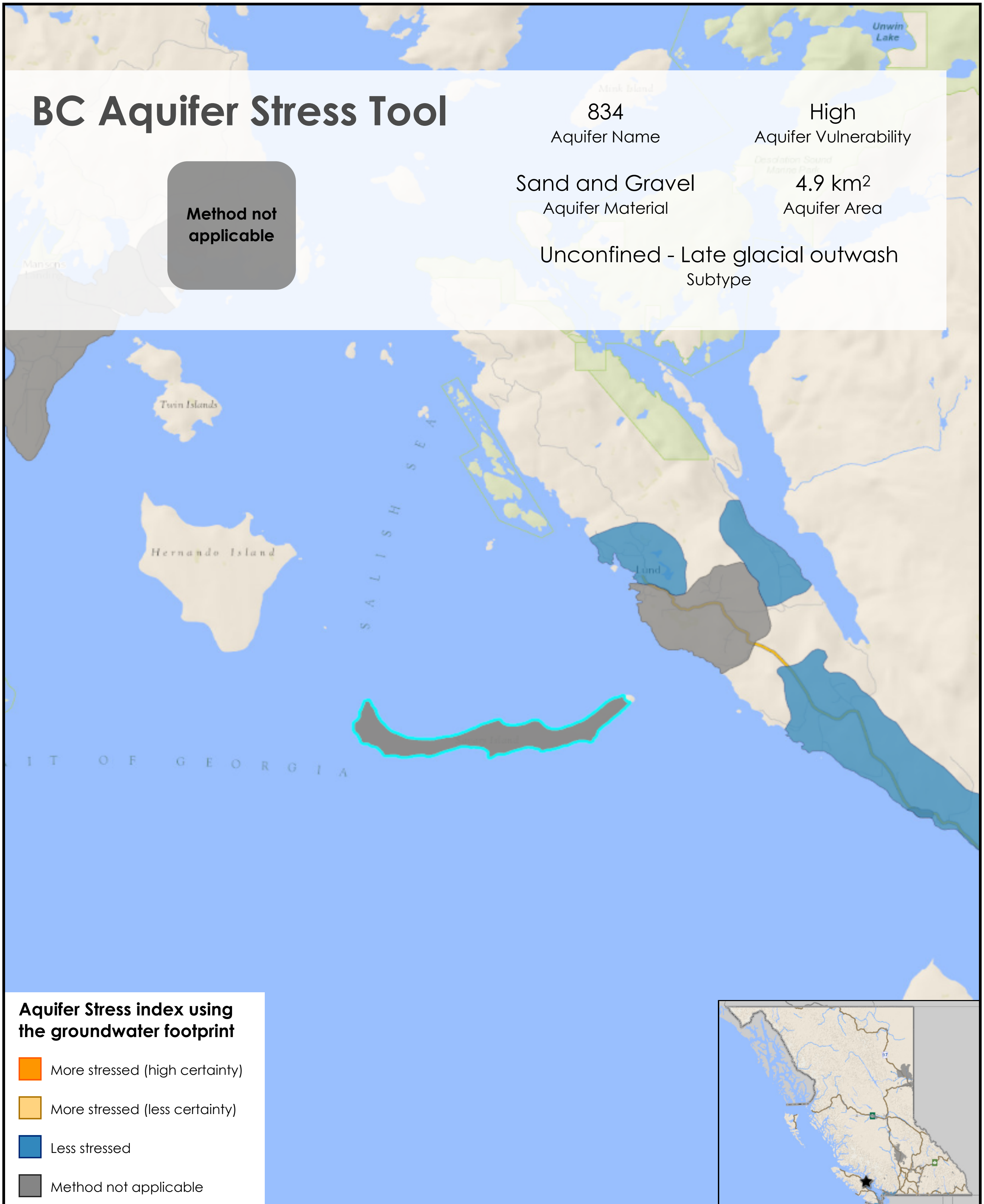
834
Aquifer Name

High
Aquifer Vulnerability

Sand and Gravel
Aquifer Material

4.9 km^2
Aquifer Area

Unconfined - Late glacial outwash
Subtype



Aquifer Stress index using the groundwater footprint

- More stressed (high certainty)
- More stressed (less certainty)
- Less stressed
- Method not applicable

British Columbia
University of Victoria

The Aquifer Stress Tool was developed by the Groundwater Science and Sustainability research group at University of Victoria, in collaboration with, and supported by the Ministry of Environment of British Columbia.

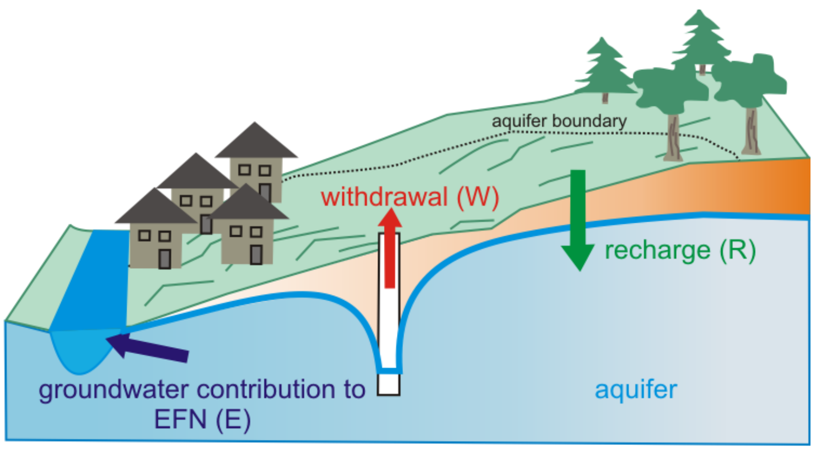
HOW TO USE THE TOOL

The BC Aquifer Stress Tool is a decision-support tool rather than decision-making tool. Screening-level values are provided to assist water managers in understanding relative levels of aquifer stress and identifying areas where detailed scientific assessments are needed.

The tool uses the groundwater footprint which is an indicator of groundwater stress with a single cutoff: GF/A > 1 suggests an aquifer is more stressed and GF/A < 1 suggests less stressed1. There is no scientific basis to interpret the calculated values more finely. Given the significant limitations (see side bar) and single cutoff, the calculated values of the groundwater footprint should not be over-interpreted. For example, aquifers with GF/A of 2 or 10 should both be considered 'more stressed' and provoke similar management decisions.

For each aquifer, the groundwater footprint is calculated four times using results from two methods to estimate recharge and two methods to estimate the groundwater contribution to environmental flows. None of the methods can be categorically considered more scientifically robust, so all four of the calculated groundwater footprints are reported and combined into four mapped categories that also highlight the uncertainty of the results:

- **More stressed (highly certain)** if ALL results suggest aquifer stress
- **More stressed (less certain)** if SOME results suggest aquifer stress
- **Less stressed** if NONE of the results suggest aquifer stress
- **Methods not applicable**



RESULTS

Aquifer stress category	Method not applicable
Groundwater footprint/ aquifer area with first combination of input data $(GF/A)_{1st\ calculation}$	NA
$(GF/A)_{2nd\ calculation}$	NA
$(GF/A)_{3rd\ calculation}$	NA
$(GF/A)_{4th\ calculation}$	NA
Withdrawal (m^3/yr)	200,000
Recharge (m^3/yr) - HELP	3,618,000
Recharge (m^3/yr) - PCR-GLOBWB	0
Groundwater contribution to environmental flow needs - groundwater presumptive standard (m^3/yr)	NA
Groundwater contribution to environmental flow needs - BC EFN policy (m^3/yr)	NA

METHODS & LIMITATIONS

The groundwater footprint[1] (GF) is calculated for unconfined aquifers from aquifer-scale, steady-state estimates of groundwater withdrawal (W), recharge (R) and the groundwater contribution to environmental flow needs (E) and aquifer area (A). Below is an overview of the methods and limitations and more information is available[2].

$$\text{Aquifer stress} = \frac{\text{GF}}{\text{A}} = \frac{\text{W}}{\text{R} - \text{E}}$$

Major limitations include:

- The analysis is aquifer scale, which can mask local-scale groundwater stress.
- The analysis is steady state (not varying with time), which cannot include long-term trends, seasonal variation or drought impacts.
- Subsurface flow between aquifers is not considered.
- The methods have not been applied to confined aquifers or aquifers where results suggest E > R (due to uncertainty to input parameters). Assessing aquifer stress in these aquifers requires additional studies.
- The input parameters, described below, are uncertain and not based on local-scale data.

Withdrawal (W) is estimated based on national, provincial, and municipal scale statistical data, generally following previous methods[3] and then distributed to individual aquifers. Withdrawal is considered a conservative over-estimate that will be replaced by licensed or reported groundwater volumes as this information becomes available.

Recharge (R) is estimated from 1) a simple water balance model, HELP[4], that has been previously used in BC[5] as well as 2) a global hydrologic model, PCR-GLOBWB[6]. HELP modeling used characteristic climatic conditions, hydrogeological properties and water table depths for each aquifer. These estimates are considered suitable for province wide aquifer scale recharge estimation but do not account for local variations in hydrology, geology or topography, neglects three-dimensional processes and time-varying properties. The global hydrologic model includes MODFLOW, has a 10 km grid resolution and is calibrated to global streamflow data and compared to BC streamflow data, but does not use local data.

Groundwater contribution to environmental flow needs (E) is estimated from PCR-GLOBWB results using two methods: 1) modeled baseflow and the groundwater presumptive standard[7] and 2) modeled streamflow and the BC EFN policy. The first method appropriately uses hydrogeologic processes such as groundwater discharge as baseflow, but not explicitly consistent with the BC EFN policy[8]. The second method is consistent with the BC EFN policy but does not consider hydrogeologic processes.

References

1. Gleeson, T. et al. Nature 488, 197-200 (2012).
2. Forstner, T. et al. Water Science Report (2018).
3. Hess, P. Ground-Water Use in Canada, 1981. (Environment Canada, 1986).
4. Schroeder, P. R. et al. U.S. Army Corps of Engineers, Vicksburg, MS. (1997).
5. Scibek, J. & Allen, D. M. Glob. Planet. Change 50 (2006).
6. de Graaf, I. E. M., et al. Hydrol Earth Syst Sci Discuss 11, 5217-5250 (2014).
7. Gleeson, T. & Richter, B. River Res. Appl. 34, 83-92 (2018).
8. BC FLNRO & ENV. Environmental Flow Needs Policy (2016).