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Nitrate Contamination in the Sumas-Blaine Aquifer, Whatcom County, Washington

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Problem Statement

The Sumas-Blaine Aquifer in northern Whatcom County has a long history of nitrate contamination. Groundwater studies conducted by federal, state, and university groups over the past four decades show that nitrate concentrations exceed the 10 mg/L drinking water standard across much of the aquifer (*2, 3, 4, 7, 8, 11, 12, 14*).

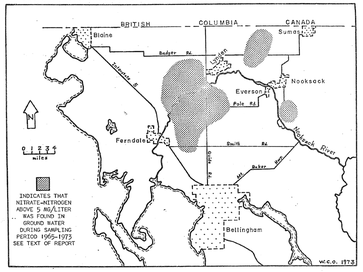
The Washington portion of the aquifer covers about 150 square miles of mostly rural farmland north of the City of Bellingham near the Washington/Canadian border. The aquifer extends north into British Columbia where it encompasses an additional 50 square miles of land area. The combined U.S.-Canada aquifer is often referred to as the Abbotsford-Sumas Aquifer.

The aquifer is the only readily available drinking water source for roughly 27,000 rural residents of Whatcom County.

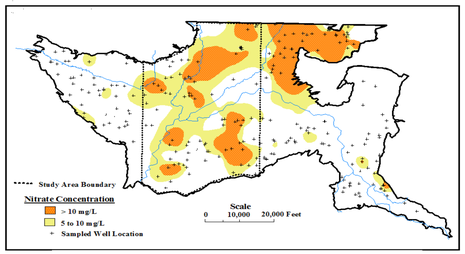
The three figures below show historic groundwater nitrate distribution and concentrations for 1973, 1997, and 2003-05.

1973

(from Obert, W., 1973. *Nitrate in Ground Water, Western Whatcom County, Washington*)



February-April 1997



(Erickson, 1998)

A 2003-2005 study of 35 local private domestic wells showed that nitrate-N concentrations exceeded (did not meet) the 10 mg/L drinking water standard during at least one sampling event in over 70% of sampled wells (*14*). A total of 26% of the wells consistently exceeded the drinking water standard. and 31% of the wells displayed an increasing nitrate trend. One well had nitrate concentrations as high as 43.1 mg/L. (See figure below.)

2003-2005

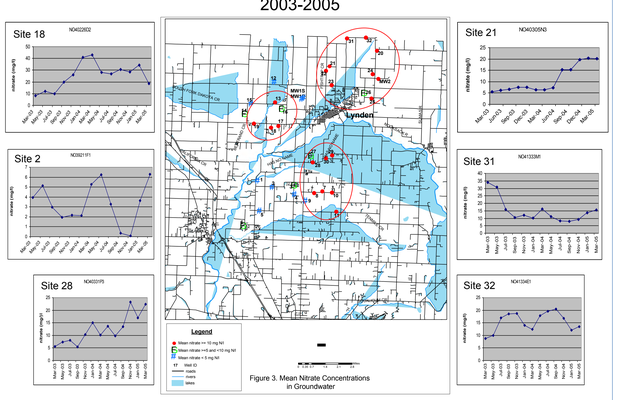


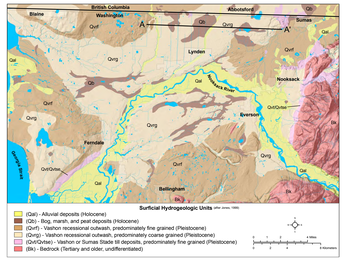
Figure 3. Mean Nitrate Concentrations in Groundwater

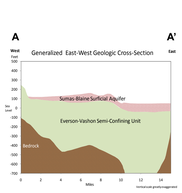
(Redding, 2008)

Physiographic Setting

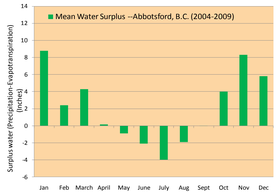
The Sumas-Blaine Aquifer consists of stratified outwash sand and gravel with minor clay lenses. The aquifer averages about 25 feet in thickness(*5*). The depth to groundwater is less than 10 feet in most areas, especially in the winter.

The underlying Everson–Vashon semi-confining unit is glacio-marine drift composed mostly of pebbly clay and sandy silt (*3*). This unit produces only marginal quantities of poor quality water that is typically unsuitable for drinking. Thus, where nitrate concentrations currently exceed the drinking water standard, drilling deeper to find an alternative water source is not always possible.





The above figures illustrate the geology and hydrostratigraphy of the underlying units. An east-west cross-section near the Canadian border shows the limited extent of the Sumas-Blaine Aquifer overlying the Everson-Vashon semi-confining unit.

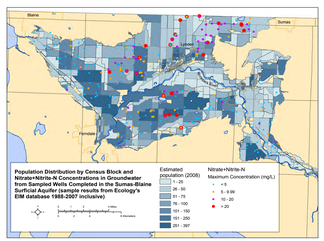


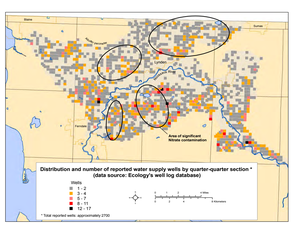
The area's shallow depth to groundwater and abundant winter precipitation makes local groundwater extremely vulnerable to contamination from overlying land uses.

The potential for groundwater contamination is highest during October to March when precipitation generally exceeds evapotranspiration (left). During this period surplus water is available to recharge groundwater or to run off to surface water.

Recent census estimates (see map at right) suggest that many people live in areas where they may be exposed to groundwater nitrate concentrations exceeding the 10 mg/L drinking water standard.

Indeed, over the past 10 years several public water supply wells in the Bertrand Creek and Northwood areas were decommissioned due to excessive nitrate. These closures affected over 1,200 area residents.



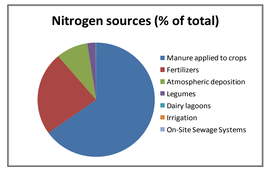


The well distribution map above, produced by plotting driller-reported locations, illustrates that many local residents rely on wells completed in areas of known nitrate contamination. Residents may not be aware of the potential health risks associated with drinking nitrate contaminated water.

There are currently no programs in place to systematically test private domestic wells for nitrate contamination.

Nitrogen Sources

Locally there are multiple potential sources of nitrogen contamination including dairy farms, irrigated agriculture, and on-site sewage systems. In some areas, nitrogen-rich groundwater also flows south into Whatcom County from British Columbia.



Source	Nitrogen Loading (lb/year)	Mean % of total
Manure applied to crops[1]	10-12,000,000	65
Fertilizers[2]	4,600,000	27
Atmospheric deposition[3]	380,000	2.3
Legumes[4]	428,000	2.5
Dairy lagoons[4]	206,800	1.2
Irrigation[2]	170,000	1.0
On-Site Sewage Systems[5]	207,000	1.2

[1] Washington State Department of Agriculture 2010 dairy summary (*13*).
Includes only farm addresses over the SBA.
Assumes 20-35% loss before applied to crops.
Lagoon leaching was subtracted from the total.

[2] (*1*)

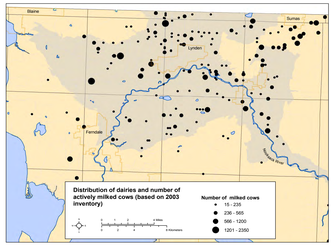
[3] Assumes 0.26 mg/L nitrogen in precipitation (*3*) over the 150 square miles of the SBA with 45.8 inches annual precipitation, plus 46% more for dry deposition (*1*).

[4] Assumes all dairies have a lagoon with leakage as estimated in *1*: (110 dairies with addresses over the SBA in 2010) x (1,880 lb N leached/dairy-year).

[5] US EPA (*16*) per capita nitrogen output from on-site systems (9 lb/person/year) assuming 23,000 residents outside sewered areas.

Dairies

- Whatcom County has the second highest number of cows in Washington State (after Yakima County with 46,000 adult cows *(13)*
- Approximately 11 to 14 million pounds of manure nitrogen are applied to local crops annually.
- Approximately 250 to 340 pounds of manure nitrogen are applied per acre per year *(13)*.



Non-Dairy Agriculture

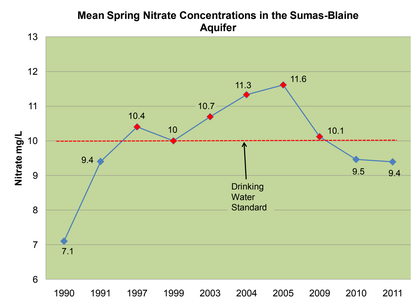
- Whatcom County is the nation's leading producer of raspberries *(15)*.
- Grass, corn, blueberries, strawberries, and seed potatoes are also grown locally.
- Non-dairy agriculture applies on average approximately 4.6 million pounds of nitrogen fertilizers annually.

On-Site Sewage Systems

- Approximately 23,000 area residents use on-site sewage systems to dispose of domestic waste water.
- These systems contribute an estimated load of 207,000 pounds of nitrogen/year to area groundwater.

Canadian Agricultural Practices

- In the Abbotsford area of British Columbia, agriculture is the dominant land use including poultry farms, raspberry farms, and dairies. The B.C. Ministry of Agriculture and Food acknowledges that local agricultural activities are a significant contributor of nitrogen to groundwater.



The collective impact of the above sources on area groundwater can be seen by evaluating the historical mean spring nitrate values (in mg/L) for 1990 to 2011 (left) (4,5,6,7,14).

These values are a rough measure of the nitrate trend in the aquifer over the last two decades.

Clean Water Hurdles

- The responsibility for overseeing and managing dairy nutrients in Washington State is dispersed across numerous agencies: each with different goals, responsibilities, and regulatory authorities. It will be extremely difficult to improve groundwater quality without the coordinated efforts of the local community and regulatory officials.
- Nitrogen loading from sources other than dairies is largely unregulated.
- Washington State has no authority to manage Canadian nitrogen sources.

Conclusions

- Nitrate concentrations in the Sumas-Blaine Aquifer have been elevated above the drinking water standard and have been increasing for more than 40 years.
- Over 70% of the wells sampled in 2003 – 2005 exceeded the drinking water standard for nitrate-N of 10 mg/L.
- The aquifer is susceptible to contamination from land use activities, especially during October to March, when precipitation is heaviest.
- The aquifer is the primary source of drinking water for the majority of area residents. Residents in impacted areas who rely on private domestic wells may not have access to water which meets safe drinking water standards. There are no readily available alternate sources.
- Dairies are the predominant source of nitrogen to the land surface, contributing over 60% of the annual average load to the aquifer. Other sources include irrigated agriculture and on-site sewage systems.
- Regulatory authority is fragmented across numerous entities.

What Can Be Done

- Where nitrate-N concentrations in groundwater exceed 10 mg/L, stringent nitrogen management techniques and programs should be used to protect groundwater quality and reduce nitrogen loading.
- Wastewater and manure should only be applied at agronomic rates sufficient to maintain a viable crop with minimal leaching below the root zone. Winter storage of wastewater and manure should be used during the non-growing season.
- Management efforts should be enhanced and focus on mitigating nitrogen loading from those dairies where the estimated nitrogen application rate exceeds crop needs.
- Public education and outreach should be enhanced.
- Residents should be encouraged to have their drinking water tested.
- Interested parties should be encouraged to work cooperatively to monitor conditions and reduce nitrate contamination. These include:

  Washington State Department of Ecology
  Washington State Department of Agriculture
  Washington State Department of Health
  Whatcom Conservation District
  Whatcom County Health Department
  Ministry of Agriculture, British Columbia, Canada
  Ministry of Environment, British Columbia, Canada
  U.S. Environmental Protection Agency
  U.S. Geological Survey
  Western Washington University
  Residents of Whatcom County

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On the web: This poster is at: www.ecy.wa.gov/biblio/1103027.html

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