

In total, 10628 groundwater samples in WQCP had boron analysed and 73 samples had boron concentrations higher than 5 mg/L in the Lantzville, Port Alberni, Ganges, Sooke, Powell River, Nanaimo, Kamloops, Quadra Island, and other areas (Figure III-10).

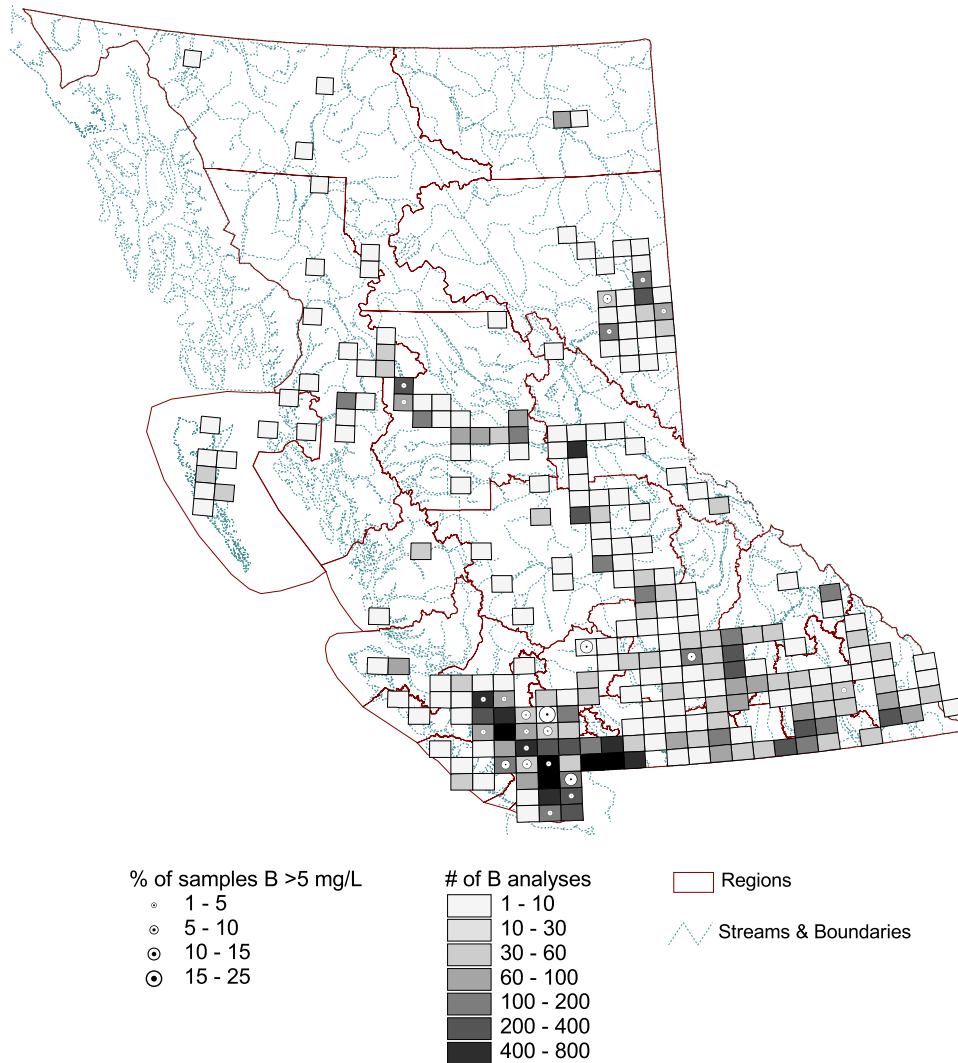


Figure III-10. Boron results of groundwater samples from WQCP

Cadmium

Cadmium is not considered as carcinogenic. However, chronic ingestion of cadmium is associated with softening of the bone, renal disease and hypertension (Health Canada, 1996). The main source of cadmium intake for general population is from food. Because it is difficult to reduce cadmium intake from food, a maximum acceptable concentration of 0.005 mg/L for cadmium has been established for Canadian drinking water quality in order to minimize cadmium intake from water. The main source of cadmium in drinking water could be from water distribution systems and contamination from mining, metal smelters, and agricultural application of sludge, fertilizers and pesticides containing cadmium.

In total, 2110 groundwater samples in WQCP had cadmium results and there were only five samples containing cadmium exceeding the Canadian drinking water guideline (Table III-2). The cadmium concentrations in these five sampling sites need to be verified and sources to be investigated individually.

Table III-2. Cadmium results from Water Quality Check Program

NTS#	Cd (mg/L)	Location
082F/05	0.006	Atherton Creek, Ladybird Forest Rd, Castlegar
082F/06	0.014	Nelson
082L/11	76.300?	Grandview Bench, Salmon Arm
092G/01	4.340	Whonock
092G/01	0.006	Riverside Rd, Matsqui

Lead

Lead is classified as possibly carcinogenic to humans and is known as a cumulative general poison affecting the central nervous system. A Canadian drinking water guideline for lead is 0.01 mg/L (Health Canada, 1996). The main source of lead in groundwater could be introduced from household plumbing systems containing lead. Other sources may include dissolution of lead-bearing minerals in nature and discharge of industrial (e.g., mining, smelting) and municipal wastewater (CCME, 1996).

In total, 2244 samples in WQCP had lead analysed. Since the minimum detection limit for lead in WQCP was 0.02 mg/L, samples with lead equal to or above 0.03 mg/L were considered as exceeding the Canadian drinking water guideline. Only 39 samples had lead equal to or above 0.03 mg/L and they scattered in various areas (Figure III-11).

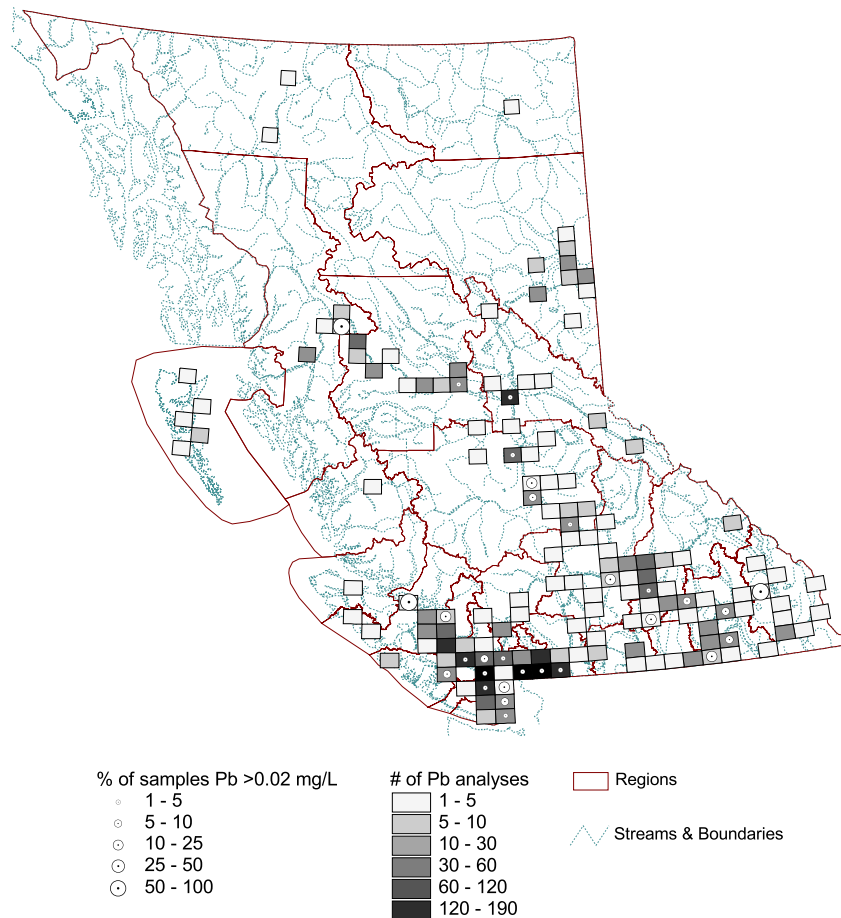


Figure III-11. Lead results of groundwater samples from WQCP

Sodium

Studies have shown that reducing sodium intake can lower blood pressure in hypertensives, although the association between sodium in drinking water and occurrence of hypertension is not clear. Canadian drinking water guideline for sodium is an Aesthetic Objective of 200 mg/L or less (Health Canada, 1996). Sources of sodium may include weathering of salt deposits and sodium-bearing minerals, road salts, seawater intrusions, and leaching of soils high in sodium content (CCME, 1996).

In total, 2133 samples in WQCP were analysed for sodium and 109 samples had sodium concentrations higher than 200 mg/L. The distributions of sodium higher than 200 mg/L and median sodium concentration per NTS map sheets are shown on Figure III-12 and Figure III-13.

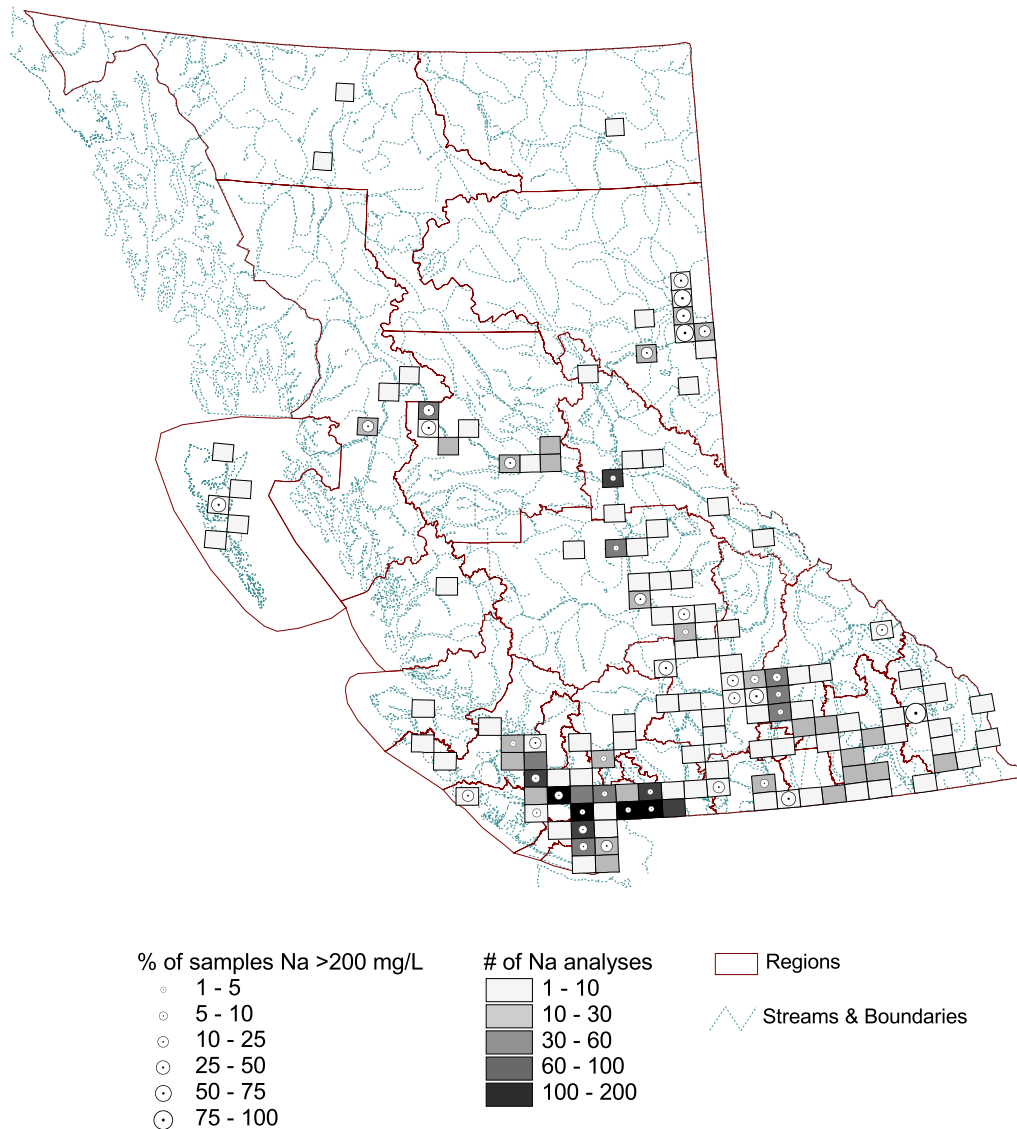


Figure III-12. Sodium results of groundwater samples from WQCP

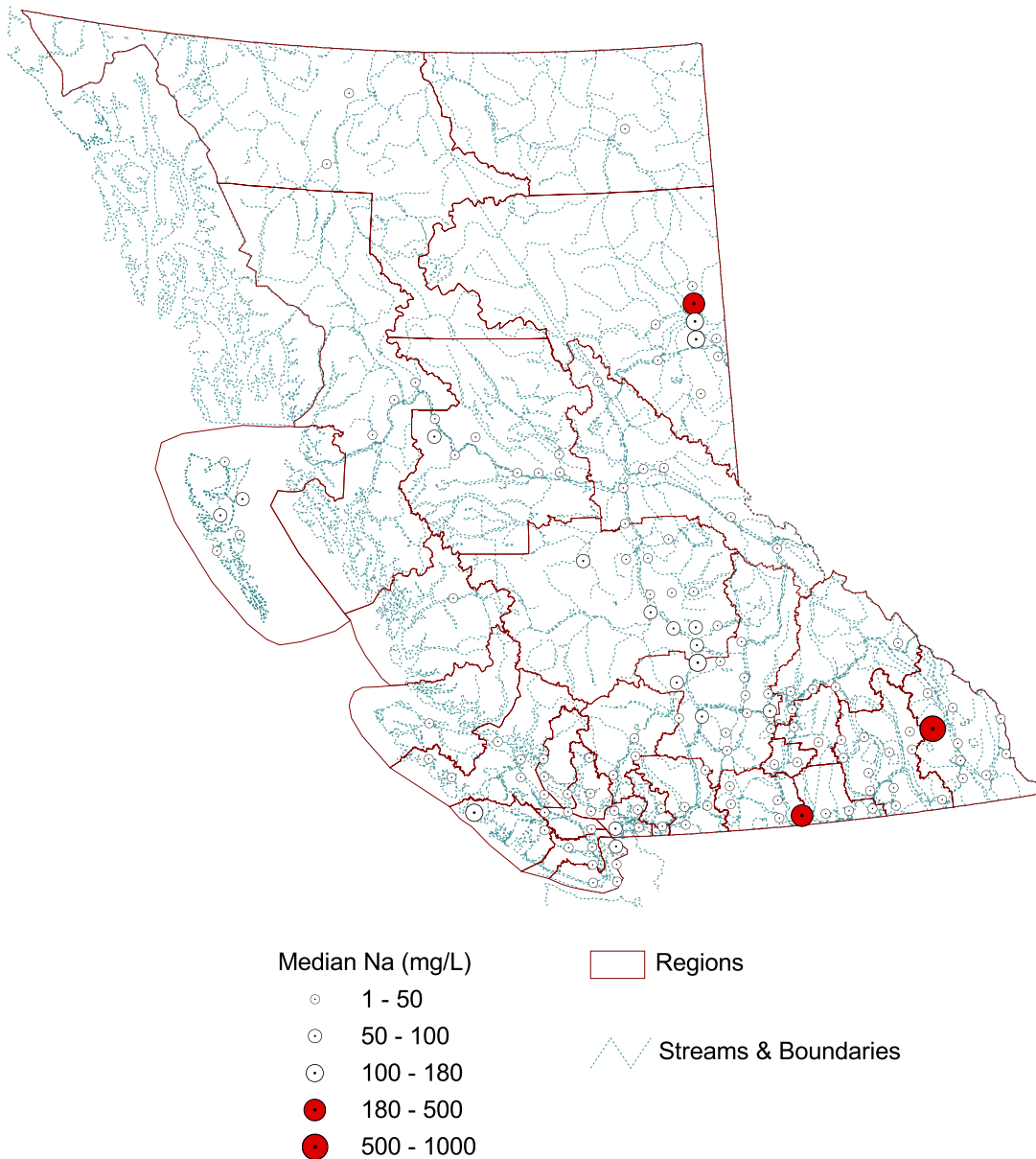


Figure III-13. Median sodium concentrations of groundwater samples from WQCP

Total Coliform

Total coliform bacteria are used as effectiveness indicator of drinking water treatment. The present of total coliform is not necessarily an indication of the presence of fecal contamination. The maximum acceptable concentrations is less than 10 total coliform organism per 100 mL water in Canadian drinking water guideline (Health Canada, 1996).

In total, 11682 samples had total coliform analysed and 1787 samples had more than 10 total coliform counts per 100 mL. The occurrences of samples containing 10 total coliform counts or more did not show apparent patterns from region to region (Figure III-14, Figure III-15).

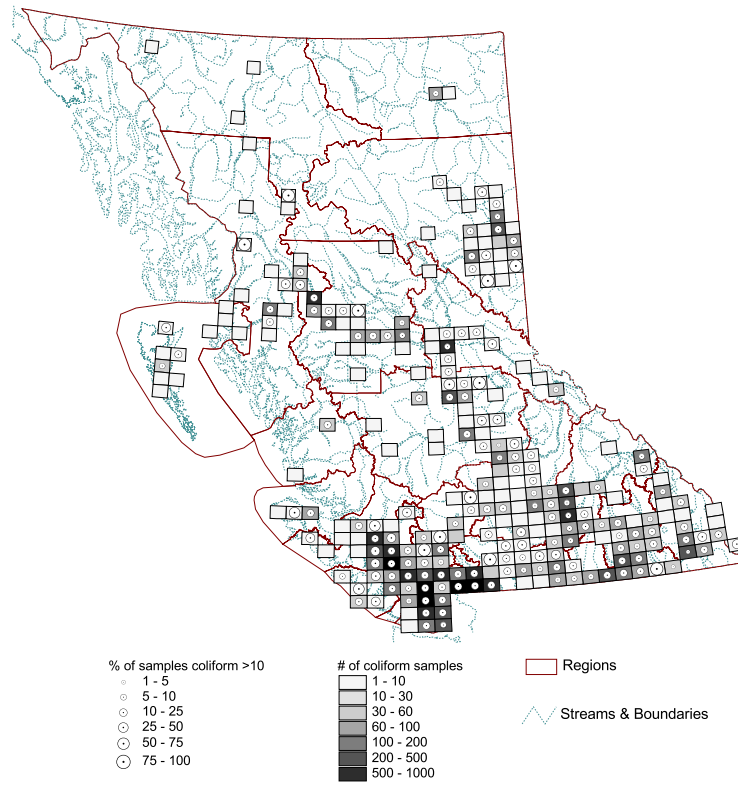


Figure III-14. Total coliform results of groundwater samples from WQCP

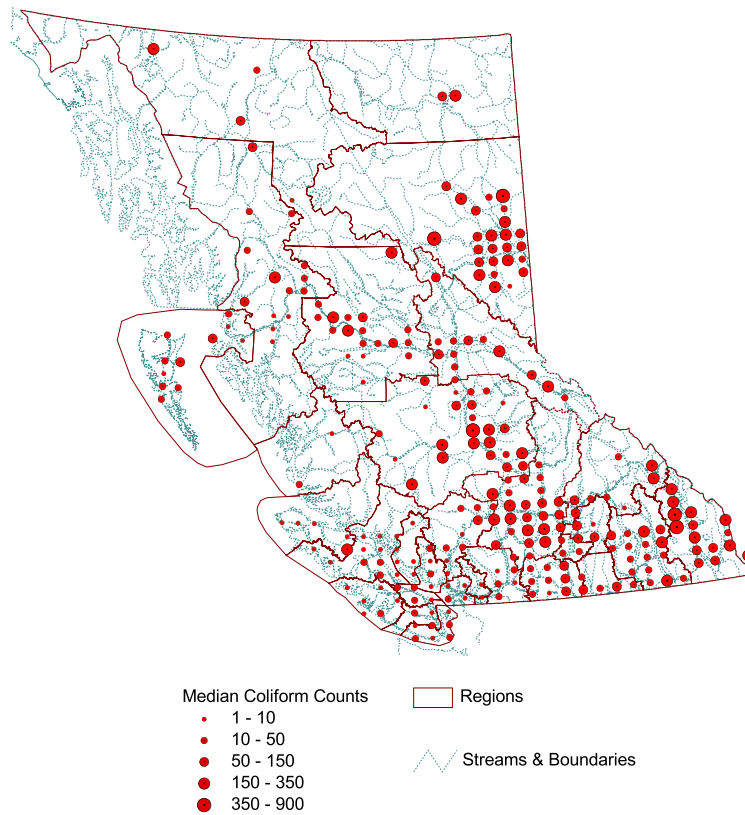


Figure III-15. Median total coliform counts of groundwater samples from WQCP

Summary

A preliminary analysis of the Water Quality Check Program database has been carried out on selected water quality parameters, including pH, hardness, specific conductance, fluoride, nitrate-nitrogen, arsenic, barium, boron, cadmium, lead, sodium and total coliform. The conclusions drawn from the WQCP are based on and limited to the quality of the WQCP database, even though efforts have been made to minimize errors introduced by data entry.

In summary, only a small portion of the groundwater samples had certain water quality parameters above Canadian drinking water guidelines. Near half of groundwater samples tended to be soft and were distributed in areas predominant with igneous rocks, while only 5% of groundwater samples had hardness above 500 mg/L and occurred in areas predominant with sedimentary rocks. Approximately 11% of the samples had specific conductance above 1000 $\mu\text{S}/\text{cm}$ and were found in the Peace River, southern Canadian Rocky and the interior areas. About 10% of the groundwater samples had pH values < 6.5 and 6% of the samples had pH value > 8.5 . Groundwater samples with low pH values were found more often in the coastal area and high pH values were found in the interior. There were less than 2% of the samples containing nitrate-nitrogen higher than the Canadian drinking water guideline and they occurred in areas predominant with agricultural use (Vernon, Armstrong, Williams Lake, Fort St. James and Smithers). About 2% - 3% of the samples had arsenic and fluoride concentrations above Canadian drinking water guideline and they were found in areas predominant with volcanic rocks. Samples with high sodium concentrations (>200 mg/L) occurred either along the coastal area where seawaters were the possible sources or in areas where road-salts might be the sodium contributors. Lead and cadmium had more localized and probably isolated sources; other water quality constituents such as barium and boron had more scattered distribution throughout the province and sources need to be identified.

These results indicate that groundwater quality concerns are limited neither to the three areas which are covered by the Ambient Groundwater Quality Monitoring Program nor to nitrate contamination.

There is a need to confirm areas where certain water quality parameters exceeded the Canadian drinking water guidelines and to investigate the magnitude of groundwater contamination in those areas based on a community aquifer approach.

APPENDIX IV. CLIENTS AND GROUNDWATER INFORMATION NEEDS

— Extracted from the Water Well Data Management Project (BC Environment, in draft)

Identify Internal and External Clients and their Groundwater Information Needs

3.1 Introduction

This section of the report lists the internal and external clients and their groundwater information needs. Table 3.1 summarizes the clients, type of groundwater information, and examples of typical uses of the information. The sources of groundwater information in Table 3.1 are presented in Section 2. Groundwater information needs for each client are discussed below.

3.2 Clients

3.2.1 External Clients

Water Well Driller: Currently, the main groundwater information need for water well drillers is water well records for siting drill sites and redeveloping wells. There is presently low to medium demand for the other types of groundwater information because drillers may not realize this information exists and how to use them. For example, aquifer classification maps could be very useful, along with well records, to identify potential areas for drilling. Drillers can also use aquifer classification maps to educate private well owners about their aquifer to foster water stewardship. This type of interpreted information needs to be made available to the well drillers.

There are 115 well drilling companies in British Columbia. Water well contractors comprise 19% of the total inquiries handled by Groundwater Section.

Pump Contractors: Current groundwater information needs for pump contractors are similar to well drillers (i.e., water well records). Pump contractors need information on well construction, well water levels, and pump test information for pump design, installation, and operation. Pump contractors, like drillers, also frequently come in contact with well owners and can provide more interpreted information to the public about the groundwater resource. There are 41 pumping test companies in the Province.

Groundwater Consultant: Groundwater consultants require all types of high quality groundwater information to prepare proposals, conduct groundwater assessments, develop water supplies, and market their services. For example, there is a high demand from consultants for water well records and groundwater maps for site assessments and water supply development. Consultants are also generally very keen about water quality protection and have used our fact sheets and publications to encourage their clients (water purveyor) to protect their wells.

There are 35 groundwater consulting offices in the Province. Groundwater consultants comprise 32% of the enquiries handled by Groundwater Section despite the fact that well records have been put on the internet.

Home Owner: A major data need for the home owner is well records. This information is needed when something “goes wrong” with their well, when home owners are planning to have a well drilled, or when they are looking into buying another property. There is keen interest from some home owners in protecting groundwater and these owners rely heavily on our advice and seek information from fact sheets and publications. In areas where there is ambient groundwater monitoring sampling or where water quality surveys have been completed, there is a demand for results of the water quality results information also. Home owners comprise 20% of the total enquiries handled by Groundwater Section.

Real Estate Agents: The main data need for realtors is water well information for buying and selling rural properties. Demand for other types of groundwater information is currently low. However, many realtors are interested in “high level” information about the resource (i.e., fact sheets), specifically on water quality, how to properly maintain wells, and prevent pollution. Realtors also rely heavily on our staff for

technical advice, especially in interpreting well records. Since the well records were put on the internet, realtor enquiries handled by Groundwater Section has dropped to 4%.

Water Well Witcher: Not much is known about groundwater information needs of water well witchers. Witchers have visited our office from time to time to get specific information on water well records. Other than that, we have very little contact with them. Home owners and even some well drillers and water purveyors frequently consult water witchers. Reliance on witchers for “groundwater information” has kept local communities in believing that groundwater is “mysterious” and prevented awareness about the resource.

Groundwater Purveyor: The demand for all types of groundwater information from water purveyors is medium to high. Water purveyors need raw data such as well records and observation well data to assist them in operating their water supply system. They also need “high level” information for reference and resource material and technical advice to plan, manage, and protect their supply.

Non-Governmental Organization: Non-governmental organizations (NGOs) range from technical organizations (e.g., *Association of Professional Engineers and Geoscientists of British Columbia*) to advocacy groups (e.g., *Sierra Club of Western Canada*). Generally, the demand for groundwater information from NGOs is on interpreted and “high level” information and technical advice, not on raw data. NGOs use groundwater information to report on state of the environment and as technical background for advocating policies and legislation.

University Environmental Departments: Demand from university environmental departments for all types of high quality groundwater information is high. For example, UBC’s *Institute for Resources and Environmental Resource Management and Environmental Studies* is currently drafting groundwater protection plans with the Township of Langley. This department not only relies on raw data and interpreted information to characterize the hydrogeologic conditions of the study area but also “high level” information to educate the public and local government.

University students seek all types of groundwater information and technical advice in their research projects. For example, students from Royal Roads College recently sought technical advice, data, and reference reports from us in conducting a contaminant inventory for the City of Abbotsford.

Regional District / Local Government Planning Departments: Groundwater information needs of local governments and regional districts are mostly in the form of interpreted information (e.g., aquifer classification maps and reports), “high level” fact sheets (e.g. *Well Protection Planning for Community Wells in British Columbia*), and technical advice. Interpreted information, such as aquifer classification maps, is used in local Official Community Plans, for example. Fact sheets provide quick information to local governments on new groundwater initiatives from the Provincial government and also are reference materials for raising public awareness locally.

Planning Tables: Interpreted groundwater information—mostly maps and associated reports—is in demand for the various planning tables in the Province. For example, aquifer classification maps are being submitted to the Okanagan-Shuswap Land and Resources Management Plan (LRMP) so that groundwater can be considered in the planning process. Part of the information need is also technical advice on how to interpret and apply the information from these maps into the plan.

Considering groundwater in planning is new in BC because interpreted information has never been readily available before. Our program needs to focus more on turning data to information to protect and manage the resource through land use and resource planning.

External Provincial Ministries: External provincial ministry clients include the Ministry of Agriculture, Fisheries and Food, Ministry of Employment and Investment, Ministry of Health, and Ministry of

Municipal Affairs. These Provincial ministries are mainly interested in interpreted groundwater information, fact sheets, and technical advice. There is medium demand from Employment and Investment, Health, and Transportation and Highways for raw data such as well records. Employment and Investment and Transportation and Highways use the lithology in the well records for geological mapping, environmental assessments related to highway construction, and aggregate inventories. Health uses well records to design water quality monitoring programs, periodically conduct water quality assessments, and interpret their water quality data. Municipal Affairs relies on us mainly for technical advice and review on groundwater supply projects.

These ministries also have geological and water use information relevant to groundwater. Employment and Investment and Transportation and Highways produce geological maps that are vital for identifying potential aquifers. Health has information on community water users and water chemistry of community wells that, if linked to our WELL database, can allow better interpretation and assessment of community groundwater supply systems. Municipal Affairs have information on large production wells used for municipal water supplies.

Federal Ministries: Federal ministry clients include Agriculture Canada, Environment Canada, GSC, Health Canada, and PFRA (part of Agriculture Canada). Groundwater information needs for these ministries vary. Environment Canada, GSC, and PFRA, with technical water resource/geological programs, rely much more on raw data (e.g., water wells records) than the other federal ministries. However, all of the ministries have high demand for interpreted groundwater information as they have interest in the groundwater resource through public health protection, sustainable agricultural development, and water quality protection. As with the external provincial ministry clients, the federal ministries, particularly Agriculture Canada, Environment Canada, GSC, and PFRA are also sources of interpreted groundwater information.

US Federal and State Agencies: Groundwater information needs of these agencies are similar to our federal ministries; high on interpreted information and low on raw data. The exception is the USGS who require raw data for their groundwater projects. These agencies are also excellent sources of interpreted information and publications on groundwater.

3.2.2 Internal Clients

Water Licensing Section: Water license's groundwater information demand is mainly for water well records, interpreted groundwater maps and reports, and technical advice in interpretation of data and policy. This information is used, for example, in treaty negotiations with First Nations. Demand for "high level" information such as fact sheets have also increased as this information is of interest to the work of the Section.

Utility Regulation Section: Utility Regulation Section's need is mainly for technical assessments of pumping tests submitted by developers. Our assessment is frequently requested on whether there is sufficient groundwater supplies to support the proposed development. Hydrology Unit does similar assessments for surface water supplies for proposed developments.

In addition to technical advice, there is also a demand for "high level" information such as fact sheets. Fact sheets such as *Well Protection Planning for Community Wells in British Columbia* have raised awareness and lead to incorporation of well protection plans as a condition of water supply approval.

Appeals Section: Most of Appeals Section's groundwater information needs have been for technical advice involving groundwater-surface water conflicts. In adjudicating appeals, staff have also requested water well records. Although need for groundwater maps and other interpreted information is currently low, demand should increase in the future as water use conflicts increase and groundwater as an option and location of aquifers need to be considered.

Hydrology Unit: The main groundwater information needs from Hydrology Unit is hydrograph data from the Provincial Observation Well Network. Observation Well data are regularly published in the Snow Survey Bulletin. Demand for other types of groundwater information, particularly well records, water quality, and groundwater maps, should increase as Hydrology Unit's mandate now includes water quality assessments for inventory purposes.

Water Quality Section: There is high demand from Water Quality Section for technical advice, “high level” fact sheets, and historically with Ambient Water Quality data and reports. There is considerable potential for increased demand for interpreted information (e.g., maps and reports) to enhance water quality interpretation, assessments, and reporting.

Regional Land and Water Management: Historically, there has been limited need for groundwater information from regional offices. Main information needs include raw data (e.g., water well records) and technical advice for specific projects/issues. Recently, there has been a growing demand for “high level” fact sheets, both to inform regional staff on groundwater initiatives and for use as educational and resource materials for the public. With increased participation in regional planning tables, Forest Practices, and Growth Management, regional staff’s needs for interpreted information, reports, and technical advice will increase. The addition of groundwater staff in Surrey also means an overall increase in activity and therefore, an increase demand for groundwater information by regional staff there.

Regional Environmental Protection: Groundwater information demand from Regional Environmental Protection (EP) staff include technical advice, water quality data, and some water well records. Recently, there has been an increased demand for interpreted maps (e.g., aquifer classification maps), which EP staff see as vital in planning water quality assessments and prioritizing clean-up.

Strategic Planning Branch: Information needs for Strategic Planning Branch has mainly been technical advice and “high level” information related to policy and legislation development. Fact sheets have been very effective in getting information across to policy staff and this is reflected in the draft groundwater policies developed to-date that includes well protection planning and aquifer vulnerability mapping, for example.

Fisheries Branch: The main groundwater information needs for Fisheries have been technical advice on groundwater and reports and publications. All of Fisheries’ trout hatcheries are dependent on spring or well supplies. Our office continues to provide advice to the Fish Culture Section on development and protection of water supplies at their various hatcheries. Hatchery managers have also requested information on groundwater and groundwater protection that they can use in their education programs with visiting school kids and the public. There is potential to raise public awareness about groundwater through this program. Another important need for Fisheries Branch is “high level” information, such as fact sheets to inform their staff of groundwater initiatives that are occurring.

Environmental Assessment Office: Technical advice is requested from our office on environmental impact assessments (EIAs) in support of the Environmental Assessment Act. “High level” information is also of interest to Environmental Assessment.

Contaminated Sites Unit: Contaminated Sites staff are mostly interested in information about ambient water quality (to establish clean up standards), groundwater reports, “high level” information (e.g., fact sheets), and technical advice and information exchanges. There is also a demand for aquifer classification maps to help prioritize site clean up and assess potential impacts of contamination.

Groundwater Section: Perhaps the biggest client is ourselves. We need to be up-to-date with groundwater information before we can satisfy client needs. Raw data are required for inventory and assessment purposes and form the basis for the interpreted information, such as groundwater maps.

Interpreted information, in turn, is required to support planning tables, management, and setting of policies.

3.3 Discussion of Information Needs

A review of groundwater enquiries received in our office shows that by far the greatest demand is for raw data (e.g., well records, water well location maps, observation well hydrographs, etc.) with some requests for technical advice and publications. There is currently relatively low demand for interpreted information such as aquifer maps. One explanation may be that the public, industry, and other agencies are not fully aware that this information exists nor how to use the information. Another reason may be that demand for interpreted information is from selected clients (e.g., local government planners) who need them but not on a continuous basis.

The demand for raw data is related to site specific projects/problems and is therefore constant. Raw data is in high demand with drillers, consultants, home owners, realtors, and universities and other government agencies involved in groundwater work. The demand for interpreted information, however, is for setting a regional framework for site specific projects and also for regional planning. Presently, demand for this type of information comes from other agencies that are not involved in actual groundwater work but have an interest in the resource (e.g., planning departments, other government agencies, and NGOs).

The demand for interpreted information will likely grow as more and more clients find out about it and learn how to use it and our ability to produce this information increases. There is also considerable potential for use of interpreted and “high level” groundwater information to educate and raise awareness about the resource. We need to educate clients about needs that they may not yet be aware of.

However, the basis for all interpreted groundwater information is the WELL database. Without a well-designed water well database, linkages to relevant databases, and a process of ensuring data are collected, processed, analyzed, and kept up-to-date, service to our clients will suffer. Our clients are also our sources of groundwater information and providing them good quality service is one way to ensure information (such as well records and consultant reports) keeps coming in.

Finally, another observation is that we are called upon frequently to provide technical advice, both to our program and to external clients. Demand for technical advice is very high and will continue because groundwater information is complex. In order to meet this demand, our staff must stay active in technical groundwater projects to maintain and enhance their expertise.

APPENDIX V. AQUIFER CLASSIFICATION

This is a partial list of aquifers mapped and classified by the Groundwater Section, BC Ministry of Environment, Lands and Parks.