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Protecting Drinking-Water Sources

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auditor general's comments

This is my fifth report to the Legislative Assembly for 1998/99.

British Columbians are used to having safe drinking water at a low cost, and we tend to take this for granted. Other jurisdictions are not so fortunate. Many have to subject their drinking water to intensive purification processes, because their sources are polluted. Certainly, failure to protect drinking-water sources carries a large price tag in terms of capital and maintenance expenditures for treatment systems.

In British Columbia, provincial and local governments play key roles in ensuring an adequate supply of safe, affordable drinking water. The water systems in Vancouver and Victoria draw from watersheds that they control and are able to protect from uses that might threaten water quality. This is not so for most other communities across British Columbia. Many activities, such as forestry, recreation, and transportation take place in community watersheds, and on land which feeds underground sources. The provincial government has primary responsibility for protecting the drinking-water sources affected by these activities.

The purpose of this audit was to look at the government's protection of drinking-water sources for these other communities. In doing so, we focused on the sources for eight medium to large systems. We also looked at the problems faced by the many small systems that exist across British Columbia. The special case of groundwater management caught our attention during this audit, and we have devoted a separate chapter to this issue.

We found that, while the drinking-water sources we examined provide good water requiring minimal treatment, almost all face risks from human activities that are not adequately managed. At the same time, we recognize that protecting drinking water by shutting

down all other economic and social activities is unrealistic. Also, even with good protection, some forms of water treatment are necessary. Therefore, we believe that a layered approach to drinking-water provision, combining an appropriate mix of protection and treatment, offers the best value for money. This would allow reasonable activities to take place, while providing an appropriate level of protection to water sources.

There are many stakeholders, such as resource industries and local governments, who can have an impact on water sources, and who in turn would be affected by decisions about protection. To balance the needs of these stakeholders while achieving an appropriate level of protection, British Columbia needs an effective, integrated planning process, in which conscious trade-offs between protecting drinking-water sources and allowing other activities are made in a structured manner.

However, government is not set up to deliver this. There are many provincial government agencies whose work impacts on drinking water. These include the Ministries of Environment, Lands and Parks; Health; Forests; Municipal Affairs; Transportation and Highways; Agriculture and Food; Energy and Mines; the Land Use Coordination Office; and the Environmental Assessment Office. No single agency has been identified as the primary protector of drinking-water sources. Government cannot achieve a leadership role in protection unless it has a focal point from within to coordinate these interests. We therefore believe that one agency should be assigned the role of the “voice of water” within government.

This was an unusually complex audit, due to the variety of agencies at the provincial and local levels of government who were involved, and the range of information we needed to assemble. I wish to thank the staff of the many agencies involved who devoted their time and resources to providing us with information and advice. I also wish to thank the advisors and consultants who assisted us in this project.

I believe that the human and financial cost of not protecting our drinking-water sources would be unacceptably high. With good management, we can avoid or reduce the kind of capital outlays involved

in building treatment plants that would be needed to remediate deteriorated water. I urge all the agencies involved to take a broad, long-term look at source protection, so British Columbians can continue to enjoy safe, affordable drinking water.

George L. Morfitt, FCA
Auditor General

Victoria, British Columbia
March 1999

highlights

protecting drinking-water sources

Introduction

The Province's drinking-water sources are showing signs of strain

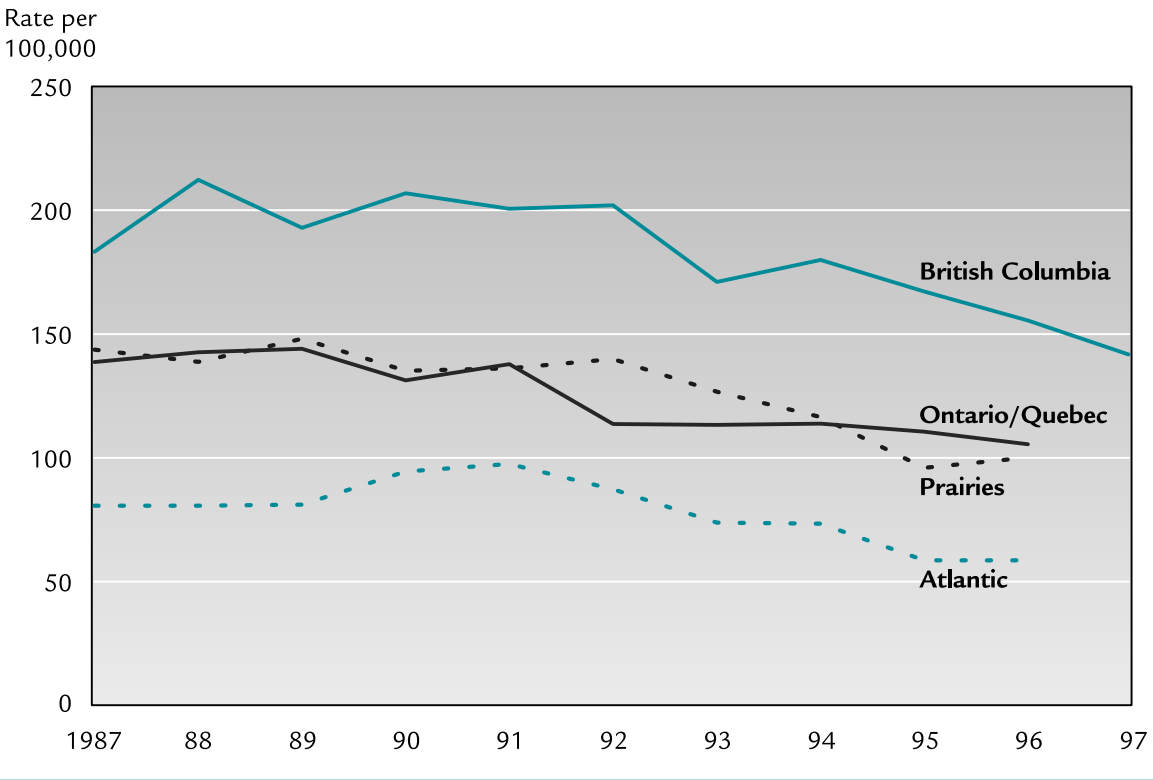
British Columbians have in recent years received several indications that their drinking-water sources cannot be taken for granted. One indication is that, on average, reported rates of enteric (water-borne or food-borne) disease are higher in British Columbia than elsewhere in Canada (Exhibit 1).

Another is that a number of our communities have had well-publicized water-related disease outbreaks. Since the 1980s, two parasites, *Giardia* and *Cryptosporidium*, have

Exhibit 1

Reported Rates of Intestinal Illness

Total reported cases of the following enteric (water-borne or food-borne) diseases: amoebiasis, campylobacteriosis, giardiasis, hepatitis A, listeriosis (all types), paratyphoid, salmonellosis, shigellosis, typhoid, and verotoxigenic E. coli



Source: Office of the Provincial Health Officer, BC Ministry of Health

concerned drinking-water suppliers worldwide, and British Columbia has not been spared. For example, a *Giardia* outbreak in Penticton in 1986, and *Cryptosporidium* outbreaks in Kelowna and Cranbrook in 1996, each affected significant numbers of water users (Exhibit 2).

Traditionally, freshwater has been plentiful in British Columbia and of such quality that little, if any, treatment was thought to be needed to maintain safe drinking-water supplies. As a result, most drinking-water systems in British Columbia have, at most, only disinfected their water. Now, however, a number of systems are considering adding filtration, in large part because of concerns about *Cryptosporidium*.

Although disease outbreaks have attracted the most attention, there are other signs of strain in British Columbia's drinking-water sources. One of these is the elevated level of nitrate contamination in wells in some parts of the province. Although the impact on water sources has been minor so far, the problem is worrisome.

Giardia and Cryptosporidium:

- are microscopic parasites, unlike most earlier health threats to drinking water, which have been associated with bacteria;
- cause intestinal infections in humans and other vertebrates;
- cause infections that are rarely fatal for most people infected (though diarrhea, cramps and nausea may be experienced for up to three weeks, and children may be more susceptible than adults), but can be fatal for people who are immunosuppressed (e.g., those who have recently had an organ transplant or chemotherapy, or have AIDS);
- are likely to be found, in varying concentrations, in most surface water sources, but to date have seldom shown up in groundwater;
- are expensive to test for (and testing is imprecise); and
- can be transmitted in drinking water, as well as by other means.

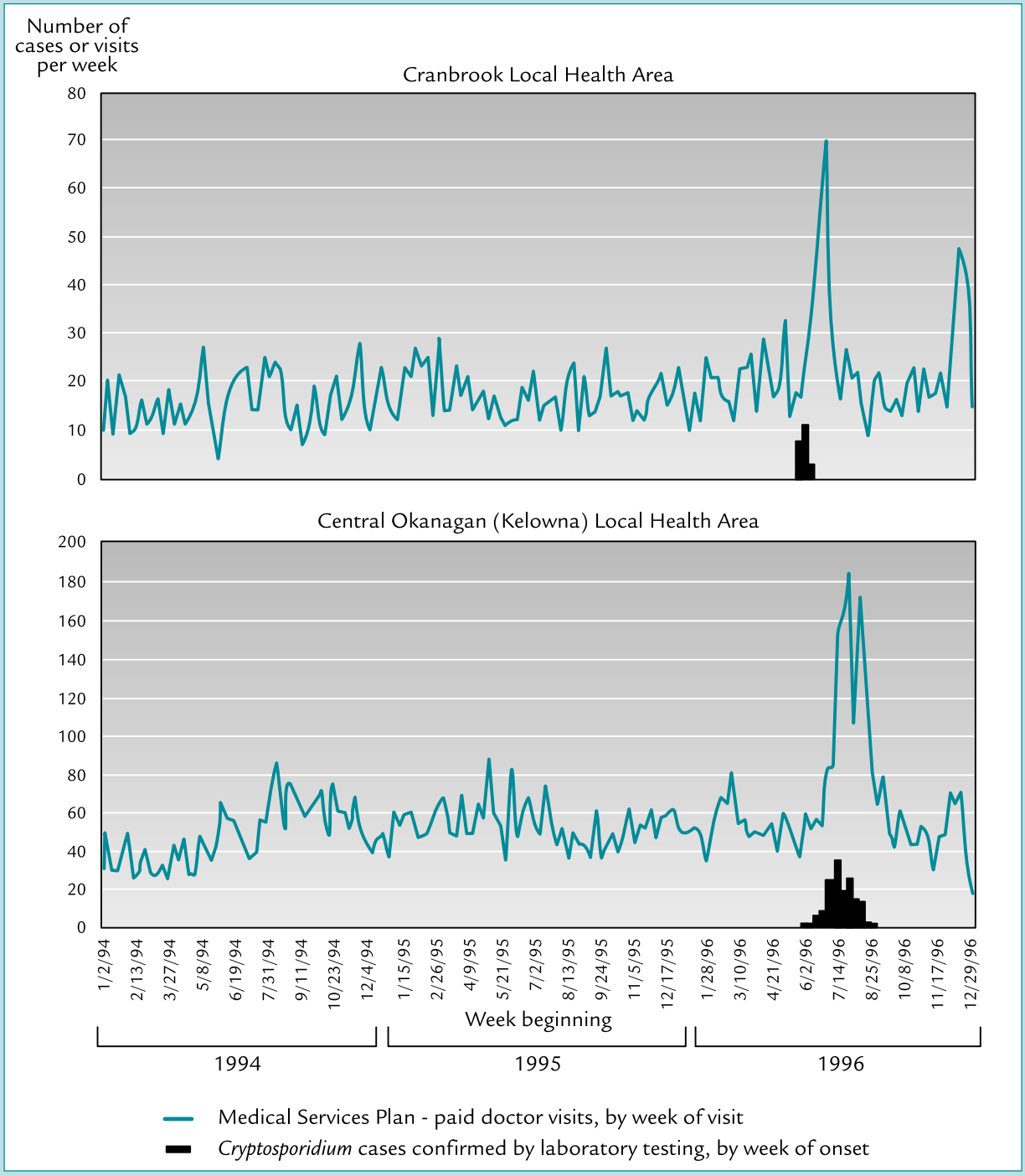
At the time of the Penticton *Giardia* outbreak in 1986, the only water treatment known to be effective was filtration. It now appears that increased protection from *Giardia* can be achieved in some water systems by relatively inexpensive changes to conventional disinfection systems. Increasing settling time in reservoirs and controlling activities in watersheds can also help to reduce parasite levels, but these methods are probably not sufficient by themselves.

Cryptosporidium is more difficult to control. With techniques currently used, disinfection at practical levels is not effective by itself in reducing infection risk to low levels; filtration is the only practical way of doing so.

Exhibit 2

Doctor Visits for Intestinal (Enteric) Illness, and Laboratory-Confirmed *Cryptosporidium* Infections

Cryptosporidium *infections can only be positively confirmed by specialized laboratory testing of stool samples from infected patients. Here are two indicators of outbreaks—the number of people visiting doctors for enteric illnesses each week, and the number of stool samples taken by these doctors and confirmed by the BC Centre for Disease Control*



Source: BC Ministry of Health

Protecting drinking-water sources is one key to supplying safe drinking water reliably and cost-effectively

Reliable provision of high-quality drinking water depends on several levels of protection—barriers to contamination—working together:

- effective control over land uses that could harm water quality;
- appropriate water treatment;
- a sound and well-maintained water distribution system operated by well-trained staff; and
- water quality testing.

Of these levels, source protection is the one for which the provincial government has most responsibility, and it is the focus of our audit.

Recent concerns with *Cryptosporidium* and *Giardia* have centred attention on water treatment. However, relying on treatment alone is not sufficient. Good protection of water sources is essential to the cost-effective provision of safe water. Some communities with good sources, especially good ground-water sources, may continue to have good drinking water without additional water treatment beyond disinfection. Even communities that need to add further treatment can save money through good source protection. Water with low turbidity and low levels of bacteria, viruses and parasites can be treated successfully by filtration and disinfection. However, with poorer-quality source water, sedimentation or other techniques is also needed, and the cost of building and operating the filtration plant increases.

Finally, water treatment plants, like other complex systems, are not effective 100% of the time, so it is unwise to rely on them as the sole means of water protection. *Cryptosporidium* outbreaks have occurred in several filtered water supplies; the best-known incident was an outbreak in Milwaukee in 1993 that affected over 400,000 people. Protecting drinking-water sources can help make water treatment plants more reliable. For example, during heavy rains in 1996, sediment from poorly controlled human activities on federal, state and private land in Salem, Oregon's watershed combined with natural erosion to put the city's filtration system out of action. This forced the city to make extra expenditures to drill emergency wells, buy water from nearby towns, and build an emergency pre-treatment system.

In short, good protection of drinking-water sources increases the reliability of our water supplies by adding to their levels of protection. It can also reduce, delay or avoid the cost of additional water treatment beyond disinfection.

Responsibility for protecting drinking-water sources is dispersed among a number of provincial ministries and agencies

No one part of the provincial government has sole responsibility for the many issues relating to protection of drinking-water sources. Instead, the Ministries of Environment, Lands and Parks; Forests; Health; Energy and Mines; and Transportation and Highways each have some responsibility for this protection. In addition, the Ministries of Municipal Affairs and Agriculture and Food, the Environmental Assessment Office and the Land Use Coordination Office manage processes that can affect drinking-water sources.

Audit Purpose and Scope

Any examination of the protection of drinking-water sources has to focus on the provincial government, since all fresh water in British Columbia—both surface water and groundwater—belongs to the Crown. So does most of the land area of the province, and therefore the watersheds supplying most drinking-water systems.

We set out to determine whether British Columbia is getting good value from an important resource—drinking-water sources. Our audit asked: Does the level of protection provided by the Province to drinking-water sources from human-related impacts appropriately balance the cost and benefits of drinking water and other resources?

"Human-related" emphasizes that we want to examine activities that the provincial government can be expected to control. Natural processes certainly influence water quality, but few are under government control.

Most of the discussion that follows in this report looks at management of Crown land. The Province has few controls over activities on private land; those are more under the jurisdiction of municipal and regional governments. Similarly, we did not examine the Vancouver and Victoria regional water systems, which control their own water sources with minimal provincial intervention.

Our attention was on the water sources supplying the 1.7 million British Columbians living outside these two metropolitan regions—about 45% of the provincial population. In particular, we visited eight regional centres to examine their water-source protection in detail: Fort St. John, Prince George, Williams Lake, Prince Rupert, Cranbrook, Kelowna, Abbotsford and Nanaimo. We also examined the special problems of smaller water systems, which we discuss in Chapter 5 of this report.

Finally, it is important to note that our audit was designed to examine administrative processes, not government policy choices, which are outside the mandate of our Office. However, we found several instances where the absence of policy is preventing effective administration, and we have highlighted these for consideration by Members of the Legislative Assembly.

In our audit examination, we focused on administrative processes in place in the 1997 and 1998 calendar years. Our examination was carried out in accordance with value-for-money auditing standards recommended by the Canadian Institute of Chartered Accountants, and accordingly included such tests and other procedures as we considered necessary in the circumstances. For more information on the way we carry out performance (value-for-money) audits such as this one, see Appendix B of this report.

Overall Conclusion

Although the major drinking-water sources we examined have continued to provide good quality water, we found that several of them, and many smaller systems, have already been impacted by, or are exposed to, threats from human-related activities. We therefore concluded that the Province is not adequately protecting drinking-water sources from human-related impacts, and that this could have significant cost implications in the future for the Province, for municipal and regional governments, and for citizens in general. The key problem is lack of an effective, integrated approach to land-use management. This could result in less-than-optimal choices being made between the need to protect source water and the need to allow other activities.

We acknowledge that increased source protection will incur costs—through increased spending on planning and monitoring by the Province, water suppliers and other resource users, or in some cases through forfeiting of economic benefits from other resource uses.

However, neglecting our drinking-water sources can also be costly. If all the surface-water systems in BC were to add filtration, the cost would be significant. For the approximately 100 municipalities outside Victoria and Vancouver that use unfiltered surface water, we estimate the capital cost of installing filtration would be about $700 million and the extra cost of financing, operating and maintaining the new treatment plants would be about $30 million a year. These amounts are large enough to suggest that the issue of source protection is worthy of increased attention.

Source protection, we know, is not a way of completely avoiding these investments. It must be backed up by appropriate levels of treatment, which may in some cases include filtration. Filtration alone, however, is not enough. It should be a way of improving the protection given to water consumers, rather than a reason to neglect source protection.

In addition to the obvious health benefits, improving our drinking water could benefit British Columbians economically. Reducing levels of water-related illnesses, and especially of outbreaks, could reduce public expenditures on doctor visits and private expenditures on finding substitutes for workers who are off sick. Avoiding well-publicized outbreaks could also be vital to our tourism industry.

Information about the relative costs and benefits of enhancing the protection of drinking-water sources is largely unavailable in British Columbia. To be meaningful, such valuation would have to be done on a case-by-case basis. In our view, such an analysis should be done as part of land-use decisions.

Key Findings

Water-source management in British Columbia is not integrated

Water quality is intimately linked to land use. When rain falls to earth, it can pick up contaminants from the atmosphere, from natural sources, and from a whole range of human land uses before it enters streams and lakes or seeps underground into aquifers (Exhibit 3). Effective water protection hinges on managing the land uses on the surfaces over or through which water flows. Accordingly, one key condition for successful water protection is integrated management of both water and the land uses that affect it.

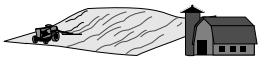
Exhibit 3

The Hydrologic Cycle, and Activities that Can Harm Drinking-water Sources

Concentrated animal-raising operations (such as pig farms, chicken farms and feedlots) can be major sources of nutrient overload. The large quantities of manure they produce may lead to application on fields in amounts greater than crops can use. Excess nutrients from manures and fertilizers can leach into groundwater and run off into surface waters.

Grazing, especially on steep-sloped pastures, can increase the potential for runoff and sedimentation in streams.

Feeding grounds and cattle wintering sites are often located near natural water sources. When livestock enter streams and ponds, they increase erosion and soil sedimentation, and cause destruction of riparian habitats. They can also contaminate the water source with their waste products.



Rain falling on agricultural lands without ground cover can lead to suspended soil particles in surface waters.

Gravel pits and other digging operations disturb the soil and can cause sediments to wash into nearby water bodies, or expose groundwater to contaminants.

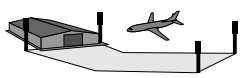
Pesticides and fertilizers are used on urban lawns, golf courses, parks and gardens, often in excessive amounts. The excess is washed into storm sewers and streams.

Rural and suburban communities can have poor sewage disposal facilities.

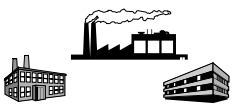
The clearing of land for urban developments often leaves the soil unprotected, sometimes for months at a time. Until vegetation re-establishes itself, sediments can be washed into nearby water bodies.

Poorly constructed or uncapped wells can be a source of groundwater contamination.

Timber harvesting can increase erosion and turbidity, and can, in some cases, cause algal blooms. Forest fires or prairie grass fires can burn vegetation cover leaving ground bare and susceptible to erosion.



Roads, parking lots, airports and other paved surfaces speed runoff water off the land. The faster the runoff, the more effective it is at carrying debris, sediments and pollutants.



Air pollutants from cars and factories are washed into water bodies by rain and blown into water by wind. Sewage treatment plants and factories may discharge effluent into surface water bodies; storm sewers may wash urban pollutants directly into rivers and streams.

Source: Compiled by the Office of the Auditor General of British Columbia

Several approaches to developing such integrated management have been tried in British Columbia in recent years. In our opinion, none of them has yet had all the elements needed to successfully integrate management of drinking-water sources. Each approach lacked one or more of the following:

- *Representation:* All stakeholders, including drinking-water consumers and suppliers, should have meaningful involvement in the management process.
- *Information:* The process should be supported by the gathering of good information on both natural conditions in the watershed and the values and impacts of competing watershed uses.
- *Implementation:* There should be an effective "hand-off" from the integrated planning stage (the stakeholders making recommendations) to the implementation stage (the elected or appointed officials acting on the recommendations).

The Province could also make drinking-water source management more effective by:

- designating *a lead agency* that will represent the interests of drinking-water users and suppliers within government and coordinate government action on drinking-water issues;
- improving *accountability reporting* on drinking-water sources; and
- carrying out a *comprehensive evaluation* of the rights of resource access of drinking-water suppliers to determine if those rights, and related responsibilities, are appropriate.

We discuss these issues of integrated resource management in more detail in Chapter 2 of this report.

Improvements are needed in managing the effects of other resource uses on drinking-water sources

Although effective integrated management tools are not yet in place, other management tools, designed to regulate specific uses of public land, do provide some protection to drinking water. A good example is the Forest Practices Code, whose main purpose is to regulate timber harvesting and cattle grazing in the Crown forest and on Crown rangeland. The Code requires that these activities be carried out in such a way that other resources, including drinking-water sources, are not put at undue risk. We examined a number of these management tools, and have suggestions for their improvement.

Logging

The Forest Practices Code gives extra protection to watersheds that are designated as community watersheds. It requires that forestry activities in a community watershed be carefully planned, and that monitoring be carried out to ensure that the results intended by a plan are being achieved. We believe that this is a sensible approach, and one that has the potential to be effective. However, several important gaps remain before that potential can be realized:

- Rules about what information is to be gathered and assessed, and who is qualified to do so, are not yet fully phased in.
- Current information systems make it difficult to determine whether government field inspections are carried out sufficiently often to ensure that plans are being followed.
- There are no regulations assigning responsibility for carrying out water quality monitoring.
- Rules about what kind of water quality monitoring is needed do not address all the variables that would ensure drinking-water quality is being protected.

Cattle grazing

The Forest Practices Code requires that, when cattle grazing occurs on Crown lands in community watersheds, the activity be managed according to an approved plan. However, the controls that must be included in such a plan do not sufficiently reduce the risk of water-quality threats from parasites.

Mining

The Province has developed controls over the effect of mining activities on water sources (e.g., the new Mineral Exploration Code), but these controls have not been in place long enough for us to determine how well they protect drinking water.

Outdoor recreation

Many watersheds that supply drinking water also provide outdoor recreation opportunities for local residents and visitors. However, water system operators and regulators are concerned that recreation may threaten water quality. Resolution of this important issue is hampered by the near-total absence of information about how much effect recreational activity has on drinking-water quality in British Columbia.

Transportation

Transportation links such as railways and major highways often lie within areas that replenish aquifers. Fuel or chemical spills in these areas, or the cumulative effects of contaminants washed off roadways, can have far-reaching effects on groundwater. Some surface-water sources are at risk as well. More attention should be paid to planning and building transportation routes so that harm to water sources is minimized.

Agriculture

Some groundwater sources in the Fraser Valley and in other areas of concentrated agricultural activity are contaminated by nitrates from agricultural wastes. To deal with this problem, regulations need to be customized to address local conditions, and existing regulations need to be more effectively enforced.

Human settlement

Controls over septic tank systems do not assure that the systems' proper functioning is maintained. Septic tank controls to prevent the release of undesirable nutrients are also weak.

More details on these single-resource management issues are provided in Chapter 3 of this report.

The absence of groundwater management has resulted in increasing problems

British Columbia is unique in Canada in having no licensing or regulation of groundwater use. There is little legal protection of groundwater from "non-point source" pollution, and little control over how much any well draws down its aquifer, or over land uses that interfere with the natural replenishment of aquifers.

In Chapter 4 of this report, we provide more details on groundwater management.

Small water systems are particularly vulnerable to the impacts of inadequate water-source protection

Existing management tools do not deal well with the problems of water sources used by small water systems or single families. These users have less choice of source, and so are more likely to depend on sources affected by competing resource uses. At the same time, existing methods of protection provide them with less assurance of obtaining adequate-quality water. Resolving these issues will require more attention to balancing the needs and responsibilities of small systems with those of other human activities in water-source areas. For more details on small water systems, see Chapter 5 of this report.

overview of recommendations

In Chapters 2 to 5 of this report, where we discuss our audit findings in more detail, we offer a number of recommendations which, for convenience, are listed together in Chapter 6. Our recommendations are focused on the following broad courses of action:

1. ***Ensuring that the Province's efforts towards integrated resource management are effective, by seeing that all integrated land-use management processes affecting drinking-water sources have appropriate representation, information-gathering, and implementation mechanisms.***
2. ***Giving better support to water management processes by designating a lead agency for drinking water, by developing better accountability reporting, and by examining the rights of resource access of drinking-water suppliers.***
3. ***Improving the protection given to drinking-water sources as a result of single-resource management processes for:***
   - ***forestry, by completing the phase-in of the Forest Practice Code's planning requirements, clarifying what water quality monitoring is required and who should do it, and ensuring that sufficient field inspections are being carried out;***
   - ***cattle grazing, by extending the Code's planning requirements to fully address threats from parasites;***
   - ***recreation, by gathering information about the impact of recreation on drinking-water sources, in order to have a good basis for policy;***
   - ***transportation, by paying more attention to the impacts on water sources when planning and building transportation links;***
   - ***agriculture, by refining existing methods of protecting groundwater from agricultural nutrients; and***
   - ***septic tank systems, by refining controls over maintenance, and over nutrient releases.***

4. ***Building an information base for better management of groundwater, through more extensive mapping of aquifers and monitoring of groundwater quality and quantity.***
5. ***Reviewing the responsibilities and needs of small water-system operators.***

chapter 1: a profile of water-source protection in British Columbia: eight case studies

Exhibit 4

The Eight Communities Whose Water-source Protection We Discuss in This Chapter

Source: 1993 British Columbia Economic and Statistical Review

a profile of water-source protection in British Columbia: eight case studies

To better understand the effectiveness of the Province's tools for protecting drinking-water sources, we visited eight communities to examine their water-source protection in detail: Fort St. John, Prince George, Williams Lake, Prince Rupert, Cranbrook, Kelowna, Abbotsford and Nanaimo (Exhibit 4). We chose these communities to capture regional representation, as well as the full range of geographical factors that can affect watershed management. We also wanted communities that would reflect regional differences in administration in two key ministries responsible for drinking-water source protection: the Ministry of Forests and the Ministry of Environment, Lands and Parks.

Our visits revealed that every drinking-water system is unique and that there is no one situation typical of drinking-water sources and users in British Columbia. A 1981 study by Environment Canada estimated that surface water made up 88% of municipal water use in British Columbia. Based on 1997 population estimates and our research, we estimate that in British Columbia municipalities not served by the Vancouver and Victoria regional water systems, surface water is 63% of the total use. Groundwater plays a larger role in rural areas where it represents 40% of water used.

Among the eight cities, we found a range of reliance on both groundwater and various surface-water bodies. We also found a wide variation in the threats to the drinking-water sources as a result of competing interests in the source areas. The human activities that we believe pose the major concerns to drinking water in each city are summarized in Exhibit 5.

Exhibit 5

Major Human Activities of Concern in the Drinking-water Source Areas of the Eight Communities Studied

Activities:	Forestry	Mining	Cattle grazing	Agriculture	Human settlement	Recreation	Transport
Groundwater sources:							
Fort St. John							X
Prince George					X		X
Williams Lake					X		X
Abbotsford				X	X		X
Surface-water sources:							
Fort St. John				X	X		
Prince Rupert							
Cranbrook	X		X			X	X
Kelowna	X		X	X	X	X	X
Nanaimo	X					X	
Abbotsford	X					X	

Source: Compiled by the Office of the Auditor General of British Columbia

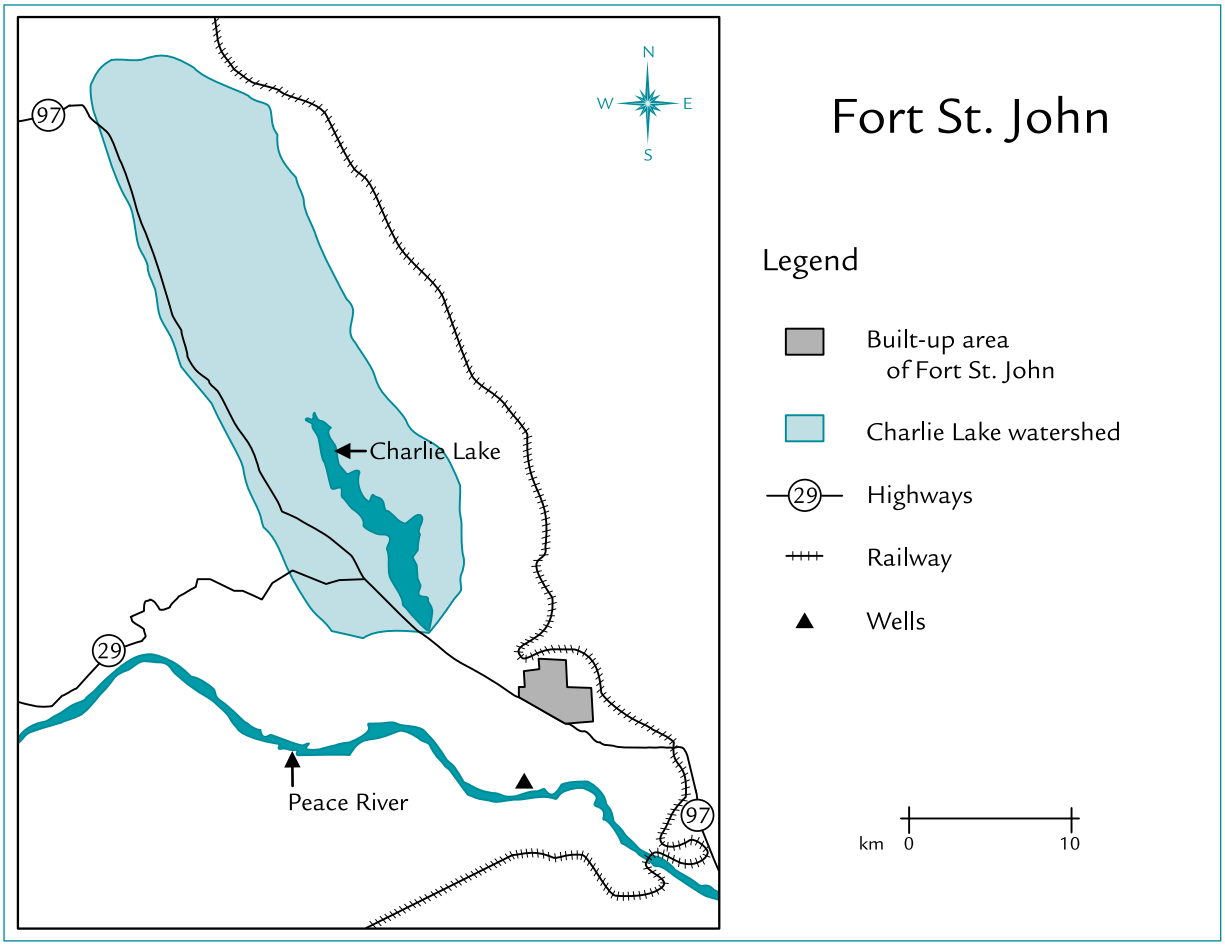
Water shortage, taste and odour problems led to a switch to groundwater in Fort St. John

Fort St. John, a city of 20,000, is fully served by the city-owned water system (Exhibit 6).

Before November 1997, the city took its water from Charlie Lake, a shallow lake about 8 km northwest of the city. The Charlie Lake facility was originally built in 1942 by the U.S. Army as part of the Alaska Highway project. It included treatment by coagulation and straining, followed by filtration through layers of charcoal, sand, aggregate and garnet, and finally disinfection using chlorine.

Because it is shallow, the lake often falls to low levels during periods of drought. In the past, water restrictions were not uncommon. In addition, nutrient levels are high in the lake, partially because of the impacts of agriculture and substandard sewage disposal practices on the surrounding private land in the past. This is associated with blooms of blue-green algae and high levels of fecal coliform bacteria. While the treatment applied was sufficient to remove the coliforms, it did not adequately reduce the green colour and fishy odour imparted by the algae. Reductions in water volume during drought served to magnify these aesthetic problems.

Exhibit 6



Source: Compiled by the Office of the Auditor General of British Columbia

Increasing complaints about colour and odour, together with concerns about volume restrictions, prompted the city to consider alternate sources. In November 1997, the city switched to a system of wells drawing water from approximately 8 m under the Peace River floor. This water is believed to be a combination of groundwater and river water induced through tight layers of granular material which naturally filter out bacteria, parasites and turbidity. Chlorination has been continued to guard against regrowth of bacteria in the distribution system, but at less than half the level required for the Charlie Lake water source. Pressure filtration is also applied to remove iron and manganese for aesthetic reasons.

By making this switch, the city of Fort St. John found an economical solution to the problems it faced with the Charlie Lake source. The initial capital cost of the new groundwater system was less than the estimated cost of upgrading the Charlie Lake system to deal with colour and odour alone. In addition, the new system offers abundant water quantities, reduced need for disinfection and filtration, and less risk from *Cryptosporidium* and *Giardia*.

The water is good in Prince George but wells are at risk from transportation spills

The city-owned system in Prince George serves the entire population of 80,000 and has used groundwater since the 1960s (Exhibit 7).

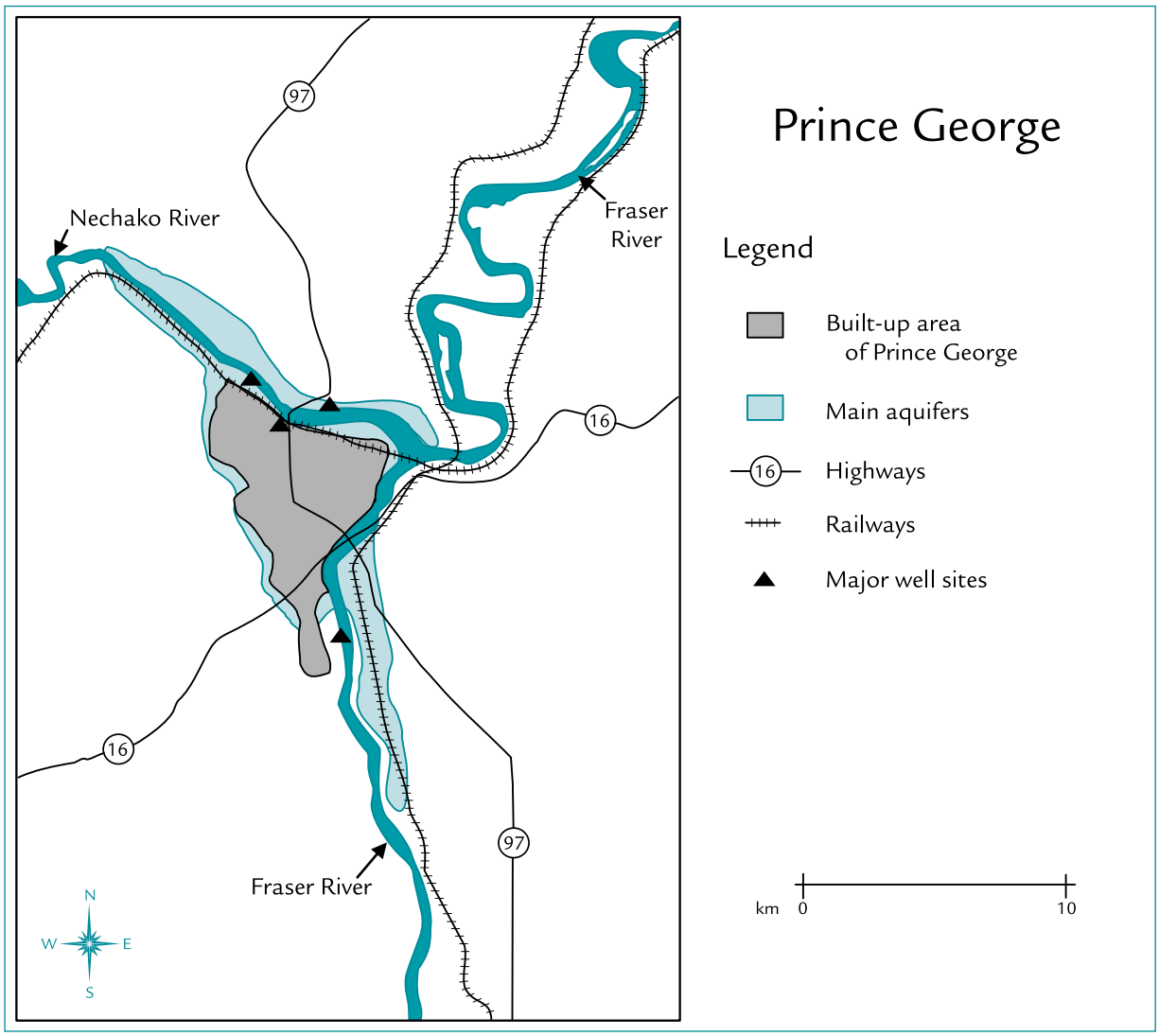
Six moderately shallow aquifers underlie the city and Prince George draws from at least three of these via a number of wells. Eighty percent of the city's water comes from two wells that use structures consisting of two layers of horizontal collectors feeding into a central well shaft.

Although there is no shortage of water, the distribution system lacks enough interconnections to ensure water delivery to all parts of the city should a major well be shut down. Two wells were earlier abandoned, one because of high manganese concentrations and a second because of potential hydrocarbon contamination from fuel leakages on a nearby tank farm. In addition, one well is being closely monitored for contamination as a result of a large fuel truck spill in July 1997. City officials are also concerned about potential fecal contamination from non-sewered housing developments upslope from some of the wells.

Approximately 55% of the city's water originates in the Nechako River and is drawn into the wells through layers of gravel and other substrata. This process filters out most bacteria and appears to be effective against *Cyptosporium* and *Giardia* cysts as well. Prince George drinking water has been used by the Ministry of Health as a zero baseline against which to compare other British Columbia water sources in tests for these parasites.

Two wells downstream from the sewage treatment plant occasionally show low fecal coliform counts in their raw water when river flows are low. At these times, the two wells are used only for back-up. Water from all but one of the city's

Exhibit 7



Source: Compiled by the Office of the Auditor General of British Columbia

wells receives chlorination as protection against seepage of contaminated water into the distribution system. The city tests the water on a regular basis to ensure this protection is adequate.

Until work can be done to map the aquifer recharge zones, the city cannot fully use zoning to protect the groundwater from contamination. Major roads, rail links and industrial yards are located on top of the aquifers close to some of the wells, creating a risk of contamination from spills.

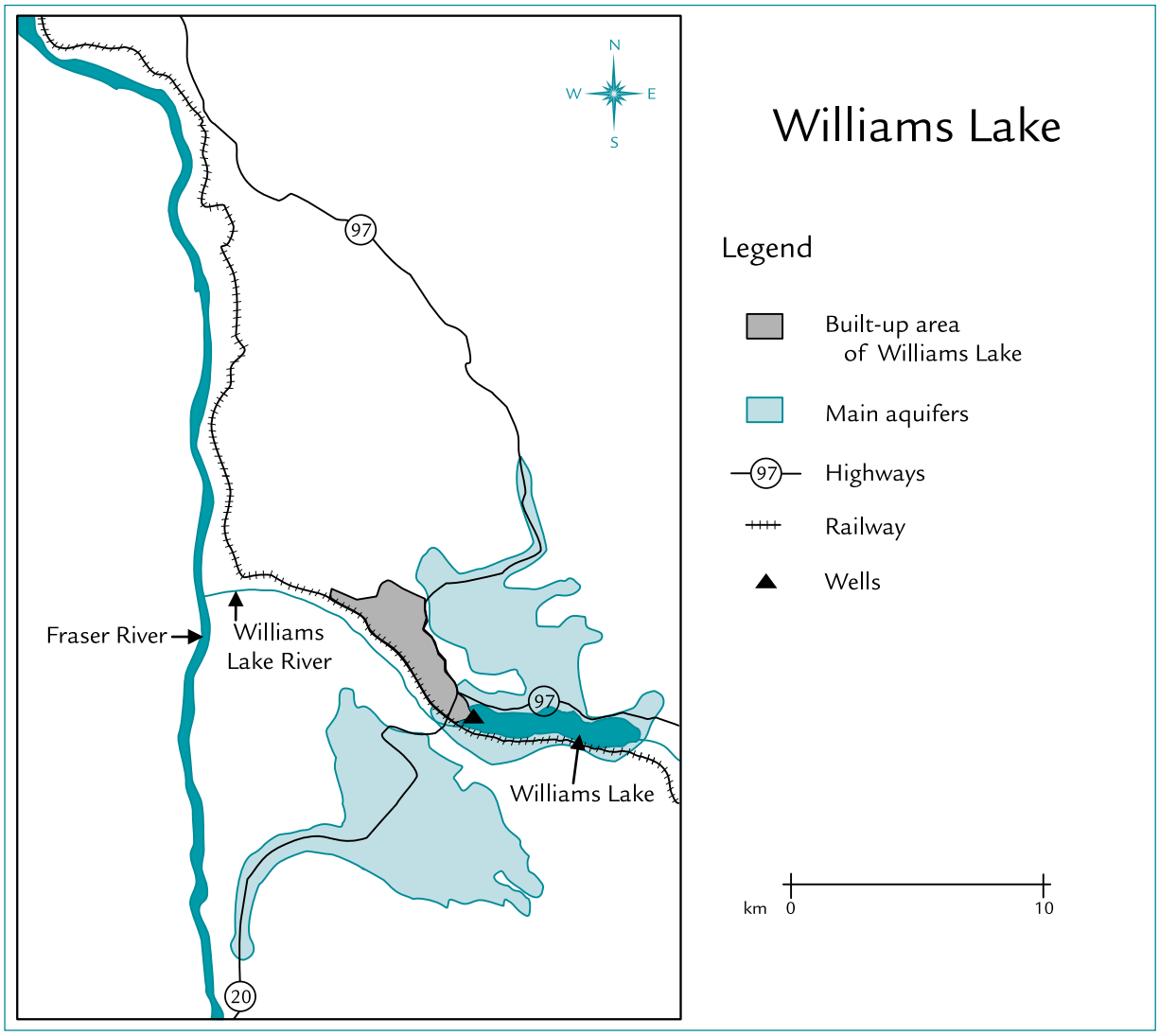
Williams Lake incurs high pumping costs, but supplies good-quality water from its deep groundwater sources

Since the 1970s, Williams Lake, a city of 12,000, has supplied its entire population from groundwater (Exhibit 8). Four deep wells located on Scout Island at the west end of Williams Lake feed into the city distribution system via two transmission mains. Each main is separately treated with chlorine and a modern computer system monitors pumping stations and reservoirs to detect and correct for flow or treatment problems. In addition to its residents, the city supplies water to a wood energy plant and four mills.

The city has experienced no problems related to turbidity, coliform bacteria, *Giardia* or *Cryptosporidium*. The water is hard but the city has no shortage. The system's biggest expense—about half of the total operating cost—is the power required to pump water from the wells to the city, which is located on the slopes above the lake.

A study commissioned by the city in 1991 estimated that the recharge zones for the underground aquifer lie on the sides of the lake and its feeder stream. Non-sewered rural residential developments and trailer parks above this zone on the south side of the lake are a potential contamination threat to the water source. However, plans are underway to incorporate this region into the city and to connect these sites to the city's sewer and water systems. City officials expressed some concern about a major rail line and bulk plants which are situated beside the lake. No spills from these have occurred, but the city intends to develop a contingency plan to deal with this risk of well contamination.

Exhibit 8



Source: Compiled by the Office of the Auditor General of British Columbia

Control over activities in its watershed allows Prince Rupert to maintain high-quality water at low cost

Prince Rupert, a city of 17,000 on the mid-coast, relies solely on surface water (Exhibit 9). The city is on an island but pipes its water from two lakes in a protected watershed on the adjacent mainland. The primary source, Woodworth Lake, supplies the city by gravity feed. A second lake, Shawatlan Lake, from which 80% of the city water used to be pumped, is now solely a back-up source. This switch was enabled by the building of a $5.4 million pipeline in 1995. Prior to this, the city risked having to shut down water to its canneries if it was required to fight a major fire.

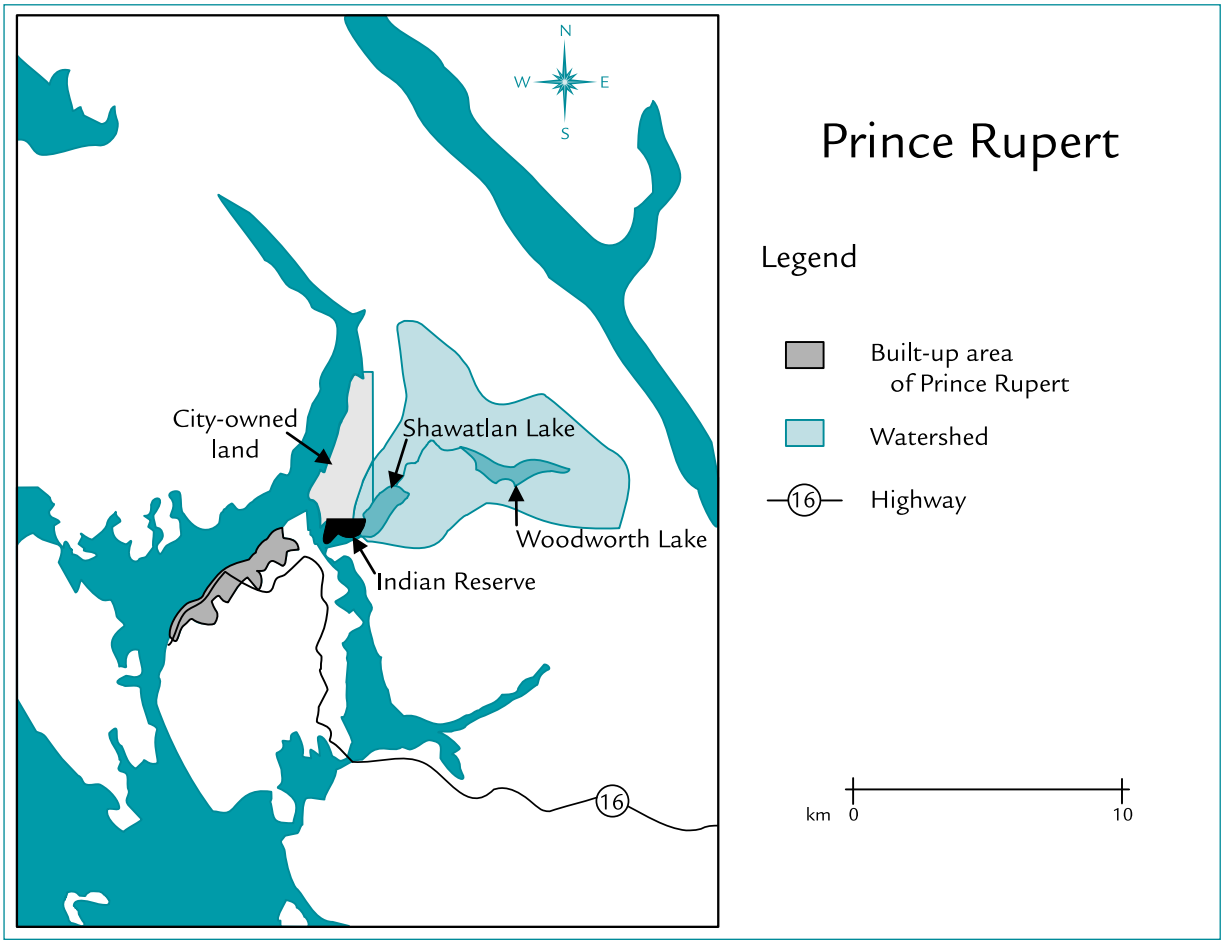
The watershed is Crown land, but it can only be accessed via boat and entry through either city land or the Shoowahtlans Indian Reserve. The single-entrance road is controlled by a locked gate, and signage informs boaters that the area is a "Watershed Reserve." A power-generating plant was in operation until the late 1970s and some fishing and hunting used to be allowed when a caretaker lived at Shawatlan Lake.

Courtesy: H. Daynard

Courtesy: H. Daynard

Access to Prince Rupert's watershed is carefully controlled

Exhibit 9



Source: Compiled by the Office of the Auditor General of British Columbia

The watershed has never been logged and local Ministry of Forests officials consider the environment too sensitive to allow harvesting. In addition, it is designated as a community watershed under the Forest Practices Code.

Testing has not shown evidence of *Cryptosporidium* or *Giardia* in the water. City officials believe there are few wild animals present to introduce these parasites, probably because of the steep sides of the watershed. In addition, stool tests are done to ensure workers who enter the watershed are not carrying the parasites. Tannins in the muskeg around the lakes give the water some colour. However, they also raise its acid content, which makes the city's chlorination more effective against *Giardia* and coliform bacteria. As long as activities continue to be restricted in the watershed, Prince Rupert officials believe there will be little risk to their water source.

In contrast to Prince Rupert, Cranbrook has little control over activities in its watershed

Cranbrook, a city of 19,000, has been drawing its water from the Joseph Creek and Gold Creek watersheds for the past 30 years (Exhibit 10). The water is stored in a reservoir created by a dam on Joseph Creek. Water diverted by pipe from Gold Creek later joins Joseph Creek above this reservoir via an open channel. At the reservoir, the water is chlorinated and then piped by gravity feed a few kilometres to the city's distribution system.

In July 1996, the city had an outbreak of cryptosporidiosis. Swimming pools were closed and restaurants, dentists and other commercial operations had to use bottled water. The cause of the outbreak is still under debate.

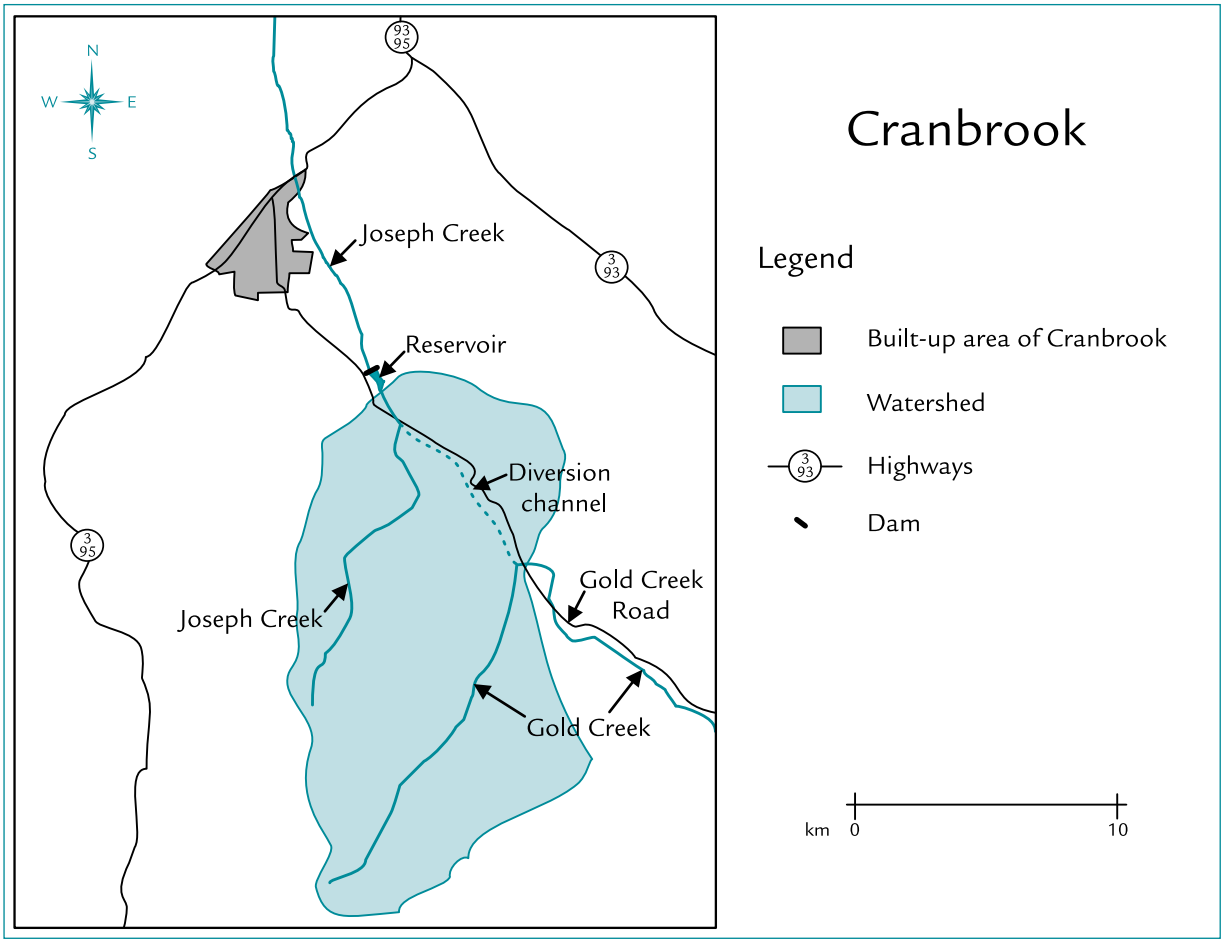
Because Joseph Creek is a multi-use watershed, there are several possible threats to the water source. A public road runs through the watershed close to the reservoir and beside the open diversion channel from Gold Creek. The road serves a logging operation and a few residences in the Gold Creek watershed, but it is primarily used for off-road motorized recreation. To date, the city has been unsuccessful in its efforts to have the road closed to public access. The city plans to replace the open Gold Creek diversion channel with a pipeline.

Much of the watershed is Crown land that is actively logged. The logging company works cooperatively with the city and assists with water-quality monitoring and public awareness campaigns. Grazing also occurs in the watershed on both private and Crown land. City fencing keeps cattle

Courtesy: H. Daynard

Cranbrook's water-storage reservoir is fenced to discourage access from the nearby road

Exhibit 10



Source: Compiled by the Office of the Auditor General of British Columbia

away from the reservoir. In addition, a fence recently constructed by the city and the Ministry of Forests should prevent contamination of Joseph Creek by cattle on Crown land close to the reservoir. Some risk still exists that cattle can get into Joseph Creek near the reservoir by walking down the Gold Creek Road from Crown lands higher up the watershed.

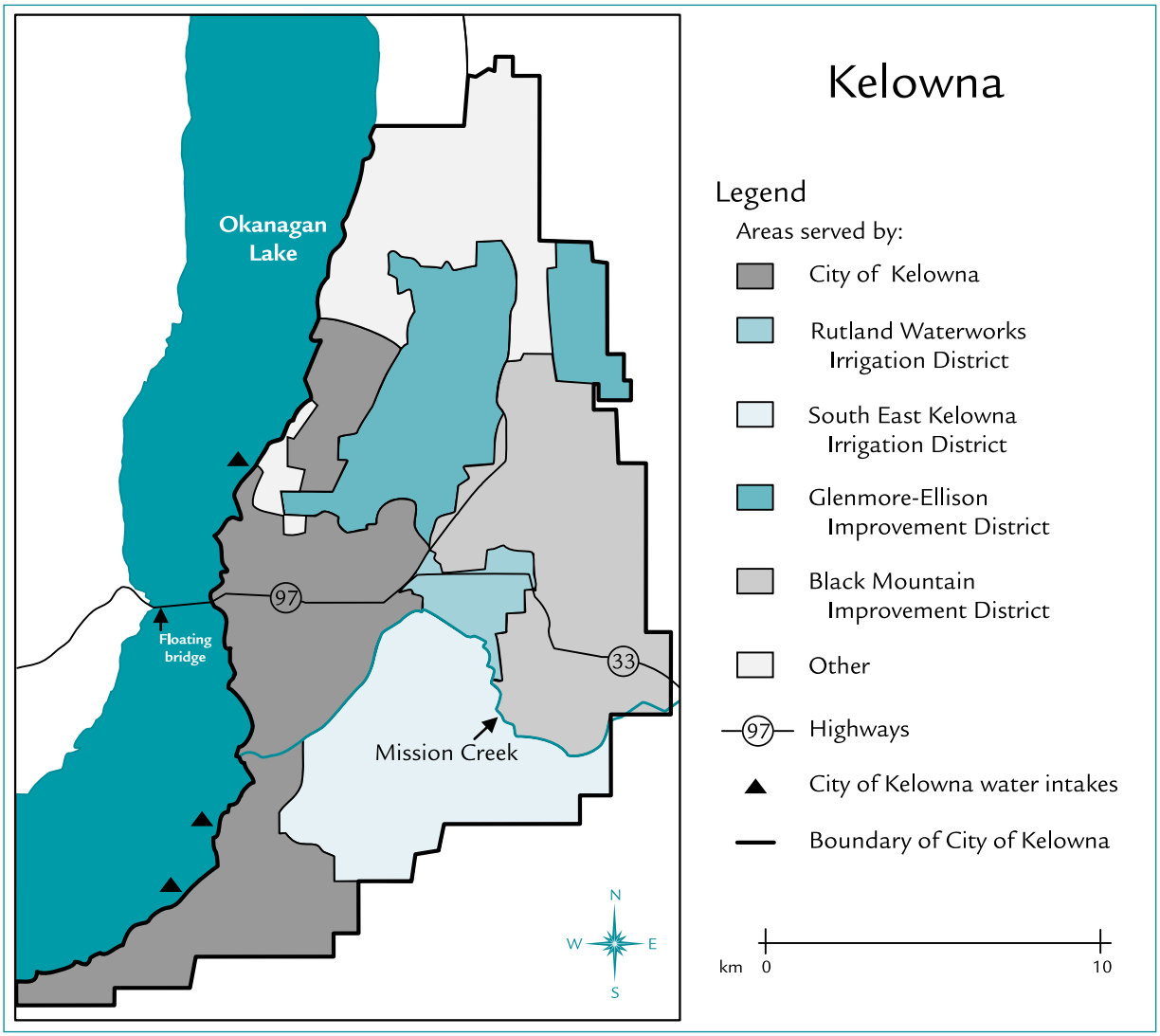
During high runoff periods, turbidity increases in the water source. The city plans to control this problem by creating a bypass to divert water past the city system at these times. Currently, the only treatment for turbidity is the settling action as the water sits in the reservoir. During high turbidity periods, the city uses two downtown wells as an alternative source, but it lacks the pumps and water volume to feed all parts of the city this way.

Kelowna also relies on a watershed over which it has little control

Kelowna, a city of 92,000, is served by five different water systems (Exhibits 11 and 12). The largest of these is the City of Kelowna system, which serves about 50,000 people and gets its water from intakes about 70 feet deep in Okanagan Lake. The other four systems are operated by irrigation or improvement districts.

In 1996, Kelowna had an outbreak of cryptosporidiosis following 100-year record levels for high creek flows. Monitoring by the city indicates that *Cryptosporidium* and *Giardia* increase during heavy rains and spring runoff, and are always present to some extent year-round. Although the

Exhibit 11

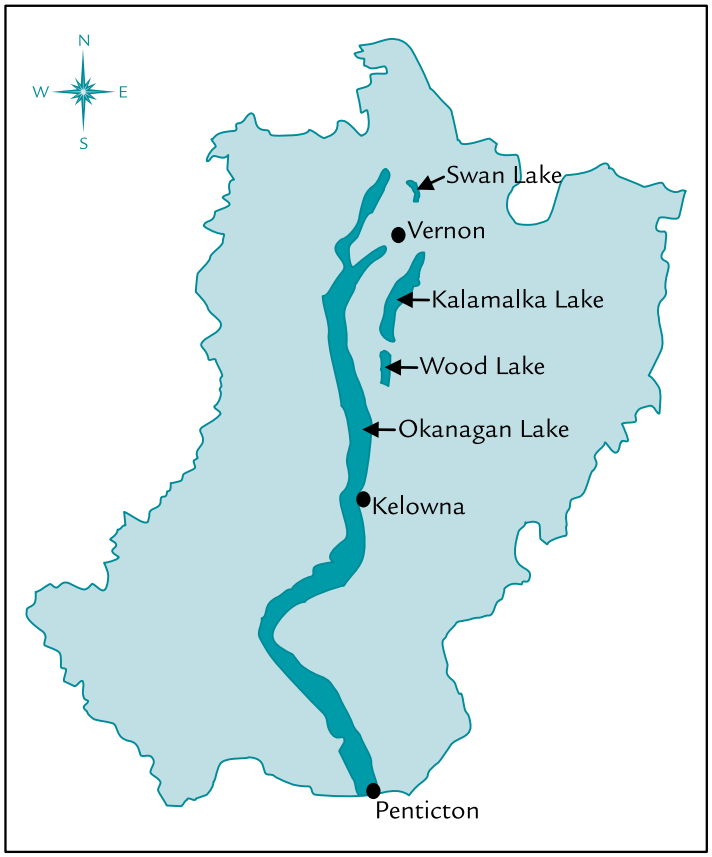


Source: Compiled by the Office of the Auditor General of British Columbia from map prepared by Kelowna Joint Water Committee

source of the pathogen is still uncertain, a study by the BC Centre for Disease Control has suggested that it was likely spread via the City of Kelowna's water system. The city chlorinates at its pump stations, however, the relative closeness of the intakes to the city restricts contact times to a period which may not be sufficient to reduce *Giardia* to an acceptable level.

Given the depth and size of Okanagan Lake, one would not expect widespread severe contamination of the lake water. Nevertheless, the lake and its many feeder watersheds are affected by the full range of human activities: transportation, grazing, logging, agriculture, human settlement and recreation. The 1996 outbreak suggested that the city system is not immune to the potential health impacts of these activities. It also highlighted the shortcomings of not having an alternative water source. Existing interconnections between Kelowna's system and the four other major systems are insufficient to service the whole city if the lake were to become contaminated.

Exhibit 12



Okanagan Lake Watershed

km 0 10 20 30 40 50

Source: Compiled by the Office of the Auditor General of British Columbia from map provided by BC Ministry of Forests, Kamloops Region

City staff recommended spending $44 million on an improved distribution system and an ozone plant to reduce the risk of outbreaks. The community, however, has not yet decided if this is the highest priority for available dollars and a Mayor's Task Force is reviewing the matter. The city is also concerned about water consumption, as a number of Kelowna customers use more water in one month than the average Canadian uses in a year. A metering and awareness project has been launched with the aim of saving $10 million over the next 10 years through a 20% reduction in consumption.

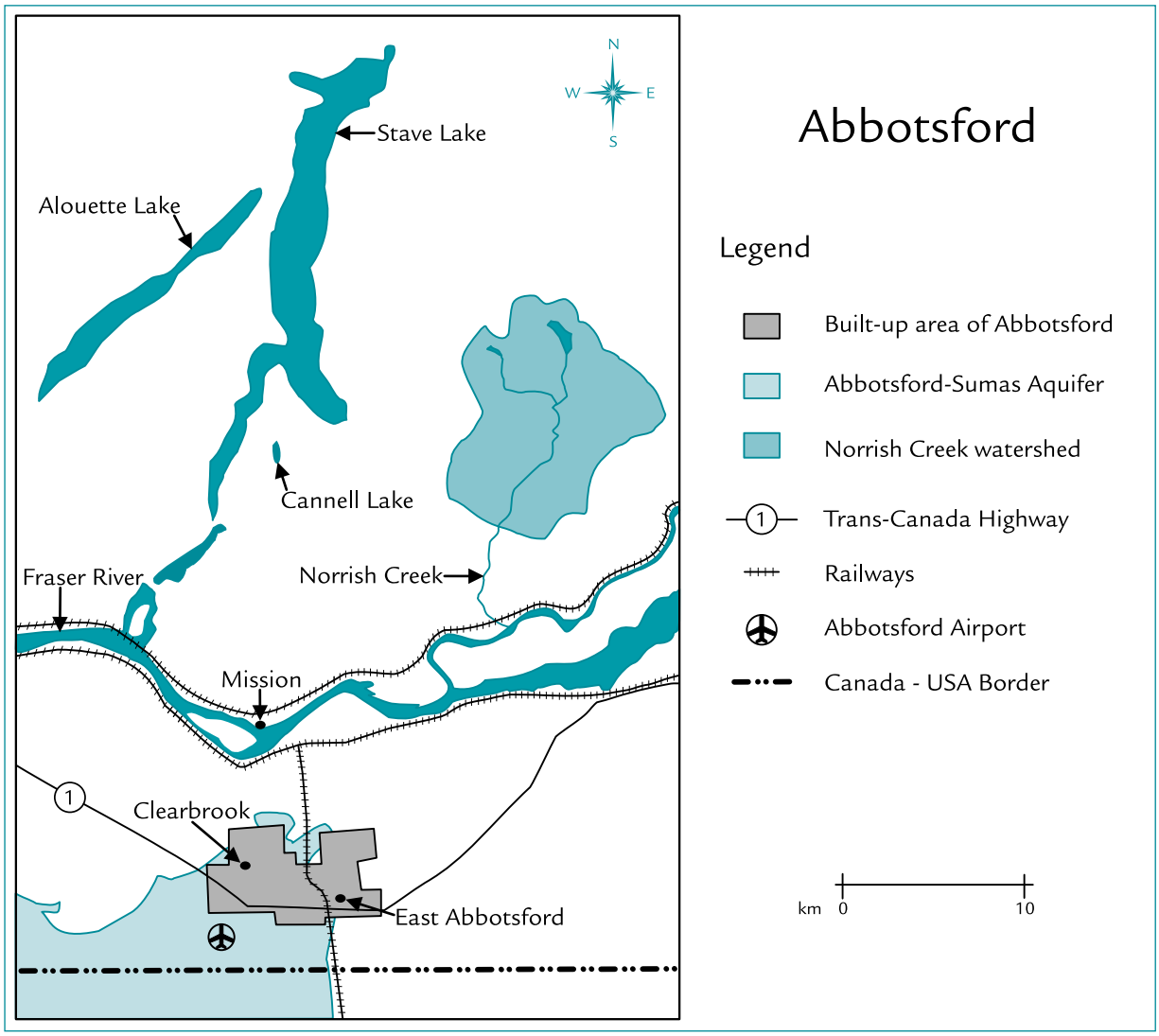
Abbotsford has found that surface water has fewer quantity and quality problems

Abbotsford is a city of 110,000, formed by the amalgamation of the Districts of Abbotsford (East Abbotsford), Matsqui and Clearbrook in 1994 (Exhibit 13). Prior to amalgamation, a portion of the area drew its water from the Abbotsford-Sumas Aquifer, which stretches south from the Fraser River into the State of Washington. Groundwater systems drawing on this aquifer have been retained and serve approximately 40,000 people in East Abbotsford, Clearbrook and part of the former Matsqui area.

The Abbotsford-Sumas Aquifer is unconfined, and thus vulnerable to contamination by surface activities. In recent years, wells drawing on this aquifer have shown elevated levels of nitrate. These are believed to be the result of excess applications of manure and fertilizers on agricultural land, and of poorly-functioning septic tank disposal systems. Two of 11 original Abbotsford wells have been shut down and some private farm wells show nitrate levels well above the generally accepted *Guidelines for Canadian Drinking Water Quality*. In addition, the distribution system for the Abbotsford wells is old and requires frequent flushing of lines to prevent bacterial regrowth. Major highway and rail lines, as well as the Abbotsford Airport, are situated above the aquifer, creating a high risk of contamination by spills. Continued supply is also a concern. Well production has increased significantly in recent years to serve the growing population and city studies estimate that little unused ground-water capacity is left in the aquifer.

The other 70,000 people in Abbotsford are served by surface water drawn from Norrish Creek and supplemented by a second line from the smaller Cannell Lake watershed. The surface water system is owned by the Central Fraser Valley Water Commission and also supplies about 30,000 people in Mission.

Exhibit 13



Source: Compiled by the Office of the Auditor General of British Columbia

The higher elevation of Norrish Creek makes gravity feed possible, thus minimizing pumping costs. However, more treatment is required to combat the higher levels of coliform bacteria in surface water than in groundwater, and the Norrish Creek water is turbid during high flow periods. Continuing the practice used in Mission and Matsqui before amalgamation, the new Abbotsford system uses chloramine as its disinfectant. Chloramine is more effective than chlorine against bacterial regrowth in distribution pipes. It also has less taste and odour and is cheaper to use. However, chloramine persists longer in the environment than chlorine and this presents an increased hazard to fish, should treated water escape into local creeks.

Fisheries authorities are concerned about this danger. They are also concerned about the health of Norrish Creek as a fish habitat, and from time to time they require the water commission to release water from its Dickson Reservoir to maintain creek flows.

The long history of logging activity in the Norrish Creek watershed has been linked by some to landslides and turbidity. In recognition of the instability of the watershed and the vulnerability of the water source, an integrated watershed management plan was completed for Norrish Creek in 1987, and has proved useful in the multi-resource management of the watershed. The use of forest roads by recreationists seeking access for unregulated camping and water sport continues to be a concern of the city as well as of Ministry of Environment and local health officials. Gating has had limited success because of vandalism and the logging company's frequent use of the roads.

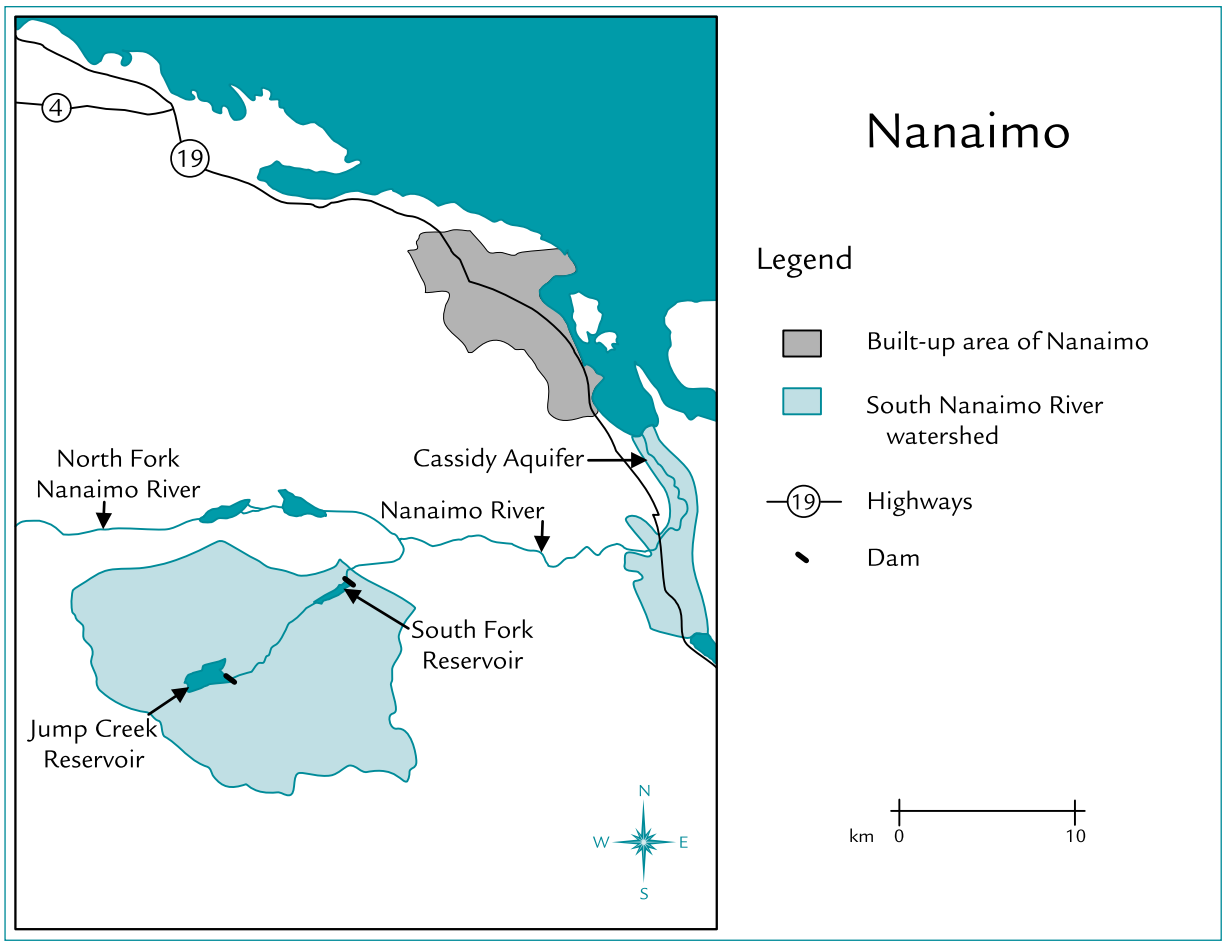
By 2035, the population served by the Central Fraser Valley Water Commission is expected to reach a minimum of 275,000. In anticipation of this growth, the commission has developed a plan to meet the drinking-water supply needs. The plan proposes the installation of slow sand filtration by 2005 to remove the turbidity that currently limits the use of Norrish Creek water during high runoff periods. In addition, the plan calls for linking the east part of the city into the Norrish supply, and leaving the wells for back-up use only. By approximately 2015, the commission plans to have begun piping water from Harrison River—at least 20 km from the Norrish Creek main—to take advantage of gravity feed, low turbidity and an abundant supply.

Nanaimo's watershed is managed cooperatively by the drinking-water supplier and the landowner

Nanaimo, a city of 75,000, is supplied by the Greater Nanaimo Water District, with water from the south fork of the Nanaimo River (Exhibit 14). Water is piped from the lower of two dams on the river and chlorinated before entering the city limits.

Virtually the whole of the Nanaimo River watershed is privately owned forest land, and most of the south fork is actively harvested. The watershed is jointly managed, under agreement, by the city and the logging company. The company manages access and patrols the creeks for silt and blockages. Water quality is jointly monitored. Turbidity levels occasionally rise above the *Guidelines for Canadian Drinking Water Quality,*

Exhibit 14



Source: Compiled by the Office of the Auditor General of British Columbia

but monthly testing has not shown a significant risk from coliform bacteria, *Giardia* or *Cryptosporidium*. At the confluence of the river's two forks, the logging company maintains a gate and caretaker to control access to its logging camp. In addition, the city has gated access to the south fork and, with the help of the company and the fish and game club, restricts entry to people who have purchased an access licence. Purchasers must first watch a video on the importance of protecting the watershed, and are issued a booklet outlining rules to be followed.

Flows in the Nanaimo River are naturally low in the late summer and early fall. Three reservoirs, two built by the Water District on the south fork and the third by the logging company on the north fork, help to ensure the necessary supplies for city and industrial users. They have also been

used at times as a source of water to augment low flows during fall salmon spawning. Flows in the lower reaches are also affected by removal of groundwater from the Cassidy Aquifer, south of Nanaimo, for domestic, irrigation, community and industrial purposes. This combination of natural variation in river flow, withdrawals from the river and withdrawals from the nearby aquifer results in low flows and elevated water temperatures during some periods. These conditions are thought to be limiting fish migration. Population growth projections suggest that the Nanaimo area population will rise 25% by 2016. These needs and the required fisheries flows cannot be met without the construction of additional storage facilities.

Lessons learned

Although the available quantity and the quality of drinking water were generally good in all of our eight case studies, we found that officials in most of the communities had concerns about the potential impacts of human activities in their water-source areas. The high water quality provided in these communities was not simply due to the quality of the source water—it was also a result of considerable effort by the communities to deal with the impacts of other activities in their water-source areas. In most cases, large expenditures to ensure adequate quantities of safe drinking water for community use had been incurred or were being contemplated. In general, the water-system operators felt their ability to provide safe water for their users would be enhanced by processes that balanced the needs of all activities in their water source area. Some communities—for example Cranbrook and Kelowna—had initiated stakeholder forums to try to achieve this balance.

In our study, we also found that many small water systems have more serious concerns than these eight larger systems. These concerns were brought on, in many cases, by competing resource uses in the water-source areas. (The issues around drinking-water source protection for small systems are discussed in Chapter 5.)

Our findings about the issues affecting drinking-water systems of all sizes have led us to conclude that appropriate drinking-water source protection is not possible without an effective integrated resource management process. In the next chapter, we discuss the need for such a process and the role of government to ensure it works.

chapter 2: water-source management in British Columbia is not integrated

water-source management in British Columbia is not integrated

Water sources need integrated management

Many drinking-water systems in British Columbia obtain their water from lands shared with other resource users. For example, Cranbrook's watershed also supports forestry, cattle grazing, recreational and transport use. Managing each resource use in isolation is unlikely to achieve results that are sustainable or that leave all resource interests appropriately accommodated. Many jurisdictions have concluded that management of competing resource demands must be integrated, not piecemeal. Here in British Columbia, integrated management has received support in several government policy statements, and the concept underlies a number of the Province's land and resource planning initiatives.

Much of British Columbia's current management of drinking-water sources is ad hoc rather than integrated

The easiest way to understand the complexity of water-source management is to trace the path of a raindrop from the point at which it first strikes the ground in a watershed until it enters a drinking-water supplier's treatment system. As it passes through the watershed, the drop of water can become purified by, or contaminated by, a range of natural processes. It can also be contaminated by a number of human activities if they are not carried out properly. These activities include logging, cattle grazing, mining, outdoor recreation, transportation, human settlement and agriculture. Some of these are unregulated; others fall primarily under the control of one or more of half a dozen government ministries or agencies (Exhibit 15).

On public land, forestry and cattle grazing are controlled under the Forest Practices Code, administered by the Ministry of Forests (Forests), in conjunction with the Ministry of Environment, Lands and Parks (Environment). On private land, grazing and use of pesticides for forestry are the responsibility of Environment, as are waste discharges from other agricultural activities.

Exhibit 15

Government Agencies with Primary Responsibility for Management of Potential Threats to Drinking Water

Activities of potential concern	Potential threats to drinking water		
	Sediment and turbidity	Bacteria and parasites	Chemicals and nutrients
	Primary responsibility for regulation		
Forestry: public land	Forests/Environment	No significant threat	Forests/Environment
Forestry: private land	No significant regulation	No significant threat	Environment
Grazing: public land	Forests/Environment	Forests/Environment	Forests/Environment
Grazing: private land	Environment	Environment	Environment
Agriculture	Environment	Environment	Environment
Mining	Mines/Environment/ Environmental Assessment Office	No significant threat	Mines/Environment/ Environmental Assessment Office
Outdoor recreation (outside parks)	No significant regulation	No significant regulation	No significant regulation
Sewage disposal	No significant threat	Environment/Health	Environment/Health
Transportation	Highways	No significant threat	Environment

Source: Compiled by the Office of the Auditor General of British Columbia

Mining is regulated primarily by the Ministry of Energy and Mines (Mines) and by Environment. As well, the Environmental Assessment Office coordinates required assessments of large development projects, including certain proposed mines.

Outdoor recreation, outside of that in parks, is almost unregulated, although Forests, Environment, and the Ministry of Health (Health) each have some authority over specific aspects of it.

Responsibility for regulating human settlement is scattered. Sewage disposal, for example, is the responsibility of both Environment, for large sewage treatment plants, and Health, for smaller systems with total sewage flows less than 22.7 m^3 a day, including septic tank systems.

The complex stew of chemicals and sediment washing off existing roads is essentially unregulated, although the Ministry of Transportation and Highways (Highways) works to ensure that its new roads minimize this threat to water quality. Point-source discharges of pollutants and cleanup of large spills are regulated by Environment.

To divert water into its water system, a drinking-water supplier, like any other industrial water user, must have a licence from Environment. However, this is only true if surface water is being diverted. Normally, there are no government controls over the use of groundwater sources. (Environment does gather information about groundwater sources and uses, and an environmental assessment, coordinated by the Environmental Assessment Office, is required for proposals to withdraw large quantities of groundwater).

Once a drop of water enters a water treatment and distribution system, it is under the jurisdiction of Health —and also outside the scope of our audit.

In short, in British Columbia there are a number of government ministries and agencies with some responsibility for activities that can affect drinking-water sources. Sometimes these responsibilities overlap. In several important areas no government body has responsibility. None of these agencies has a lead role—a primary responsibility for protection of drinking-water sources. This patchwork of responsibility is, we believe, one reason that the Province has so far been unable to achieve integrated management of drinking-water sources.

Several approaches to integrated land-use management have been used in recent years

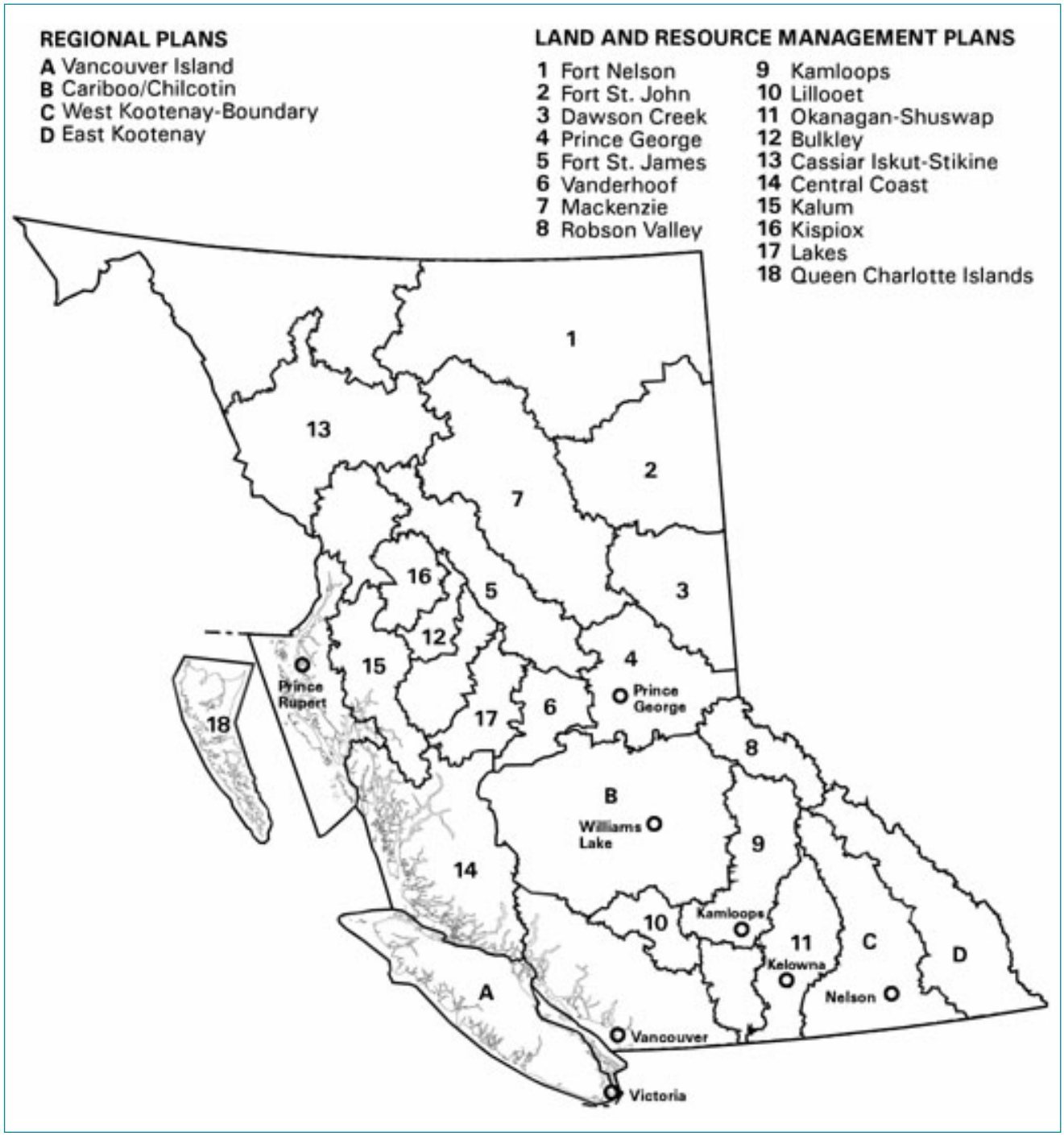
Over the years, the Province has put considerable effort and attention into the integrated management of land use on Crown lands. Methods have ranged from large regional processes covering many millions of hectares, to local processes looking at single watersheds.

We examined several recent uses of integrated management processes to see what could be learned from them about effective management of drinking-water sources. We focused our attention on three major processes: plans produced through the Commission on Resources and Environment (CORE), and land and resource management plans; integrated watershed management plans; and community watershed round tables. (We also gathered information on other processes, such as growth management strategies.)

These processes have required considerable investments of time, effort and money by provincial and local governments, the private sector and citizens. For example, the Cariboo-Chilcotin CORE plan involved 24 sectors, or interest constituencies, each of which had two representatives, in 62 days of discussion and negotiation. Ministries made equally significant efforts in

Exhibit 16

Strategic Land-use Plans in British Columbia



Source: BC Land Use Coordination Office

CORE plans and land and resource management plans: These are strategic plans, looking at large regions or sub-regions of the province. CORE was set up by the provincial government in 1992 to develop a province-wide strategy for land use. The commission coordinated the development of land use plans in the Cariboo-Chilcotin, Kootenay-Boundary and Vancouver Island regions. After CORE was disbanded, the Province began 18 land and resource management plans in regions not covered by CORE plans (see Exhibit 16). Some of these plans are complete, others are in progress.

Integrated watershed management plans: These local plans are of particular interest from the drinking-water point of view, because they address management issues within single watersheds. They were begun before the Forest Practices Code was enacted, by joint effort of government ministries and local stakeholders, as a way to manage watersheds that supply drinking water to communities. Originally, 60 watersheds in the province were identified as needing planning, but only 8 plans have been completed.

Community watershed round tables: These, too, are local processes for addressing management issues in single watersheds. They are set up under the Forest Practices Code. The Code's *Community Watershed Guidebook* recommends that a roundtable of stakeholders be set up to advise on forestry decisions affecting a community watershed. Part of a roundtable's suggested responsibility is to consider scientific information on watershed conditions that must be gathered before logging or forest road building are allowed.

supporting the negotiating table with inventory information, maps and documents. Local integration processes have similarly depended on large time commitments by local constituencies and government employees. For example, the integrated watershed management plan for Chapman and Gray creeks in the Sunshine Coast has been underway since 1990, and involves representatives of four provincial ministries, one federal department, two forest companies, a regional district and a First Nations government.

An important constraint on the effectiveness of most of these integrated management processes (but one that is outside the scope of our audit) is that, by policy, they only address the management of Crown lands. Thus, they are more relevant for water sources such as Cranbrook's, where land in the watershed is mainly Crown-owned, than for Nanaimo's, where it is privately owned.

We examined integrated processes from the perspective of whether they gave appropriate consideration to protection of drinking-water sources. We concluded that no integrated processes used to date in British Columbia have been fully successful in achieving this. Each, we found, lacked one or more elements that are preconditions for success.

To date, integrated land-use management processes have not had all three essential elements: representation, information and implementation

We concluded that integrated management processes are unlikely to deal cost-effectively with drinking-water use as well as with other competing resource uses unless:

- drinking-water interests are represented on an equal footing with other interests (representation);
- decisions are grounded in appropriate information on the values and impacts of each resource interest and on natural conditions in the water source area (information); and
- there are mechanisms for translating findings of these processes into action (implementation).

Drinking-water interests have had appropriate representation in local plans, but not strategic plans

Government policy calls for full participation of affected groups in land-use decisions. Drinking-water consumers would certainly qualify, but it may sometimes be difficult to identify representatives of such a widespread interest. In looking at existing land-use processes, we assumed that in many cases water suppliers could reasonably represent the consumers' interest. Indeed, we did find this method of representation in use at the local level, where drinking-water suppliers are key players in integrated watershed management plans and watershed round tables.

Representation has been less clear in strategic planning processes. The Kootenay-Boundary land-use plan had watershed representatives at the negotiating table, and its report included recommendations on drinking-water issues. The Okanagan land and resource management planning process has representatives whose special interest is drinking-water sources. Other planning processes, however, have given less attention to drinking water. Several have included representatives of local governments (which are sometimes also water suppliers), but local governments have a number of areas of interest, not just water supply. Based on our review of completed resource plans, and of studies of the way these plans were developed, we concluded that most planning processes focused their efforts on other issues of importance to local governments, such as local economic development, rather than on water-source issues.

Information on competing needs and values in watersheds has been incomplete

To support the balancing of interests and values in a watershed and enable informed decision-making by stakeholders, two kinds of information are required: information on natural watershed functioning, and information on resource uses in the watershed.

Because the natural processes to be managed in a watershed are so complex and natural conditions so variable, it is generally accepted that good resource management calls for good information on the watershed. For example, a recent government document advising municipalities on watershed management recommends that decisions be based on "strong science and good data." The plans we examined have all, to varying degrees, avowed this precept, although we were not able to determine the extent to which they were able to act on it. However, land and resource management plans, and probably the other planning processes discussed here, rely heavily on available information. Our discussion of the management of specific resource uses in Chapter 3 of this report highlights a number of significant areas for which information is not available.

Also, we found that these planning processes were not consistently gathering and considering information about the values and impacts of the competing resource uses in watersheds. This information is not always easy to gather and apply because some values—biological, aesthetic and spiritual—cannot be reduced to dollars. Nevertheless, useful comparisons of the economic value related to various resources can be obtained by looking at measures beyond the market price of traditional resources. For example:

- The cost difference for a municipality between protecting its local water source and adding extra treatment to compensate for declining source quality is a measure of the value of that source.
- The difference in price between two otherwise-similar rural homes, one with a good-quality water source and one without, is a measure of the value of that source.
- The costs resulting from an outbreak of water-borne illness are a measure of the value of avoiding the outbreak through, among other things, having a good-quality water source. (For example: costs to the Province for extra doctor visits, increased private spending at pharmacies, cost to employers to replace absent employees, lost business for the tourism industry.)

- The amount that Forest Renewal BC has to spend to restore a stream damaged by past logging practices is a measure of the value of preventing that damage in the first place, and can be weighed against the economic return from those logging practices.

Similar approaches can be used to evaluate other watershed resources, either as an adjunct to market values or as a substitute for them (for example, in valuing outdoor recreation, where market information is scarce).

Expressing resource values in economic terms can provide the groundwork for trade-offs between different resource users. For example, a municipality might want to buy the rights and assets of a resource user operating in its watershed, rather than spend more money on water treatment to correct problems created by the resource use. Doing so also heightens user awareness of the true value of a resource—a factor cited as critical to protecting water quality.

The integrated management processes we examined have not made full use of economic valuation techniques:

- CORE plans gathered significant information on the economic importance of forestry, but little on the value of, for example, tourism. The economic analyses in support of land and resource management plans are similar to those for CORE plans.
- Integrated watershed management plans varied in their approach to information gathering, but we are not aware of any that carried out this kind of economic analysis.
- Watershed round tables appear to be constrained from carrying out economic analyses, since their mandate is limited to advising on how logging can be carried out so as to reduce the risk to drinking-water sources. They are not asked to consider, for example, whether the relative values of the timber and drinking-water assets in a watershed argue for or against harvesting there.

This shortage of information on the relative values of drinking-water sources and other watershed uses in British Columbia has meant that we are unable to provide any value comparisons in this report.

Mechanisms for acting on the findings of integrated resource management processes are weak

The processes we examined are all advisory: none gives its participants the authority to act on their conclusions and recommendations. Implementation depends on making a "hand-off" to a person or agency with authority to act. This

hand-off can be the most critical step in the planning process, because plans may call for changes in the existing rights of some users of the watershed, for the greater good. Only the Province has the authority to change rights or compensate for losses. (It may also be in the best position to broker trade-offs.)

CORE plans and completed land and resource management plans have had such a hand-off. Once Cabinet approves a plan's recommendations, officials are assigned responsibility for implementation. Integrated watershed management plans, however, do not have an implementation mechanism, other than perhaps through unanimous agreement of all stakeholders. Watershed round tables give their advice to Ministry of Forests district managers, so these processes do have a link to an empowered official. However, the link is only partial. That official has jurisdiction over logging, road building or cattle grazing in the watershed, but cannot act on advice from the roundtable on activities not governed by the Forest Practices Code, such as mining.

We recommend that the Province ensure that in integrated management processes dealing with drinking-water issues:

- ***drinking-water consumers and suppliers are meaningfully represented;***
- ***decisions are grounded in sufficient reliable information about natural conditions in the watershed and the values and impacts of competing resource uses; and***
- ***findings and recommendations are handed off to elected or appointed officials with the authority to act on them.***

Administrative support for the integrated management of drinking water should be improved

In addition to using a well-designed process for balancing the interests of all users in resource management, government should ensure that its administrative structures and tools support the process effectively. We noted four areas needing improvement.

Government needs to designate a lead agency to represent drinking-water interests

Stakeholders in integrated planning processes often have two avenues for making sure that their interests are considered. One is being directly part of the process, as we discussed above. The other is having a government agency, one focused on the special conditions and interests of the stakeholder, involved in the process. For example, in all major integrated management processes in the province to date there has been participation

by Ministry of Forests staff, who are knowledgeable about concerns of the forestry sector.

To be on the same footing as other major resource users, we concluded, drinking-water users and suppliers need a designated lead agency in government, one focused on their particular concerns. Such an agency could be of great practical value. Integrated management processes involve extensive meetings, often at night or on weekends, making it difficult for interest representatives to attend. Government staff from a lead agency could give continuity and representation when water system representatives and other stakeholders are not able to be present, and in some cases might also contribute experience and technical knowledge that stakeholders do not have.

Another advantage of having a lead agency for drinking water involved in the integrated management process is that it could simplify translating the recommendations from the process into government activity. Lead agency staff would know the context and detail behind the recommendations, so would be well placed to convert them into practice.

Other government activities would also benefit from the existence of a lead agency. Such an agency could coordinate the development of drinking-water policy and legislation and the collection of supporting information (such as information on how outdoor recreation affects drinking-water sources; see section 3.4). In addition, it could ensure representation of drinking-water users and suppliers in processes such as the planned review of the new Mineral Exploration Code.

Finally, a lead agency could take a useful role in resolving ambiguities over responsibility. An example of where such resolution would be useful is the confusion over who is responsible for monitoring water quality during logging operations (discussed in section 3.1).

As we indicated earlier in this chapter, no single government agency focuses primarily on drinking-water issues and concerns. However, several agencies currently look at particular aspects. Therefore, our suggestion is not that a lead agency be added to the list of government activities, but rather that existing responsibilities, now distributed over several ministries, be realigned to focus more clearly on drinking-water issues.

We recommend that the Province designate within government a lead agency for drinking-water interests, to coordinate government policy and action on drinking-water issues.

Accountability reporting on drinking-water sources needs improvement

In our view, a lead agency could also help improve accountability reporting on drinking-water sources, by taking responsibility for giving legislators a regular overview of the state of drinking-water sources in the province. Currently, little or no information of this type is being reported.

We found that accountability reporting to the Legislative Assembly and the public on drinking-water sources is weak in BC.

To meet the needs of legislators, accountability reporting should summarize the overall condition of provincial drinking-water sources; and to meet the needs of water consumers, it should detail the level of protection given to local sources. Reports should include the Province's goals for source protection, the processes it has put in place to reach those goals, and the resulting quality of water at the point of entry to a drinking-water supply system. Guidelines for water quality should also be reported (see below), so that information can be understood in context.

We suggest that the Province work with local drinking-water suppliers to ensure information is gathered and reported cost-effectively. Many larger water suppliers already monitor the quality of water as it enters their treatment system. The

What Is Accountability Reporting?

Accountability—the obligation to account for responsibilities conferred—is fundamental to democracy. It is the right of citizens to know what government intends to achieve and how well it has met its intentions. In British Columbia, the provincial government is accountable to the Legislative Assembly for the way in which it manages the power and resources entrusted to it. In turn, the Legislative Assembly, on behalf of citizens, is responsible for ensuring that accountability takes place.

Accountability reporting should be:

- relevant—deal with matters of interest to the Legislative Assembly
- complete—deal with all significant aspects of the subject
- meaningful—present context, and be understandable
- fair—in tone and balance
- timely—in time to be of value in performance assessment and decision-making
- accessible—in a medium that is readily usable
- consistent—reported in the same manner over time
- verifiable—capable of independent checking or auditing

Depending on the needs of the Legislative Assembly and other information users, different kinds of information may be required quarterly, annually or periodically.

Province could make use of this information, and focus its own information-collecting in watersheds where there are no large suppliers.

For local or regional reporting, the Province and suppliers could give a combined report. In it, the Province could describe what it has done to protect the water source, and the drinking-water supplier could describe how, using that source, it has provided high-quality tap water to its customers. Regular local reporting like this could play an important role in educating the public about the importance to them of their water source and the need to protect it.

We recommend that the Province report annually, at both provincial and local levels, on its protection of drinking-water sources.

Comprehensive water-quality guidelines would aid accountability

Citizens and legislators need benchmarks for what constitutes good source water for drinking purposes in order to get full value from accountability reporting. For example, it would be useful for them to know maximum desirable levels for problem constituents of water such as parasite cysts, dissolved nitrates and turbidity.

We suggest that such benchmarks or guidelines state expectations for water delivered to the consumer (tap water) rather than for water quality within a watershed or aquifer, for three practical reasons:

First, the Province already has a mechanism for setting standards or guidelines for tap water, through the Health Act. It also has useful sources of appropriate guidelines, including the *Guidelines for Canadian Drinking Water Quality* developed by the federal and provincial governments (including British Columbia) and similar U.S. government documents.

Second, by focusing on the result desired rather than on the inputs used to achieve that result, the Province gives drinking-water suppliers the freedom to choose the treatment methods most appropriate to their particular water source.

Third, comprehensive tap-water guidelines would better address the needs of tourists and business travellers. The eight larger water systems we focused on endeavour to meet the *Guidelines for Canadian Drinking Water Quality.* However, we also learned of smaller communities who choose to meet only the provincial coliform standard. (While the guidelines address several dozen chemical, physical and biological threats to drinking-water quality, only one guideline has a corresponding

mandatory requirement in BC: the level of total and fecal coliform bacteria, an indicator of the risk of contamination by disease-causing bacteria.) Such choices may reflect the cost implications of achieving higher standards, or they may reflect the views of long-time residents who have developed immunity to local microbes and see no advantage to spending more money on the water system. The problem with the latter is that visitors have no say in local decisions and may lack the local immunities. Water-borne disease outbreaks have occurred during the tourist season in major centres such as Penticton and Kelowna. These incidents, were they to happen more often, could do long-term damage to British Columbia's tourism industry. Information on whether local water supplies meet provincial guidelines would allow visitors to make an informed judgment about whether to drink from them.

We recommend that the Province issue a comprehensive set of guidelines for good drinking water, so that decision-makers and citizens can better understand the information they receive about drinking-water quality.

The rights of drinking-water suppliers to access the resource may lack some protections afforded to other resource licensees

Choosing a public drinking-water source is a major decision. Because of the capital works required to make use of a water source (e.g., sinking large wells, or running a pipeline to a mountain lake), suppliers normally rely on a source for long periods. Only one of the eight cities we focused on has changed its main water source in the last 20 years. Prince Rupert has used the same watershed for over 80 years.

Provincial regulatory tools, however, do not appear to reflect the long-term nature of drinking-water suppliers' needs. A water supplier, through licensing under the Water Act, obtains the right to a proportionate share of available water volume. However, this licensing is not designed to protect the quality of the water against human-caused damage over the long term during which the supplier will depend on that source. In contrast, other resource users have more broadly-based rights of resource access appropriate to their long-term needs, through such instruments as tree farm licences.

We recommend that the Province carry out a comprehensive evaluation of the rights of resource access of drinking-water suppliers, to determine if they are appropriate.

Such an evaluation might appropriately also include a review of related fees.

By analogy with the forms of tenure now used in British Columbia for other resource uses, we suggest that such an evaluation of rights might address some or all of the following elements:

- giving licensees rights to the resource and what sustains it, but no more (for example, timber tenures are concerned with trees and the soil that sustains them, but do not include mineral rights);
- making the licence term proportional to the time required to obtain a reasonable return on the investment required of the resource user (for example, tree farm licences last longer than grazing permits);
- requiring licensees to use the resource prudently and, where possible, sustainably (many of the provisions of the Forest Practices Code, for example, require that timber harvesting be prudent and sustainable); and
- having licensed resource users take on certain responsibilities for resource protection (for example, timber tenure-holders have specific responsibilities for fire prevention and fire-fighting).

Appropriately-defined rights could help address the problem of financial responsibility that drinking-water suppliers face. The Health Act holds a water supplier responsible for providing safe water to its customers. Even if its source has been contaminated by the activities of another party, the water supplier must carry out, and pay for, any steps required to render the tap water safe. These steps might include providing emergency water treatment, trucking in safe water from elsewhere, or even finding a new water source.

The Waste Management Act and other legislation requires those who cause contamination to correct the damage they have caused to the environment. (For example, the trucking company responsible for the fuel oil spill in Prince George—discussed in section 3.5—must clean up the spill and prevent it from spreading into the groundwater.) However, there is no requirement for those who cause contamination to compensate the water supplier for the costs they incurred as a result of the contamination. The water supplier's only recourse is a civil lawsuit, which we understand is uncommon. Carefully-defined statutory rights of compensation for water-source contamination might give a better balancing of the rights and responsibilities of drinking-water suppliers, and one that would encourage appropriate protection of drinking-water sources.

chapter 3: improvements are needed in managing the effects of other resource uses on drinking-water sources

improvements are needed in managing the effects of other resource uses on drinking-water sources

In the previous chapter, we emphasized the importance of integrated land-use management processes. However, these are not the only ways in which the provincial government can protect drinking-water sources. There are also a number of processes that regulate specific land uses and, as a by-product of that activity, provide specific protections to drinking water. We report on the most important of these processes in this chapter.

We examined seven types of land-use activity that could materially affect drinking-water sources

Many human activities have some potential to affect drinking-water sources. Our first task was to determine which activities have the potential to materially affect drinking-water sources in British Columbia. We judged each activity on a combination of three factors:

- How frequently does the activity occur in the province's drinking-water supply areas?
- What is the likelihood of harm if the activity is not effectively controlled?
- What is the strength of current controls over the activity?

We concluded that a number of human activities are important in this province, in terms of their potential impact. In no particular order, they are:

- forestry: specifically, timber harvesting, forest road construction and use, and application of pesticides and fertilizers
- cattle grazing
- mining: specifically, exploration for or extraction of metals or coal
- outdoor recreation
- transportation: specifically, construction of impervious surfaces such as roads and runways; and movement, storage, and handling of fuels and chemicals
- agriculture: specifically, manure handling

- human settlement: specifically, construction of impervious surfaces and disposal of human wastes through septic tank systems.

The following discussion focuses on the management of these activities on Crown land. Control over similar activities on private land is more often the responsibility of regional and municipal governments—through such tools as official community plans and zoning bylaws—than of the provincial government.

During our audit, we learned of several other activities that could affect the quality of drinking-water sources, but we were unable to obtain sufficient information to reach a firm conclusion about their importance. We discuss these activities briefly at the end of this chapter.

3.1: the tools that keep logging from harming drinking water are not yet fully implemented

The Forest Practices Code, enacted in June 1995, is an important tool for water protection. It regulates logging and road building in the Crown forest, within constraints designed to minimize damage to other forest values, including water. The main threat these activities could pose to water quality is increased turbidity, or cloudiness, usually due to suspended particles of fine sediment (or, sometimes, to increased nutrient loading). Turbidity can interfere with water treatment processes or impair the appearance of water. On occasion, use of pesticides or fertilizers may also be a concern.

It is important to note that the Code does not apply to privately-owned forest land. According to Ministry of Forest estimates, more than one-eighth of the forest area harvested in recent years has been on private land. This proportion varies by region and by year. For example, in 1994/95, 33% of the forest area harvested in the Nelson forest region was on private land.

A community watershed designation is required before many of the Forest Practices Code's protections apply

Only a drinking-water source designated as a community watershed is eligible for many of the Code's protections. There are over 400 such community watersheds in the province, including the watersheds of Prince Rupert, Cranbrook and Abbotsford (Norrish Creek). Community watersheds cover about 1.5 % of the land surface of British Columbia, and provide water for about a quarter of the provincial population.

The Code defines community watersheds as watersheds of streams or rivers, where water use for human consumption is licensed under the Water Act for a waterworks purpose, or for a water users' community, and where the watershed is smaller than 500 km^2. Watersheds meeting that definition were declared to be community watersheds when the Code was introduced in 1995. There is also a method by which sources that did not automatically qualify in 1995 could be designated as community watersheds. These otherwise non-qualifying sources include:

- streams or rivers with watersheds larger than 500 km^2, such as the watershed for Kamloops, which draws water from the South Thompson River;

- lakes, such as the City of Kelowna's water source; and
- sources which do not meet the licensing requirements stated above, but where there are sufficient residences drawing water from a short reach of a stream to constitute a community.

Also not qualifying as community watersheds are:

- sources used only by hotels, resorts, logging camps and other commercial enterprises;
- watersheds on private land, such as Nanaimo's, Victoria's, and part of Vancouver's (community watersheds may contain private lands, but in practice most provincial administrative controls only apply to the Crown land within a watershed); and
- groundwater sources, such as those of Prince George and Williams Lake.

The Code uses two approaches to protecting drinking-water sources:

- rule-based controls, which forbid specific potentially harmful activities; and
- site-based controls, which require careful planning before on-the-ground work starts, then monitoring to ensure that plans are carried out and that desired results are achieved.

Rule-based controls to protect drinking-water sources restrict certain actions, especially in protected zones

The Code restricts a number of activities that could harm drinking-water quality, such as felling trees into a stream, yarding or skidding logs through a stream, or operating heavy equipment along stream banks. However, exceptions are allowed. For example:

- Trees must not be felled into a stream, unless that is the only way they can be felled, a plan allows it, or a Ministry of Forests district manager allows it.
- Timber must not be yarded or skidded through a stream, unless a logging plan or a Ministry of Forests district manager allows it.

The Code also requires *riparian management areas* around streams in community watersheds—areas where trees and other vegetation are preserved to protect water quality. These areas consist of a *riparian reserve zon*e up to 50 m wide next to a stream, then a further 20- to 30-m *riparian management zone.* Logging is generally forbidden in reserve zones and restricted in management zones, but exceptions may be permitted.

We were unable to obtain information on how often exceptions to these rule-based controls occurred, and whether such exceptions affect drinking-water sources. Lacking such information, we have been unable to conclude whether these controls give appropriate protection.

However, we noted that the Forest Practices Board recently completed a study on stream protection in coastal watersheds. For the streams it sampled, the board found that forest practices now cause significantly fewer impacts to streams than they did before the Forest Practices Code was introduced, and that harvesting-related alterations to streams are uncommon. This study was restricted to streams on the coast. Also, it did not focus on drinking-water sources. If similar examinations were carried out in other areas of the province, and in community watersheds, they would be useful indicators of whether rule-based controls are providing appropriate protection.

Site-based controls to protect drinking-water sources start with plans based on careful assessment and mapping

Under the Code, forest companies must prepare operational plans and have them approved by government before logging or road building can take place. Such plans must be based on detailed study of the land where the work will take place, and must specify how operations will be carried out and what conditions will be like on the land after operations have been completed. In community watersheds, these plans must be based on two kinds of professional assessments: watershed assessments and hazard evaluations.

A watershed assessment evaluates a whole watershed, and is used in determining the allowable rate of logging in that watershed. It starts with an office analysis, based on maps and air photos, that identifies the overall risk from the cumulative effects of past logging and other resource uses in the watershed. If this analysis highlights problems, the assessment can be extended to include, for example, field investigations of damaged streams. Reviewing and commenting on the recommendations arising from the watershed assessment is a major function of watershed round tables, as we discussed in Chapter 2.

A hazard evaluation focuses on problem areas. It provides information about terrain or soil conditions that may cause landslides or erosion. Hazard evaluation has two parts: mapping and field assessment. Mapping locates problem areas, which field assessments then examine in detail. All potentially unstable

areas found by mapping, with limited exceptions, must receive a field assessment. So must all roads, unless mapping has shown they are not in an area of high erosion risk. Once the initial phase-in period for hazard evaluation is past, the Code will require that mapping and most field assessments be carried out by registered professionals.

A hazard evaluation can lead to restrictions on logging, such as no clearcutting or no skidder trails. However, logging is only banned if landslide risk is high or erosion risk very high. Road building is never banned, but, since December 15, 1998, high-risk roads are allowed only if they have been designed by a professional engineer or geoscientist.

Requirements for hazard evaluations are being phased in

Hazard evaluations were not standard practice before the Code was developed, so time was allowed for professionals with the needed skills to be recruited or trained. In the three-year interim, people with practical experience but no professional designation were allowed to carry out the work. Phase-in has been extended, so that the requirement to have hazard mapping carried out by a licensed professional will not be mandatory until June 15, 2000. This means it will be five years after the Code became law before hazard evaluations performed by professionals become mandatory.

The requirement that key examinations and judgments in planning be carried out by professionals is an important provision of the Code. Unlike those without a designation, professionals can be held legally accountable for the quality of their work through requirements to sign or seal work and through the disciplinary processes of professional institutes. We believe that this extra degree of accountability is necessary, when government protection of forest values relies so heavily on the quality of planning work done by forest companies.

We recommend that the Province implement, as soon as possible, the requirements of the Forest Practices Code to have certain key examinations and judgments done by licensed professionals.

We are concerned that government reviewers of forestry operational plans may sometimes lack specialist support

Once approved, an operational plan is a kind of contract, allowing logging to take place in exchange for it being done in a certain way. This means government review of a plan before sign-off is a key step in protecting forest values. It is especially

important for drinking water, because water suppliers or users have no guaranteed say in decisions made during the planning process, and must depend on government officials to represent their interests.

Watershed assessments and hazard evaluations are highly technical processes, often involving specialists such as hydrologists and geomorphologists. Their findings and recommendations are similarly technical, and often require specialists to review and interpret them properly. We are concerned that government decision-makers may not always have the professional advisors they need to assist them in their examination of operational plans. We noted instances where such specialists were in short supply or difficult to retain.

We recommend that the Province determine whether it has sufficient specialists on staff to support its approval processes for forestry operational plans appropriately.

The effectiveness of site-based controls in protecting drinking-water sources depends on careful monitoring

The Code requires logging companies not only to carry out the processes described in an approved plan, but also to achieve the on-the-ground results the plan promises. Both of these aspects—process and result—must be monitored to ensure that the plan is effective.

The extent of field checks is unclear

Checking that plans are being adhered to in the field is the Ministry of Forests' job. The ministry's district compliance and enforcement staff assess the risk to forest resources posed by each active logging site in their district, and develop a plan for on-site inspections based on this risk assessment. District offices we visited generally gave priority to forest operations in community watersheds, and planned to inspect them with increased frequency. However, the ministry's information systems did not allow us to find out, for the province as whole, whether on-site inspections of logging sites that could affect drinking water were being carried out according to plan.

We recommend that the Province examine and regularly report on both priorities for on-site inspections of operations in community watersheds and the frequency of inspections actually carried out.

Water quality objectives are not in place

Water quality objectives are defined as measurable criteria of water quality, designed to protect the most sensitive designated water use at a specific location with an adequate degree of safety. Meeting these objectives is the main legislated requirement for results monitoring in the Code, which specifies that logging or other resource activities within a community watershed must not cause water quality to fail to meet water quality objectives. These provisions are an important part of the Code, because they are a way of ensuring that not only are activities carried out in a specified way, but also that the desired results are in fact achieved.

Although it was intended that water quality objectives would be customized for every watershed, in fact this has happened in very few, because the process involves several years of work in each one. The Ministry of Environment, Lands and Parks, the agency responsible for developing water quality objectives, is proposing a streamlined method, which it estimates would provide objectives for about 90% of the more than 400 watersheds needing them. However, this method has not yet been approved for use.

We recommend that the Province develop water quality objectives for all community watersheds as a matter of priority, if such objectives are to remain the main legislated mechanism for results monitoring under the Forest Practices Code.

Responsibility for monitoring is unclear

Even when developed, water quality objectives may be ineffective because it is not clear who is responsible for carrying out the monitoring needed to make the objectives useful. The *Community Watershed Guidebook* suggests that a drinking-water supplier should do the "before" monitoring, a forest company should do the "during" monitoring, and the ministries of Forests and Environment, Lands and Parks should jointly determine whether changes found during monitoring were caused by logging or other regulated activity. However, we could not find any legislated support for this assignment of responsibility.

Controls over pesticide and fertilizer use on Crown land suffer from the same lack of clarity about responsibility for monitoring. For example, the Code requires that if a person applying a pesticide detects pesticides in the water at the intake to a water system, application must stop until the Ministry of Health permits its resumption. However, testing for pesticides in water must be done only if specified in the

pesticide-use permit from the Pesticide Control Branch of the Ministry of Environment, Lands and Parks (the permit required before pesticide application is allowed on public forest land). Most of the half dozen permits issued for pesticide use in community watersheds in the past two years have not stipulated that water testing be carried out.

We recommend that the Province clearly assign responsibility for monitoring whether water quality objectives are being met, at all stages of forest development within community watersheds.

Results-based monitoring in community watersheds could extend beyond measures currently included in water quality objectives

Water quality objectives describe the make-up or physical condition of water. Common measures include maximum temperature and maximum levels of coliform bacteria, nitrate, and turbidity. Monitoring to see if objectives such as these are being met is valuable in alerting water-supply operators and land managers to problems. These measures may be less useful, however, in diagnosing what conditions in the watershed are causing the problem, and whether it is of natural or human-caused origin. Also, water monitoring can only detect problems in a watershed once they affect water, but that may not be until after damage is done. For example, an error in road construction could over-stress a slope, which could slide in the next rainy season. Only then would the problem have been detected by water-quality monitoring showing, for example, increased turbidity. Had slope conditions been monitored, however, early warning of the problem might have been obtained.

Measures going beyond those included in water quality objectives are now being used (or are proposed for use) to evaluate watershed restoration work funded by Forest Renewal BC, and to monitor the effectiveness of integrated watershed management plans. Use of similar extended measures is also recommended by the U.S. Environmental Protection Agency as best management practice for evaluating the effects of forestry on streams. The agency rated 30 different water-quality monitoring parameters for their ability to detect problems caused by logging or road building. The parameters were of six types: water column physics and chemistry; water flow; sediment; channel characteristics; riparian vegetation; and aquatic organisms. The agency concluded that water column physics and chemistry was the category least affected by, and least sensitive to, logging or road building. Most of the measures, other than turbidity, usually included in British

Columbia water quality objectives relate to water column physics and chemistry.

We recommend that the Province give consideration to widening the range of results-based monitoring in community watersheds required under the Forest Practices Code.

Overall we concluded that, fully implemented, site-based controls would be useful tools for protecting drinking-water values while recognizing timber values. By "fully implemented," we mean that site-based controls should be appropriately designed to achieve the goals set for them, as long as:

- watershed assessments and hazard evaluations are carried out and, where necessary, the work is done by licensed professionals;
- government officials have sufficient technical counsel to aid their decision-making; and
- monitoring can ensure that operational plans are being adhered to in the field, and desired results are being achieved.

3.2: management of cattle grazing does not fully address threats from parasites

If not properly managed, cattle grazing can add sediment, harmful bacteria and parasites to drinking-water sources. Responsibility for managing these risks on public lands lies with the Ministry of Forests, which regulates grazing in the Crown forest, including community watersheds.

As with logging, the Ministry of Forests uses rule- and site-based controls to manage grazing. Because enforceable rules for grazing are, in our view, insufficient by themselves to give appropriate protection to drinking-water sources, we only discuss site-based controls here.

Site-based controls to manage grazing are designed to maintain rangeland in proper functioning condition

Ranchers using Crown range must abide by range use plans. Through these plans, the ministry aims to achieve, among other goals, *proper functioning condition*—a state in which plants and streams on the range can sustain themselves and have the resiliency to stay in condition despite outside disturbances. Rangeland that is in proper functioning condition can support an appropriate level of grazing without incurring damage to natural values or to future grazing potential.

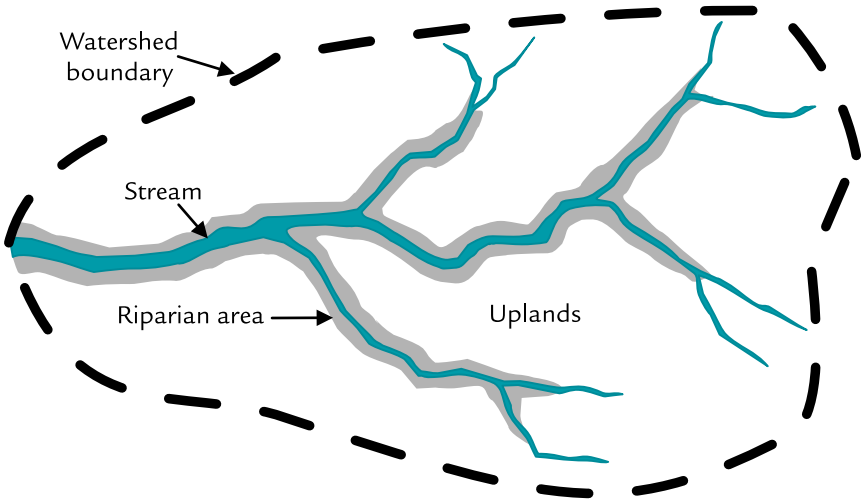
Proper functioning condition helps to minimize sediment and turbidity by:

- maintaining stable stream banks and stream beds, which reduces sediment released as a result of bank damage or scouring of the stream bed;
- minimizing soil disturbance, which reduces the sediment available to be washed into streams;
- minimizing overland flows, which keeps sediment on surrounding rangeland from entering a stream; and
- keeping stream flows stable, which reduces the chance that sediments already on the stream bottom will be re-suspended during peak flows.

Dry uplands, not riparian (stream-influenced) areas, make up most of the area of grazed watersheds (Exhibit 17). Cattle kept in uplands have little effect on water quality, as long as the range is in good condition. Unfortunately, cattle prefer

Exhibit 17

Riparian Areas and Uplands in Grazed Watersheds



Source: Compiled by the Office of the Auditor General of British Columbia

riparian areas, where their presence is more threatening to water quality. The crux of managing cattle in watersheds supplying drinking water is managing how they use the riparian area.

Our examination of the research literature showed that when range and riparian areas are managed so as to be in proper functioning condition for grazing, they are unlikely to contribute problem levels of sediment and turbidity to local water supplies under normal flows. However, we also found that proper functioning condition alone may not keep harmful bacteria and parasites from entering a water supply.

Four variables affect whether cattle grazing will harm drinking-water sources

Four variables play a part in determining whether harmful levels of bacteria and parasites will reach a drinking-water supply as a result of cattle grazing:

- *Volume of manure:* The volume of manure in or near streams depends on the number of cattle present and the length of time they graze in these locations. The higher the volume, the greater the risk that harmful bacteria and parasites will get into the water supply. Both grazing numbers and duration are key controls for managers in maintaining proper functioning condition.

- *Concentration of bacteria and parasites in the manure:* Cattle health is the key factor affecting how many bacteria or parasites are in manure. Cattle age can be particularly significant. For example, young calves are more likely to]spread *Cryptosporidium* cysts than are older animals.
- *Barriers to bacteria and parasite movement, on land and in water:* Whether bacteria and parasites can move into nearby streams depends mainly on whether cattle are allowed in, or close to, a stream, and on whether there is overland water flow. The ground cover provided by vegetation on land in proper functioning condition is an important barrier to overland flow. As long as high levels of overland flow do not occur, manure would have to be deposited in water—or within a metre or two of it—to significantly raise the water's bacteria or parasite levels. However, once in a stream, it appears that bacteria and parasites have a reasonable chance of remaining viable until they reach a water intake. Although the *Community Watershed Guidebook* suggests 1 km as a minimum distance between grazing areas and water intakes, there is evidence that *Cryptosporidium* can remain alive after travelling this distance and more.
- *Extent to which previous deposits of bacteria and parasites are re-suspended:* Bacteria and parasites can remain alive for extended periods in sediments on a stream bottom. If these sediments are re-suspended by high stream flows or by cattle wading in the stream, large quantities of bacteria and parasites can be quickly released into the water. Such sudden pulses can result in bacteria or parasites entering a drinking-water system. Water treatment works by reducing the percentage of bacteria or parasites in water, but no treatment achieves 100% success. A high enough concentration of bacteria or parasites entering a water treatment system can result in enough of them remaining alive after treatment to infect drinkers of the water.

In short, we found that the proper functioning condition requirements of the Code, even if fully enforced, are not sufficient by themselves to control the risk of bacteria and parasites reaching a drinking-water supply. The main concern here is parasites, as water disinfection is usually able to deal with the risk from bacteria. Exhibit 18 summarizes these findings.

We note that in response to the outbreak of *Cryptosporidium* infection in Cranbrook in 1996, the Ministry of Forests went beyond requiring proper functioning condition, and made two changes that may help address the concerns highlighted in Exhibit 18. The range use plan for Cranbrook's community watershed, developed by the Ministry of Forests with help

Exhibit 18

Controls Over Parasites Offered by Proper Functioning Condition

Critical control link	Will managing for proper functioning condition using the Forest Practices Code provide critical control?	
■ Control volume of manure	Yes	If cattle numbers and timing are controlled.
■ Control concentration of bacteria and parasites in manure	No	If ministry does not regulate for cattle health.
■ Control movement of bacteria and parasites		
— Overland	Yes	If healthy vegetation cover controls overland flow.
— In water	No	If cattle are not kept out of critical few metres closest to streams and if distance from manure to water intake is too short.
■ Control re-suspension of bacteria and parasites		
— Peak flows	Yes	If uplands and stream are in proper functioning condition.
— Cattle in stream	No	If cattle are not kept from wading into stream and trampling stream bottom.

Source: Compiled by the Office of the Auditor General of British Columbia

from the Ministry of Agriculture and Food, now excludes calves from the watershed until they are old enough to be unlikely to carry high levels of *Cryptosporidium*. As well, the Ministry of Forests and the City of Cranbrook cooperated to build a fence that generally keeps cattle away from the stream for about 2 km above the city's water intake.

We recommend that the Province expand the range provisions of the Forest Practices Code to more effectively address risks from parasites.

Doing so would, we believe, help in obtaining value for money from public range resources by cost-effectively minimizing the risk of bacteria and parasites reaching drinking-water supplies as a result of cattle grazing. We suggest that the Ministry of Forests (responsible for grazing) and the Ministry of Health (responsible for drinking-water safety) take the lead in developing the range controls needed, using technical advice from other ministries.

It is worth noting that the Code includes special rules for using livestock in silviculture work such as site clearance and weeding. In this type of work, animals (usually sheep) are concentrated, but under close supervision. These rules require all livestock to be "inspected and certified by the Minister of

Agriculture and Food," and forbid the use of livestock within the riparian management area of community watersheds.

The effectiveness of range use plans is weakened by unclear responsibility for their preparation and enforcement

Clear assignment of responsibilities is a keystone of the Forest Practices Code. Logging companies, for example, have been given clear responsibility for developing operational plans and ensuring that the goals of such plans are achieved. Responsibility for adhering to range use plans, however, is less clear.

Range use plans are often prepared by Ministry of Forests staff, sometimes the same staff responsible for monitoring the plan, and are only later signed off by the rancher. Those range use plans prepared by ranchers themselves do not need professional sign-off, as do those required for logging plans. We heard two reasons why range users are not required to take full responsibility for plan preparation: specialists able to prepare these plans are rare outside the ministry, and small ranch operations cannot afford to hire professionals to help them prepare plans.

We believe it is undesirable for the same ministry staff members to have responsibility for both developing plans and enforcing them. The strict division of responsibility seen elsewhere in the Code is sound, and should be applied equally to all commercial users of forest resources. Some Ministry of Forests districts maintain this division, using separate staff for range planning and range monitoring.

If this is not feasible, there should be a compensating control, such as regular oversight inspections by, for example, regional or headquarters specialists, to ensure that grazing plans are leading to the results envisioned in the Forest Practices Code.

We recommend that the Province consistently separate the responsibilities for developing range use plans and for enforcing them, or introduce compensating controls.

As with logging, responsibility lies with the Ministry of Forests to make sure, through monitoring and field inspections, that range users are abiding by their approved plans. Our concerns about this monitoring and field inspection are similar to those we raised in section 3.1: the extent of field checks is unclear, responsibility for monitoring is unclear, and water quality objectives are not in place.

3.3: regulations on mining near drinking-water sources are too new for their effectiveness to be judged

The physical nature of mining means that, without proper controls, water quality can be put at risk. Mining involves the movement of large amounts of soil or rock, so sediment production is a possibility. Sometimes the materials being handled are chemically active, or can become so after processing, and this can result in the release of acid, heavy metals or other chemical contaminants. Finally, many mining processes use large quantities of water, which are then returned to the local environment.

Regulation of mining activities has increased significantly in recent years, but some problems continue from activities carried out prior to the present regulations. Modern mines are carefully regulated to control acid mine drainage. However, some abandoned properties, such as the Britannia mine above Britannia Beach and the Mt. Washington mine near Courtenay, still release acids and heavy metals into local waters—fortunately not drinking-water sources—despite large expenditures made in an attempt to control the releases. Several rivers still have problems with sediment because of past placer mining activity.

Mines go through three stages—exploration, operation and reclamation—and each stage can add sediment and possibly chemical contaminants to water sources unless properly managed. The Province has regulatory tools for each of the three stages.

Exploration is governed by the Mineral Exploration Code

Exploration is not forbidden in community watersheds, but is more heavily constrained there than on other Crown lands. Since May 1, 1998, exploration has been governed by the Mineral Exploration Code.

We found several provisions of the Mineral Exploration Code to be less prescriptive—and thus offering a lesser degree of assurance to drinking-water users—than provisions of the Forest Practices Code that address similar activities, such as building forest roads. For example:

- Logging companies must carry out terrain and other assessments before planning a road in a community watershed (see section 3.1). Mining exploration companies must make use of any existing assessments when planning

exploration roads, but are not required as a matter of course to carry out assessments in watersheds that lack them.

- Ministry of Energy and Mines inspectors need only consult with officials of the Ministry of Environment, Lands and Parks when approving roads in high-hazard areas. For logging roads in similar situations, the Ministry of Environment, Lands and Parks has decision-making authority, not just the right of consultation.

However, we noted that the Ministry of Energy and Mines is proposing to have the committee that developed the Mineral Exploration Code review it soon to see if it needs changes. We support this initiative, and suggest that the review committee be expanded to include a representative of drinking-water suppliers, or a representative from the Ministry of Health.

Mines are approved initially, and then monitored throughout their operating life, and afterwards

Proposed mines go through one of three approval processes. Large projects undergo formal environmental assessments managed by the provincial Environmental Assessment Office. Medium-sized projects are reviewed by regional mine development review committees of the Ministry of Energy and Mines, with representation from other ministries. Small projects are reviewed by local offices of the Ministry of Energy and Mines, again with consultation with other ministries.

The rules for formal environmental assessments specify opportunities for public comment, and require keeping the public informed during an assessment process. These steps are not mandatory in regional or local reviews of exploration activities (although ministry staff told us it was common to inform and consult with affected stakeholders during these reviews).

Once approved, mines must operate according to their permits. Permits under the Mines Act and the Waste Management Act can require monitoring of an operation's effect on water quality in local streams or groundwater, or specify who is responsible for detecting and correcting damage to local water supplies. Such provisions are not mandatory. However, if incorporated in a permit, they are enforceable.

A mine owner's obligations continue after a mine shuts down. Management is exercised through continued monitoring and maintenance by mine owners to prevent pollution, and through bonding to cover the cost of correcting pollution

damage. These requirements are specified as part of the operating permits; new mines cannot start operation until the Province is satisfied that they will not be environmental hazards after production stops.

We were unable to examine in detail the effectiveness of current provisions for managing mining and water quality, because none of the watersheds or aquifers we focused our attention on contained significant mining activity. However, we believe that the large volumes of material handled in mining, the chemical activity of some of these materials, and the long time period over which they can remain chemically active all suggest that these regulatory processes are important, and that their effectiveness should be periodically examined.

3.4: information on recreation's impact on drinking-water sources is lacking

How much recreation should be allowed in community watersheds is a controversial question in British Columbia. On one hand, watersheds are often attractive for recreation: located near centres of population, they contain streams and lakes, and often other recreational resources such as road networks. Public access to these areas and to roads on Crown land is strongly supported by many citizens and recreational groups.

On the other hand, most water-system operators and regulators we interviewed worry that recreation can threaten water quality. They point to the Victoria and Vancouver water systems, which ban recreation, and wonder why their own water systems deserve less protection. American water-system operators have similar concerns with recreation in their watersheds.

We found that, in practice, the restrictions on recreation in the watersheds of our case study cities were as much the result of local circumstance as of provincial policy. Prince Rupert can restrict recreation in its watershed because it owns the land controlling access to it. Nanaimo's watershed is on private land, and the landowner controls public access. In Kelowna's case, the federal government has jurisdiction over the surface of Okanagan Lake and regulates recreational boating there.

Provincial policy has generally been to allow unfettered public recreation in the Crown forest. For example, the Forest Practices Code has more restrictions on non-recreational activities that threaten a recreation resource, than on the recreational activities that threaten other resources. Similarly, the *Community Watershed Guidebook* has guidelines for reducing damage from recreation, but these are not legally binding. The guidebook acknowledges that recreation should sometimes be limited, but only in unusual circumstances:

- where there is no current recreation, and recreation opportunities outside the watershed are adequate;
- where, in small watersheds, there is little dilution of human waste; or
- where the Ministry of Health finds a high risk to the water source.

Different kinds of recreation pose different concerns for protection of drinking-water resources

We found that little research has been done on how recreation affects drinking-water quality. From the limited information available, it appears that, for land-based recreation, off-road motorized recreation (Exhibit 19) is the greatest threat to drinking-water quality and non-motorized recreation is the least, and that in-water activity is a greater threat than on-water. For example, the integrated watershed management plan for Chapman and Gray creeks (Sechelt's water sources) calls for banning off-road vehicles and limiting other motorized recreation, but allowing existing non-motorized uses.

Better information about the effects of recreation on water quality is essential

When views are as strongly opposed as those on recreation in communities' watersheds, good public policy needs to be based on sound information. Unfortunately, very little information has been collected about the effects of recreation on water quality in British Columbia. Even basic information such as the number of people visiting watersheds is lacking. Without good information it is unlikely that the Province will be able to devise management strategies that obtain best value for money from both the drinking-water resource and the recreational resource.

At present, no single agency has responsibility for recreation in watersheds. The Ministry of Forests is the landlord of the Crown forest and provides (and manages) basic recreational

Exhibit 19

Types of Land- and Water-Based Recreation

Location	Type of recreation	Example
Land	Motorized off-road	Driving cross-country or on deactivated roads
	Motorized on-road	Driving on a forest road to a campsite
	Non-motorized	Backpacking, horse packing
Water	In-water	Swimming, windsurfing
	On-water	Boating, fishing

Source: Compiled by the Office of the Auditor General of British Columbia

facilities where demand warrants. The Ministry of Environment, Lands and Parks has expertise in water quality generally, and in managing recreation in parks. The Ministry of Health has expertise on health risks from drinking water. We believe that all three ministries have important roles to play in examining, understanding and managing recreation in watersheds that are used as drinking-water sources.

We recommend that the Province gather information on the impacts of recreation on drinking-water sources, as a basis for future policy development.

3.5: the design of transportation routes and infrastructure does not adequately address water-source protection

The process of transporting materials and people in support of the various industries and activities in our economy is a complex undertaking with wide-reaching impacts on water. These impacts are of two general types: chemical and non-chemical.

Chemical threats to water quality from transportation-related activities result from:

- single-source spills or leaks originating from an identifiable point; and
- ongoing degradation caused by the release of harmful substances over a wide area.

Roads, rail lines and runways create non-chemical impacts on water as well:

- They increase dust and sediment, which wash into water sources.
- Their coverings of impervious materials hamper the normal absorption of water into the ground where it is filtered and recharges aquifers.

Ditches alongside roads intensify the impacts on water by interrupting natural flow patterns over the surface while collecting and channeling road run-off directly into surface water bodies. This has the effect of bypassing the land's capacity to remove and break down contaminants, accumulating them instead in surface water.

While some progress has been made in remediating these impacts, the processes are costly and only partially effective. In this section, we discuss the damage to water sources from transportation-related activities, and the need to give more attention to protecting these sources when planning transportation routes and infrastructure.

Single-source chemical spills and leaks cannot always be cleaned up

From time to time, trucks overturn and rail cars derail, spilling harmful substances. Since human developments typically spring up near water sources, the road and rail corridors that serve them frequently run beside water bodies or through watersheds. This can present major risks to drinking-

water sources. In Cranbrook's watershed, for instance, a public road runs close to the city's reservoir, crosses one creek just above the point where it enters the reservoir, and runs alongside an open channel that carries water for the reservoir from a second creek. Trucks carrying drums of diesel fuel use the road, as do furnace oil trucks, snowmobiles, hunters and mountain bikers. City officials believe there is a high potential for accidents involving these trucks and, hence, for contamination of the city's water source by a spill.

The damage that results from spills of even small quantities of chemicals can sometimes be widespread and lasting. For example, a standard 200-litre drum of trichloroethylene would need to be diluted with 60 billion litres of water to make it harmless. This amount of water is roughly equivalent to that which a small village well, supplying 500 litres per minute, could produce in 230 years. Contamination by petroleum products has destroyed some British Columbia water bodies as drinking-water sources for many years. For example, a full load of diesel fuel that was dumped into Blueberry Creek, near Castlegar, contaminated the Blueberry Irrigation District water source to the extent that an alternative source had to be found. Similarly, a group of wells in Sparwood remained unsuitable as a drinking-water source for over 20 years after water used to wash engines and vehicle parts flowed into one of the wells.

The risks from spills and leaks can be particularly serious for groundwater, despite its protection, in most cases, by the layers of strata above it. The risks are higher for aquifers which are unconfined (overlaid by layers which are not impervious) and close to the surface. For example, both the Trans-Canada

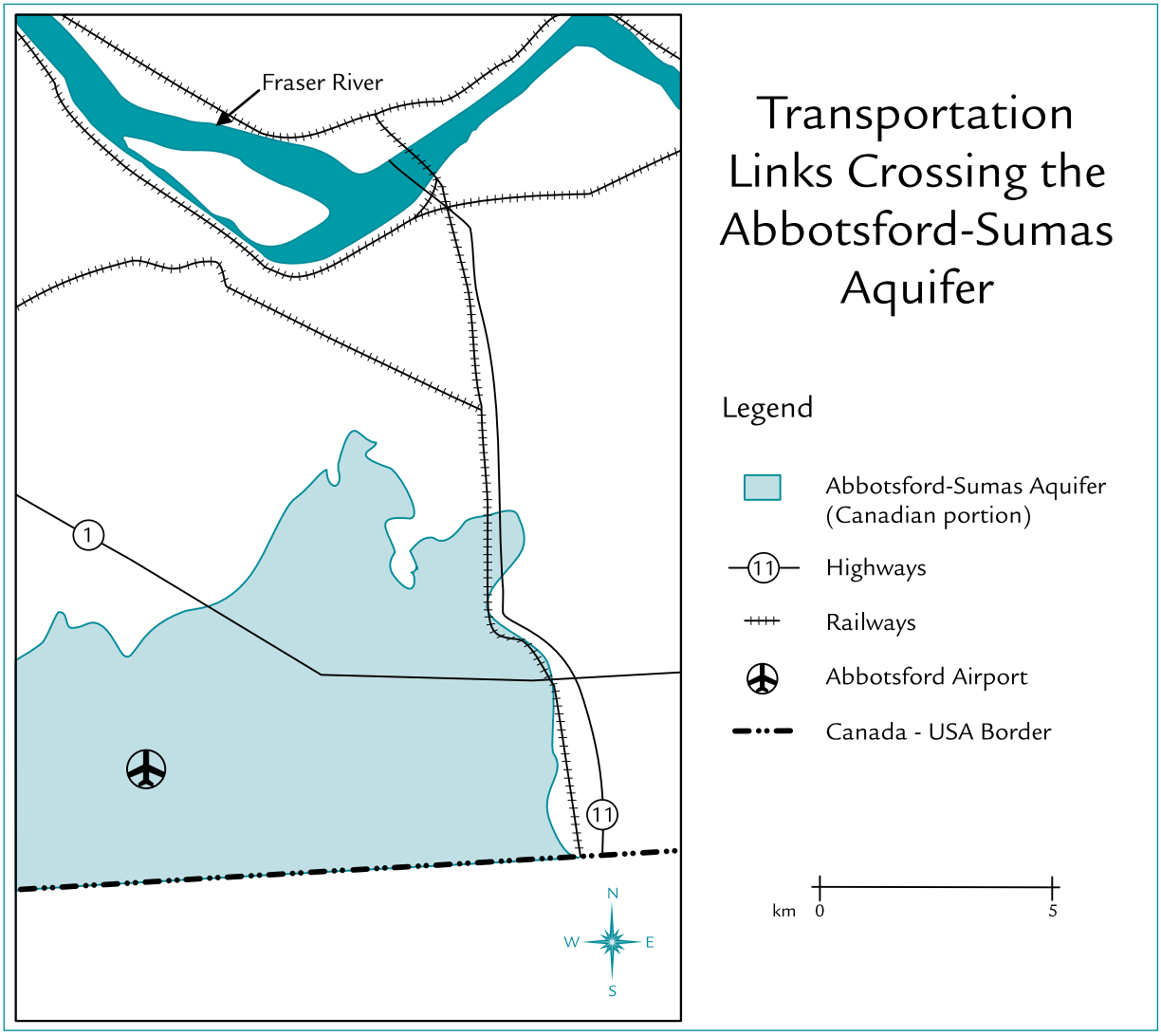
Courtesy: H. Daynard

Accidents involving vehicles carrying harmful substances can lead to degradation of drinking-water sources

Highway and the Abbotsford Airport are located above the Abbotsford-Sumas aquifer (see Exhibit 20). A major spill from either could pose a serious threat, as the aquifer is very porous. Once they have entered the aquifer, fuels and other petroleum compounds tend to cling to particles of rock and sand, preventing a complete flushing-out of the contamination for years to come.

Groundwater flows slowly and therefore, it is often possible to entrap a contaminant and recover it before it infiltrates an aquifer. However, this process is very expensive. In 1986, a major rail spill occurred in Fort Langley. The rail company installed collection wells which are helping to contain the

Exhibit 20



Source: Compiled by the Office of the Auditor General of British Columbia using aquifer map provided by BC Ministry of Environment, Lands and Parks

contaminant. However, pumping by the company will be required for some time, and the total cost is estimated at $4 million to date. In Prince George, two of the city's wells are currently threatened by diesel fuel from a July 1997 tanker spill on the Hart Highway Connector. The trucking company was directed to remove and clean several loads of contaminated soil, to install recovery wells, and to monitor water quality in the city wells on a regular basis. To date, only half of the spilled fuel has been recovered and the company will be required to continue cleanup for another one to two years. Total clean-up costs are estimated at $1 million.

The Waste Management Act attempts to limit the impacts of spills by requiring polluters to clean up polluting substances. While the source and responsibility for transportation spills are usually easily determined, monitoring of the impacts of pollution is expensive and not all cases can be cleaned up. For example, the cost to test one water sample for the contaminant PCP is about $1,300, and the technology for complete clean-up of contaminants such as PCB in bedrock does not yet exist. Even the best cleanup of any spill usually leaves residual contamination.

Because successful containment of spills depends on prompt action, the Waste Management Act requires immediate reporting of spills to the Provincial Emergency Program. The Health Act also requires reporting of potentially toxic chemical spills to the nearest Medical Health Officer. In practice, however, those responsible for drinking-water supplies are not always informed of the spills. This was the case in Port Edward in 1995. A contractor, involved in building a new dam, spilled diesel fuel

Courtesy: Prince George Citizen newspaper, Dave Milne, photographer

A 1997 diesel fuel spill on the Hart Highway Connector in Prince George threatens two city wells

into a creek feeding into the town's water source. The 60-gallon spill was not reported by the contractor and the town was unaware of the spill until its residents reported a bad taste in the water.

All water purveyors are required to have written plans to respond to emergencies affecting their waterworks system. However, the legislation gives no guidance as to either the types of emergencies all purveyors should plan for or key risk factors that should be addressed in plans. The Ministry of Health has taken steps to promote emergency planning by purveyors, but has placed little emphasis on monitoring implementation of the requirement since it was introduced in 1992. Victoria's Capital Regional District Water Department is one of the few large systems considered to have a good emergency response plan, and even this plan has been assessed as incomplete to deal with the full range of potential problems.

In addition to large spills of chemicals, the transportation of materials and people contributes to minor spills of pollutants that ultimately find their way into adjacent water bodies. Engine oil, antifreeze, jet fuel and transmission fluid are among the chemicals that are frequently spilled, either accidentally or deliberately. Individually, each spill is seldom noticeable, but the cumulative impacts can destroy drinking-water sources.

Existing legislation does not appear to be effective for these spills. For example, although the Waste Management Act prohibits such non-permitted release of pollutants, enforcement is limited because the multiple sources of these minor spills make responsibility for cleanup and prevention hard to identify. In addition, the regulation that requires collection and treatment of rainwater from fuel transfer areas does not apply to retail service stations.

Underground transportation and storage of chemicals and fuels also pose potential threats to water sources. Leaks arising from either faulty construction or deterioration of tanks and pipes can contaminate both ground and surface water while remaining undetected for some time. In Grand Forks, the city's first water well remains unusable following leakage from underground gasoline storage tanks in 1981. Currently, there is no specific legislation in British Columbia to control leakage from underground tanks, but other jurisdictions have taken steps in this direction. For example, regulations proposed by the City of New York are expected to create standards for buffer zones between tanks and watercourses or reservoirs, place limits on the location of new gas stations near water bodies, and limit the underground placement of home heating oil tanks for houses.

Vehicle use can lead to ongoing chemical contamination over a wide area

Transportation can also contribute to pollution of water sources through the release of contaminants such as trace metals, vehicle emissions and road salt over a wide area on an ongoing basis.

Trace metals

Transportation is a major source of trace metals in water. A study of the Brunette River watershed in Burnaby shows a strong connection between rising vehicle use and large increases in the levels of lead, copper, zinc and manganese in sediment cores. The load discharged to the watershed from transportation was found to be higher than the total of all the permitted discharges from industrial point sources in the watershed. Although the Brunette watershed is not used for drinking water, its demise as a fishing resource shows clearly the potential for contamination of water sources by trace metals released by vehicles. In sources that are used for domestic water supplies, some trace metals will cause only aesthetic problems. However, others, like lead, cadmium, chromium and mercury, present health risks.

Vehicle emissions

As well as trace metals, motor vehicles release gases and particulates containing compounds of nitrogen and sulphur that eventually reach the ground as dust or acid precipitation. These compounds ultimately reach water sources and can gradually acidify them to the point where their natural buffering capacity is exceeded. A dramatic increase in acidity occurs that can corrode pipes and faucets, creating the need for costly new water treatment measures, new water fixtures, or the development of new water sources.

Greater Vancouver now has more cars per capita than Greater Los Angeles, and the population of the Lower Mainland is expected to reach 3 million by 2021. More vehicles and longer travel times in congested traffic can be expected to increase the contamination of water sources by trace metals and emissions in the Lower Mainland and other high-traffic areas.

Road salt

Contamination of groundwater by road salt can also be a threat to drinking-water quality. This occurs where salt is applied frequently to roads during snowy conditions, and where salt is improperly stored in gravel pits. For example, in 1994, the Ministry of Transportation and Highways was

required to find an alternative water source for the community of Heffley Creek after its well was contaminated by the ministry's sand-salt supply in a nearby gravel pit. To date, this problem has cost the ministry about $2 million in remediation measures. These measures include not only removing contaminated soil and building a properly lined and covered storage facility, but also digging seven wells to find a good water source, replacing heating and plumbing systems, and monitoring water quality in wells downstream of the salt storage area for several years.

The non-chemical impacts of transportation systems affect both water quality and quantity

In addition to chemical contamination, transportation systems present physical threats to drinking water. Unpaved roads, in particular, contribute to sedimentation in surface water; paved surfaces, such as roads, runways and parking lots, hamper normal absorption of rainwater into the ground.

Sediment in drinking water causes turbidity, which is aesthetically objectionable. More importantly, sediment can transport biological contaminants into a water system and turbidity can impair the effectiveness of disinfection. Roads contribute to these problems where they pass close to water sources and are not well maintained.

Other problems arise when land is covered with an impervious coating such as pavement, which reduces the area over which rainwater can be absorbed into the ground. This harms water sources in two ways:

- It reduces the opportunity for rainwater to filter through the soil, where natural agents and processes can remove contaminants and pathogens, and it ultimately decreases the amount of water available to recharge underground water sources.
- It increases surface run-off (stormwater), which can degrade surface water bodies by adding sediment and other contaminants. These contaminants include pesticides and herbicides from roadside spraying, detergents and waxes from vehicle washing, and fuel and oil from automobile and airplane maintenance. Highway stormwater combines the worst of industrial and residential run-off in its variety and concentration of metals, particulates and petroleum compounds.

The Ministry of Transportation and Highways has increased its efforts to address contamination from highway run-off. A

great deal of retrofitting activity is currently taking place across the province to correct highway structures that were built in the 1950s and 1960s without regard for environmental issues. Most of this work is driven by federal and provincial fisheries acts to correct hazards to fish populations, but drinking-water sources benefit from reduced contamination as well.

Protection of water sources is also receiving greater emphasis in new highway projects. Depending on the project size, the planning phase will include a review of environmental impacts as part of a referral to environmental agencies, a highway environmental assessment, or a full review under the provincial Environmental Assessment Act. Conflicts between project plans and environmental and community values are resolved by altering road locations, mitigating negative impacts, or compensating for losses. For example, the planned route of the Vancouver Island Highway was altered to avoid passing through the catchment area of the Union Bay water source. This same highway project used the concept of engineered wetlands—ponds filled with species of plants that can capture contaminants and sediment, and located to detain roadway run-off above the watersheds of highway-side communities.

Highways are only one source of impervious surfaces. There are others, but so far no mechanism exists to track their overall impact within watersheds. As part of its Non-Point Source Action Plan, the Ministry of Environment, Lands and Parks proposes to encourage local governments to establish bylaws concerning (1) the maximum percentage of areas that can be covered by impervious coatings and (2) the control of pollutants commonly washed through storm drains into surface waters. Some American states (e.g., Georgia and North Carolina) have statewide limits on the amount of impervious surface covering allowed within drinking watersheds. The City of New York has proposed buffer distances to be maintained between impervious surfaces (including roads) and watercourses, wetlands and reservoirs to ensure run-off filters into the ground before reaching the water bodies. Recent amendments to the Municipal Act and provisions in the Fish Protection Act will enable British Columbia municipal authorities to require better stormwater management practices through local bylaws.

Prevention of water-source damage should be the priority

While legislation is in place to provide for cleanup, the reporting of spills is not always fast enough or wide enough to enable prompt action. Water purveyors, in particular, are not always notified about spills affecting their water source and are not well prepared to cope with chemical contamination

emergencies. Cleanup activities are long, expensive and usually incomplete. Surface sources can be put out of commission for long periods because of spills, and groundwater, in some cases, cannot be saved if spill contamination occurs. Non-point sources of contamination are hard to pin down and causation is difficult to establish. In addition, the infrastructure required to support transportation activities is itself a threat to drinking-water sources. Unpaved surfaces contribute to sediment in water; paved roads and airports increase run-off and prohibit natural recharge of groundwater sources. Much can be done in designing transportation corridors and infrastructures to mitigate these threats, but retrofitting is expensive.

Given these barriers to effective clean-up of contamination, and the potential impacts of poorly-planned transportation infrastructure, we have concluded that protection of drinking-water sources cannot be economically achieved through the current avenues for correcting damage once discovered.

We recommend that the Province give priority to planning and building transportation routes and infrastructure in ways that will prevent the degradation of drinking-water sources. Measures that could be applied include: locating new roads, rail lines and airports away from water sources used for drinking-water supplies; using infrastructure designs that will reduce the potential for water degradation; limiting the amount of impervious land covering created for transportation-related activities; and removing roads and infrastructure that are no longer required.

In addition, ***we recommend that the Province continue to strengthen procedures to minimize damage to drinking-water sources from chemical spills and leaks, and to implement provisions to prevent wide-area (non-point source) contamination.***

We believe these actions will reduce the degradation of drinking-water sources and hence the potential level of funding required to treat drinking-water supplies.

3.6: management of agricultural wastes is not yet successful in protecting groundwater sources

Crop growing and livestock raising, if not properly managed, can add a number of contaminants to drinking-water sources (Exhibit 21).

For example, an Alberta study of agricultural impacts on water quality concluded that some agricultural practices in that province are degrading water quality, and that problems grow with increased use of fertilizer and herbicides and increased livestock densities. One U.S. study found that drinking-water providers using surface-water sources rate agriculture as the land use causing the most problems with sediment, nutrients and pesticides. Another study identified agriculture as the U.S.'s greatest source of non-point pollution.

In British Columbia, excess nutrients entering groundwater have been the main agricultural threat to drinking water so far: agricultural nutrients have contributed to well water contamination in the Fraser Valley and in the Armstrong, Osoyoos and Grand Forks areas. Also, operations that concentrate livestock for feeding or calving have been linked to increased levels of pathogens such as *Cryptosporidium* and *Giardia* in nearby surface waters.

Exhibit 21

Types of Land- and Water-Based Recreation

Potential contaminants	Crops	Livestock
Surface water:		
■ sediment	X	X
■ parasites		X
Surface and ground water:		
■ nutrients	X	X
■ pesticides	X	
■ bacteria		X

Source: Compiled by the Office of the Auditor General of British Columbia

Control of water contamination from agricultural wastes depends on compliance with the Code of Agricultural Practice for Waste Management

Normally, discharging waste to a water body in British Columbia requires a permit under the Waste Management Act. However, agricultural operations are exempt from this permit requirement if they follow the Code of Agricultural Practice for Waste Management, which lays out methods for managing agricultural waste in an environmentally sound manner. These methods are set out in more detail in a series of environmental guidelines for different agricultural specialties.

Because it lacks the staff and budget to monitor compliance with the Code of Practice, the Ministry of Environment, Lands and Parks tends to take action on possible water pollution from farm wastes only when it receives a complaint. Complaints are referred to a volunteer inspection team made up of farmers whose specialty is the same as that of the farm being investigated. This peer group can advise the farmer on how to correct any violations, and may allow up to six months for that to happen. If a farmer does not comply, then the ministry deals with the problem directly. It can investigate and, if necessary, issue a pollution abatement or pollution prevention order. Issuing an order is an expensive and legalistic process, and orders are often appealed. Nevertheless, if an order is ignored or unsuccessfully appealed, charges can be laid under the provincial Waste Management Act or federal Fisheries Act.

To succeed, the current regulatory process depends on compliance by farmers. Although information and education programs have made farmers aware of the need for good waste management, these efforts have not convinced enough of them to follow the Code of Practice to solve the nutrient-loading problem.

Complicating the issue is that farm patterns are changing in the Fraser Valley. At one time there was a rough balance between raising livestock, which produced manure, and raising crops, which used manure as a fertilizer and soil conditioner. Now, increasingly, farming in the valley is divided between crops whose need for manure is low or seasonal, such as berry crops, and intensive animal-raising operations that use mainly imported feed. As a result, nutrient loads from manure significantly exceed the absorptive capacity of the land. Excess nutrients from manure or other fertilizer use can leach into groundwater, increasing nitrate levels. Some wells which draw from vulnerable aquifers in the Fraser Valley and other agricultural areas already have nitrate levels above the

maximum acceptable concentration allowed by the *Guidelines for Canadian Drinking Water Quality* (see Exhibit 22). High levels of nitrates can be particularly dangerous for babies under six months, since nitrates interfere with the ability of the blood to carry oxygen.

Regulations specific to local conditions are needed

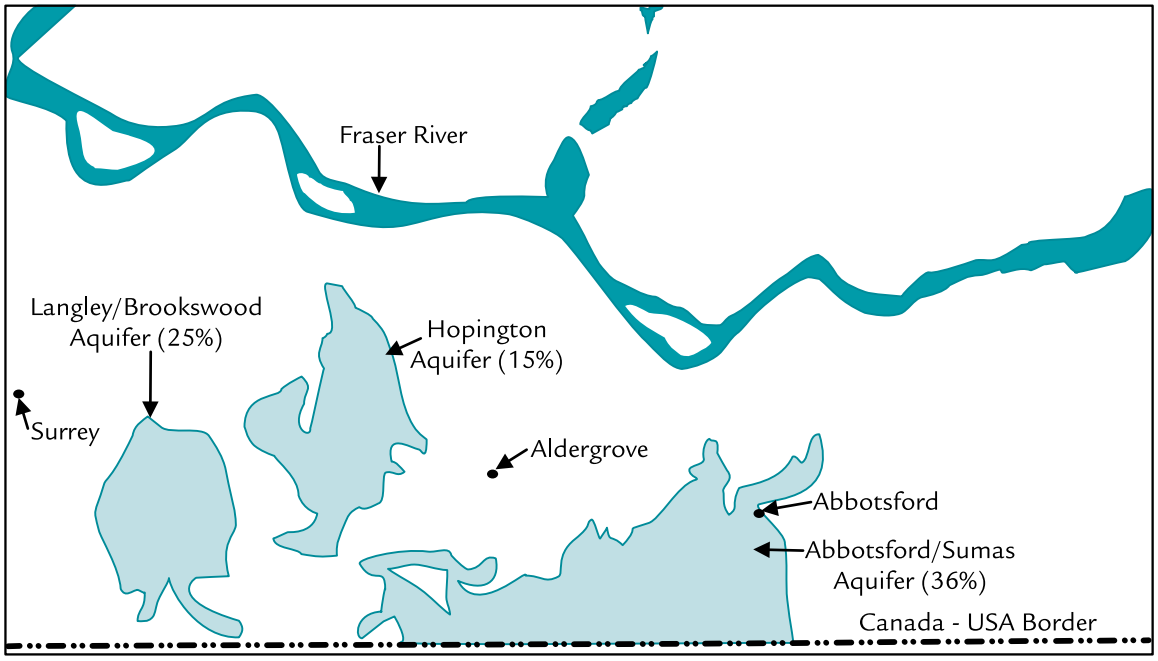
We believe the most cost-effective way to deal with this nutrient loading problem is to focus regulatory efforts in problem locations, and to give both positive and negative encouragement to farmers to follow the Code.

In areas where nutrient loading exceeds absorptive capacity, regulations should be stiffer than in regions where nutrient loadings are in balance. The Province has recognized this as a requirement for sewage plants, and is proposing region-specific standards for nutrient loadings from them. We believe that this is a reasonable approach for nutrient loadings

Exhibit 22

Nitrate Contamination of Groundwater in the Fraser Valley

The map shows some of the main aquifers in the Fraser Valley, and the percentage of tested wells in each aquifer with nitrate levels exceeding the Guidelines for Canadian Drinking Water Quality



Source: *Fraser Valley Groundwater Monitoring Program Final Report,* 1995; BC Ministry of Health, Ministry of Environment, Lands and Parks, and Ministry of Agriculture, Fisheries and Foods

in general. Management tools developed in other jurisdictions for dealing with location-specific nutrient loadings could provide a good starting point for the Province. These include the Total Maximum Daily Loads program of the US Environmental Protection Agency, and nutrient credit trading in the Tar-Pamlico watershed of North Carolina.

We recommend that the Province develop region-specific regulations for agricultural sources of nutrients.

Encouraging compliance is important

Compliance does not always happen naturally; it must be encouraged. Investments in education for voluntary compliance can yield high payoffs. For example, the provincial government used federal funding to hire an outreach worker who has helped many Interior ranchers to minimize water pollution from their operations.

We recommend that the Province strengthen compliance with the Code of Agricultural Practice for Waste Management through more outreach efforts to encourage voluntary compliance by farmers.

At the same time, allowing non-compliance with the Code is unfair to those farmers who comply willingly. It may discourage them from doing so. If compliance adds to their costs, which is likely to be the case when disposing of excess manure, it puts them at a competitive disadvantage with non-compliant farmers.

We recommend that the Province give priority to monitoring compliance with the Code of Agricultural Practice for Waste Management, and to enforcement actions that encourage compliance with the Code, in order to maintain the incentive for voluntary compliance.

3.7: controls over septic tank systems do not pay sufficient attention to maintenance or to nutrient release

Towns, subdivisions and other human settlements can have a number of damaging effects on water sources if not properly planned and controlled. Some effects result from altering existing water flows by, for example, diverting streams or interfering with the recharge of aquifers by paving large areas. We discussed several of these effects in section 3.5 of this report.

Disposal of human waste can have important implications for drinking-water sources

We focus here on nutrients and infectious agents from sewage disposal. This is one of human settlement's most important impacts on British Columbia drinking-water sources. As well, regulation of sewage disposal is an aspect of human settlement for which the Province has a major responsibility. This is not as true for other human settlement issues, where local and regional governments are responsible for most regulation and control, under powers delegated to them under the Municipal Act.

Human waste can be safely disposed of through municipal sewage treatment plants or through on-site sewage disposal systems. Sewage treatment plants are regulated by the Ministry of Environment, Lands and Parks. Smaller on-site disposal systems—those with estimated total sewage flows under 22.7 m^3 per day—are regulated by regional health authorities.

It is uncommon in British Columbia to find sewage treatment plants upstream of drinking-water sources. Because of this, we focused our attention on on-site sewage disposal systems, especially septic tank systems. There are about 250,000 septic tank systems in British Columbia. If not located, constructed and operated properly, they can contaminate drinking-water sources with pathogens or nutrients. A single failing septic tank system can pose an infection risk, and even an immediate health threat if the infectious agent is not controlled by water treatment. The risk from nutrients is related less to individual septic tank systems than to the cumulative effects of many systems. The nutrient load from one septic tank system is unlikely to be significant—an average human excretes between 4 and 5 kg of nitrogen wastes per year, about

half of which will be released into the soil. However, adding new systems in an area that already has high nutrient levels may trigger problems. Nutrients can build up in the soil and groundwater over time to unhealthy levels, or encourage the growth of algae that make water treatment more expensive.

For example, Fort St. John's previous water source, Charlie Lake, had elevated levels of both coliform bacteria and nutrients, partly as a result of poor sewage disposal standards in houses near the lake. The city's water treatment system controlled the bacteria successfully, but the nutrients led to blooms of blue-green algae which affected the taste and smell of the water. In the Fraser Valley, some drinking-water wells have had to be shut down because they exceed safe nitrate levels. Nutrients from septic tank systems are believed to be a contributor to these nitrate levels.

Drinking-water impacts from septic tank systems can be addressed at four different stages

Undesired impacts from septic tank systems can be managed:

- during land-use planning;
- during subdivision approval;
- when a septic tank system is designed, approved and built; or
- during operation of the system.

We believe that good source-water protection calls for appropriate controls at each of these stages.

Land-use planning: no provincial tools have been used sufficiently for us to examine their effectiveness in dealing with septic tank systems

Land-use planning can reduce sewage impacts on drinking water by encouraging compact settlement patterns that can be cost-effectively served with sewer lines and sewage treatment plants, and by determining acceptable land uses in sensitive areas such as community watersheds and recharge areas. The Province has three major land-use planning tools that can address these issues:

- Broad-scale land-use plans (CORE, and land and resource management plans), which we discussed in Chapter 2.
- Regional growth strategies, which are regional visions, developed with provincial support, that commit affected municipalities and regional districts to a course of action to meet common social, economic and environmental objectives. One goal of the Growth Strategies Act, which

makes possible these strategies, is to protect the quality and quantity of groundwater and surface water.

- Liquid waste management plans under the Waste Management Act, by which municipalities or regional districts can work out how best to manage municipal sewage, stormwater run-off, and other liquid wastes for which they have responsibility. (Municipalities and regional districts can also influence the impact of septic systems through their official community plans and land-use bylaws, and through extension of sewer lines into previously un-sewered areas, but these are outside the scope of our audit.)

We lacked sufficient information to examine the effectiveness of these planning tools. We were unable to find examples where these tools were being used to deal with septic tank issues, and where the processes were sufficiently advanced for us to judge their likely effectiveness.

Subdivision approval: attention to cumulative impacts is lacking

Approving officers—provincial or municipal employees with the authority to approve new subdivisions—must ensure that a proposed subdivision conforms to provincial Acts and local bylaws, and that the best interests of the public are protected. However, when reviewing subdivision proposals that call for septic tank systems, approving officers can only look at each proposal in isolation; they cannot consider the cumulative effects of similar projects that have already been built or are currently under application.

We recommend that the Province consider giving approving officers the authority to take into account the cumulative impacts of septic tank systems when examining subdivision proposals.

Design, approval and construction: nutrient control requirements should be considered for wider application across the province

Newly constructed septic tank systems are regulated under the Sewage Disposal Regulation of the Health Act, which prohibits new systems from releasing infectious agents into nearby waters. Pathogen control is the primary intent of the regulation, and we found no reason to be concerned with this aspect of septic tank system management.

However, we noted that the risk of nutrient accumulation was less well addressed. Being soluble, nutrients may not always be removed as completely by the septic field and surrounding soil as are the pathogens, which are particles. As mentioned above, nutrient problems usually result from the

cumulative effect of many systems, rather than from a single system. Yet, when applying the regulation, health officials can only look at a proposed septic tank system in isolation, and not at whether a number of similar systems could together result in undesired impacts.

The regulation does have specific provisions designed to control nutrient build-up from septic tank systems in areas of the province where this is considered a special risk. These provisions currently apply only in the Okanagan Valley. (Two regional districts, Fraser-Fort George and Okanagan-Similkameen, have developed their own regulations for septic tanks to protect lakes from nutrient build-up.)

We recommend that the Province determine whether there are areas of British Columbia in addition to the Okanagan Valley where nutrient-control provisions for septic tank systems could help reduce the need for investment in new drinking-water sources, or in higher levels of water treatment.

System operation: controls over long-term maintenance of septic tank systems are being developed, but are not yet in place

Regulations have been developed that require municipal sewage treatment plants and small on-site packaged treatment plants to be serviced and kept in good condition. In contrast, there are at present no explicit maintenance requirements for septic tank systems. However, the Ministry of Environment, Lands and Parks and the Ministry of Health are currently working on a proposal to help local governments develop maintenance bylaws for septic tank systems.

We recommend that the Province complete and implement the proposal to help local governments develop maintenance bylaws for septic tank systems.

3.8: several other activities may also affect drinking-water sources

During our audit, we became aware of a number of other human activities that could affect drinking-water sources. In some cases we learned that an activity was a problem in other jurisdictions, or we noted that an activity is similar to others that we already concluded had a significant potential for harm. In other cases, knowledgeable land use managers or researchers expressed concern to us about an activity as currently carried out and managed in British Columbia.

Although we were unable to conclude that the following activities are significant threats in BC at the present time, we received sufficient indications to believe they are worthy of further examination:

- forestry and cattle grazing: fire suppression, use of retardant chemicals to fight fires, use of controlled burning in silviculture or range management
- mining: gravel and aggregate extraction, oil and gas extraction
- transportation: corridors for electricity transmission lines and pipelines
- agriculture: application of pesticides
- human settlement: disposal of sewage sludge, industrial and other point sources of pollution.

chapter 4:
the absence of groundwater management has resulted in increasing problems

the absence of groundwater management has resulted in increasing problems

Groundwater in British Columbia is threatened by both contamination and depletion. As part of its groundwater inventory work, the Ministry of Environment, Lands and Parks classifies British Columbia aquifers according to the risks to their quantity and quality. To date, over 300 aquifers have been classified, largely in the areas of highest population density. Of these, which represent about one-half of the province's developed aquifers, 8% are at risk due to heavy use and 31% are highly vulnerable to contamination from surface sources. Ninety-three percent of these classified aquifers are used for drinking water.

Groundwater degradation is a concern in rural as well as urban areas. The 1996 report on *The State of Canada's Environment* noted that 20–40% of all Canadian rural wells are believed to be contaminated by high levels of nitrates or fecal coliform bacteria. Such signs of degradation have been found in rural wells in the Lower Mainland and Southern Interior parts of British Columbia.

Damage to underground water sources is a concern because groundwater moves and recycles slowly. A typical flow rate for groundwater is around 30 m per year. In addition, contaminants such as petroleum products tend to cling to the particles of the strata in which the groundwater is located and are not easily flushed out. These two factors make remediation of contamination much more difficult for groundwater than for surface water sources, and can result in the destruction of groundwater as a drinking-water source for many years.

Examples in other jurisdictions illustrate how serious the degradation of groundwater can become. In the Kitchener-Waterloo area of Ontario, groundwater depletion has necessitated a search for an alternative source such as Georgian Bay, 120 km away. In Elmira, Ontario, it is estimated that cleanup of toxic chemicals in the town's groundwater source will take about 30 years. Remediation and provision of an alternative water source have cost $50 million to date. Officials in Manotick, Ontario, have abandoned hope of cleaning up groundwater contaminated by dry-cleaning solvent leaked from a storage tank. Even where wells have been abandoned, contaminated groundwater has continued to move, eventually re-emerging where it can affect the quality of surface waters.

For example, hazardous waste disposal sites in the United States have been leaching toxic chemicals into the Niagara River via groundwater for decades.

Twenty-five percent of all the groundwater extracted in Canada is used in British Columbia. Industry is the largest user of this groundwater (55% of the total use), followed by agriculture at 20%, municipalities at 18%, and rural domestic use at 7%. Despite being one of the largest users of groundwater, British Columbia is the only province without specific groundwater legislation. There are few controls over withdrawals of groundwater, and existing pollution prevention legislation is limited in its application to groundwater contamination. Regional consultations held by the Ministry of Environment, Lands and Parks in 1994 to discuss proposals for comprehensive groundwater legislation showed strong public support for better management of this resource. In 1998, the ministry again proposed legislation to address the need for better groundwater information, planning and protection, but this legislation was later postponed for at least one year.

We found disturbing signs that groundwater in British Columbia is at risk and believe there is a need to protect it. If not addressed now, groundwater degradation could necessitate costly treatment and heavy investment in alternative drinking-water sources.

Groundwater use in British Columbia is significant

About one-fifth of British Columbians depend on groundwater for their drinking water. This reliance is higher in rural areas (where 40% of all water used is groundwater) than in municipal areas (where groundwater accounts for 12% of the total municipal water use).

Groundwater is often preferable to surface water because sediment and pathogens are naturally filtered out as water seeps through layers of gravel sand, silt and rock on its way into and out of underground storage areas (aquifers). This reduced need for treatment—and the resultant savings—was a key factor in Fort St. John's switch to a groundwater source. It also allows many systems to use groundwater as a backup against intermittent surface-water problems.

Groundwater is clearly a resource of considerable value in British Columbia. Its use is expected to increase in the future, particularly in rural areas. Consequently, its continued degradation represents an increasing financial risk to the Province and water purveyors.

The known quantity of groundwater in the province is shrinking

Monitoring at observation wells throughout British Columbia has shown an increase in the number of areas with declining groundwater levels over the past 30 years. There are concerns that this will soon jeopardize drinking-water sources of groundwater users, and also the water available in surface-water bodies that are fed by aquifers.

As noted above, over 300 British Columbia aquifers have been classified by the Ministry of Environment, Lands and Parks. Eight percent of these are considered to be at risk due to heavy use. Heavy aquifer use lowers levels in nearby wells and may draw poor-quality water into an aquifer. For example, aquifer depletion on the Gulf Islands and Saanich Peninsula is causing salt water intrusion. Aquifer depletion is also occurring as a result of constructed artesian wells which are allowed to flow freely, thus wasting water in areas such as Surrey, the Okanagan, the Gulf Islands and Saanich. Groundwater levels can also be affected by the presence of impervious ground cover which reduces the area over which rainwater can seep into the ground to replenish aquifers (see discussion in section 3.5 of this report.)

Groundwater withdrawal is not regulated in British Columbia

From our research, we have identified four components of control that we think are necessary to protect groundwater from depletion:

1. controls on the quantity of groundwater removed
2. ongoing monitoring of aquifer levels
3. requirements that any negative impacts be remediated by the party responsible for removing the groundwater
4. enforceable consequences to prevent further depletion by the responsible party.

None of these four components is present in the current groundwater management program in British Columbia.

Groundwater withdrawal is not regulated through a licensing or permitting process. The Water Protection Act restricts the bulk export of groundwater in containers greater than 20 L in size and requires the registration of wells if they are used for exporting groundwater outside the province. As well, the Environmental Assessment Act requires environmental assessments for large groundwater withdrawals—those in excess of 75 L per second. (The Environment Assessment Office, which administers the Act, has stated that the process

of approving a project includes the identification of mitigation measures with which the proponent must comply. Requirements to monitor negative impacts may also be included as part of the terms of project approval.) Beyond this, however, there are no legal requirements to monitor aquifer levels or remediate depletion caused by withdrawals. The Water Act, which serves as an allocation instrument for surface water, does not apply to groundwater (although it contains an un-enacted section for the extension of the current surface-water licensing scheme to cover groundwater). And, finally, because removal of groundwater is unregulated and unmonitored, there are also no requirements for remediation of damage or processes to prevent further depletion.

While other jurisdictions in North America have implemented measures to regulate groundwater withdrawals, we believe British Columbia may not have sufficient information about groundwater usage to determine what steps should be taken to protect this resource. As a first step, ***we recommend that the Province ensure regular monitoring of groundwater usage and levels in all developed aquifers across the province.***

Land-use practices can harm groundwater quality

Groundwater is vulnerable to contamination from land-use practices, particularly where aquifers are unconfined or where water levels are close to ground surface. Thirty-one percent of the more than 300 aquifers classified by the Ministry of Environment, Lands and Parks are considered highly vulnerable to contamination. Ten percent have been affected to the point that the water quality is a health concern.

Most of this contamination is a result of human activities. For example:

Transportation and industry: Wood waste, landfills, chemical spills and underground tank leakages can all degrade water quality. Transportation-related spills in Sparwood and Grand Forks have resulted in ongoing closures of wells for drinking-water purposes.

Agriculture: Over-application of manure, fertilizers and pesticides can result in high nitrate levels and organic chemicals in groundwater. Although there is little evidence of significant pesticide levels in British Columbia groundwater to date, parts of the Lower Mainland aquifers consistently show nitrate levels above those accepted in the *Guidelines for Canadian Drinking Water Quality.* A similar situation exists in the Osoyoos and Grand Forks regions of the province. Large pig, cattle and poultry operations, such as those in the Lower Mainland, Peace

River and Kamloops areas, are a concern because the volume of manure they produce often exceeds the absorptive capacity of the land available to spread it on. A typical beef feedlot houses several hundred cattle, each of which would produce nutrient waste roughly equivalent to that of 10 people.

Sewage: Groundwater can be contaminated by septic tank systems that malfunction or are located too close to wells. This has been a concern to city officials in Williams Lake, where rural residential developments and trailer parks with inadequate septic tank systems have been located outside city boundaries and above the aquifer recharge zone. In response, steps are being taken to bring the developments into the city and onto city sewers.

Mining, oil and gas: Mining and oil and gas activities have the potential to contaminate groundwater. Salt water is often found underground in the same location as oil and gas reserves and can be released by the drilling and extraction processes, creating a potential to contaminate groundwater sources. Geologic formations that are sources of minerals such as zinc and coal are also a potential source of acid rock drainage. Mining exposes them to rainwater, which can then carry the contamination into groundwater.

Well drilling: Poorly constructed or uncapped wells may allow pollutants to enter an aquifer, particularly if run-off is high, or if a well is in a low-lying area or close to a source of contamination. Examples of poor well construction resulting in degraded well water quality can be found on the Gulf Islands and in Saanich.

Controls over groundwater pollution are incomplete

The components of an effective program to protect groundwater *quality* are similar to those outlined above for the protection of groundwater *quantity:* controls over potentially harmful activities, ongoing monitoring, requirements for polluters to remediate damage, and an enforceable means of seeking compensation and preventing further damage.

Most of these elements are missing in British Columbia's regulatory program for groundwater. The main tool of control is the Waste Management Act, which authorizes the Ministry of Environment, Lands and Parks to issue pollution abatement orders and spill clean-up orders, and to regulate the use of substances or activities that may pollute ground or surface water. However, there are a number of areas where current legislation is not effective in controlling the types of groundwater contamination listed above.

Transportation and industry: Effective control of pollution depends on prompt identification of the source of pollution and assignment of responsibility for its cleanup. This is not possible with many sources of groundwater contamination such as leaking underground fuel storage tanks, run-off from vehicle washing and servicing facilities, and seepage of road salt and herbicide applications. In situations like these, where the pollution is from a diffuse source or is not immediately apparent, causation is hard to prove and cleanup difficult to enforce (see section 3.5 of this report).

Agriculture: Farm operations are supposed to adhere to the Waste Management Act's Code of Agricultural Practice which, if followed, should minimize contamination of underground water sources. To date, however, the Code, as applied, does not appear to be achieving this goal (see section 3.6 of this report). We are concerned that, if this continues, water systems drawing from groundwater sources affected by farm discharges will be required to spend increasing amounts to treat drinking water or to arrange alternative sources.

Sewage: Small on-site disposal systems are exempt from the Waste Management Act. Regulation of these operations comes under the Health Act. However, there is no requirement to monitor operations to prevent harmful discharge into groundwater (see section 3.7 of this report). Similarly, no monitoring requirement exists for another section of the Health Act, which prohibits contamination of wells as a result of washing, bathing or disposing of dead material, sewage or factory waste.

Mining, oil and gas: Discharges from mining and oil and gas operations also come under the control of the Waste Management Act. We found that mining had no negative impacts on drinking water in the eight centres we visited. We also noted, however, that assignment of responsibility for detecting and correcting damage to local groundwater sources is not a mandatory requirement of all mine operations.

Oil and gas wells are usually permitted one at a time under the Waste Management Act. Ministry of Environment, Lands and Parks officials have expressed concern that there is no tracking of the cumulative impacts of such wells on groundwater. In addition, they have noted the potential for contamination from inactive oil and gas sites that have not yet been cleaned up.

Well drilling: Water-well drilling is currently unregulated in British Columbia. In 1982, the Ministry of Environment, Lands and Parks implemented voluntary guidelines for well

construction, and in 1986, developed a voluntary well drillers' certification program in partnership with the British Columbia Water Well Drilling Association and the Ministry of Labour. A draft Code of Practice for construction, testing, maintenance, alteration and closure of wells was developed in 1994 to support future regulations and augment the earlier guidelines. Both the Code and the training program have been supported in varying degrees by water well drillers in British Columbia, but poor well construction is still a cause of groundwater contamination in the province. Ministry of Environment, Lands and Parks documents suggest these measures would be more effective if compliance were mandatory.

Measures to address the major sources of groundwater contamination are discussed in the corresponding sections of Chapter 3. However, as other jurisdictions have done, the Province may find specific regulatory measures are required to protect groundwater sources. To enable the Province to assess the condition of its groundwater sources and determine if specific protection measures are required, ***we recommend that the Province ensure that monitoring of groundwater quality occurs regularly in all developed aquifers in the province, and more frequently in all vulnerable aquifers.***

Notwithstanding the lack of legal protection for groundwater quality, the Ministry of Environment, Lands and Parks continues to promote better management of groundwater via non-regulatory mechanisms. In keeping with its ongoing focus on stewardship as a key to good water management in British Columbia, the ministry is encouraging communities and purveyors to initiate well protection plans. These plans are intended to prevent groundwater degradation through better management of activities within the capture zone of community wells. As part of such a plan, a community would determine local well capture zones and the contamination risks, and then take measures to safeguard or eliminate the risks such as monitoring the water quality on an ongoing basis. Preliminary well capture zones have been drawn up around community wells in the Lower Mainland as part of the Fraser Valley Groundwater Monitoring Program. We believe these plans offer good potential for reducing groundwater contamination and suggest that the government consider working with communities to establish such plans on a broader basis throughout the province.

Knowledge about our groundwater sources is limited

Little is known about the location of British Columbia's underground water sources, their recharge patterns, or the state of the water in them. This hampers the province's ability to protect the resource.

Since 1994, the Ministry of Environment, Lands and Parks' aquifer classification program has mapped about one-half of the developed aquifers in the province—parts of eastern Vancouver Island, the Fraser Basin and Lower Fraser Valley, and the Okanagan-Shuswap. Well-record information, voluntarily submitted by well drillers, helps the ministry to map, classify and assess aquifers. In addition, the ministry maintains a network of 150 observation wells strategically located throughout the province to provide data on groundwater level fluctuations in major areas of groundwater use. Water quality in these wells is also tested, but only every one to five years. Site-specific groundwater quality monitoring studies have been undertaken in areas such as the Lower Fraser Valley, Osoyoos and Grand Forks where degradation is known to be occurring.

The work that ministry staff have done to date appears to be sound and valuable. However, most of the information accumulated relates to the developed aquifers in the province and little is known about other sources of groundwater. Groundwater mapping is not covered in the base budget of the ministry, so it can only be done where other projects will fund it. Much of the existing knowledge about British Columbia's groundwater has been assembled with funding from other jurisdictions or other provincial initiatives. For example:

Federal funding: Fort St. John's new groundwater source was initially identified through exploratory drilling and aquifer mapping done by the Prairie Farm Rehabilitation Administration, which also worked with the city's consultants to locate the best well sites for the city, and is now advising the city on a well maintenance program. Mapping of the aquifer underlying Prince George was funded under the federal Green Plan as part of the Fraser River Action Plan. Environment Canada and Agriculture Canada are monitoring water quality and mapping contaminant sources for the Fraser Valley aquifers, and Environment Canada has provided funding and technical support to the Ministry of Environment, Lands and Parks for aquifer classification and vulnerability mapping in this area.

Municipal funding: Williams Lake sank its first well in 1970, but had little information on the underlying aquifer until it commissioned its own study in 1991 in response to dropping well levels. Chilliwack has hired consultants to develop a plan for its aquifer, including detailed vulnerability mapping, mapping of recharge areas, flow modeling and an inventory of contamination risks.

Funding from other provincial initiatives: Aquifer mapping on east Vancouver Island was funded by the Corporate Resources Inventory Initiative in support of CORE. Funding for mapping the Okanagan-Shuswap aquifer was provided as part of the land and resource management plan process.

This dependence on other funding sources means that work cannot always be directed to the areas of greatest urgency, or towards a systematic information-gathering program by the Ministry of Environment, Lands and Parks. For example, vulnerability mapping—to identify sensitive areas needing protection—has been carried out in the Abbotsford aquifer, but current funding levels cannot support extension of this activity to other parts of the province. Resource constraints prohibit the expansion of site-specific groundwater quality monitoring studies into a more systematic groundwater quality monitoring network. Without such ongoing monitoring of quality, no baseline exists against which to measure the impacts of contaminating activities.

The Ministry of Environment, Lands and Parks has recently proposed a five-year renewable program aimed at acquiring information about British Columbia's groundwater resources to support an effective groundwater management program. We believe this work would be valuable.

On the other hand, we note that the Province is not making full use of the information it has already collected. Lack of a consistent format for information submitted by well drillers to the Ministry of Environment, Lands and Parks detracts from its usefulness to the ministry. In addition, ministry staff have reported that, because of a lack of resources, submissions are frequently not entered into the ministry database. Well drillers belonging to the B.C. Groundwater Association recently lifted a moratorium on the voluntary submission of well records to the ministry, based on assurances that efforts would continue towards improving the currency and availability of complete information on the ministry's computer database. We support the strengthening of this program to ensure that up-to-date information is available to provincial staff, the well drillers and the groundwater users.

A final shortcoming in the existing system is the lack of integration amongst the various collections of provincial groundwater information. Most of this information is kept in five separate databases:

- a well water database,
- a water licensing database,
- an environmental monitoring database,
- and the Water Quality Check Program database,

all maintained by the Ministry of Environment, Lands and Parks, and,

- a water quality monitoring database,

maintained by the Ministry of Health.

For a variety of reasons, these different databases are not linked and therefore the information in them cannot be easily combined. Until these linkages are developed, the Province cannot effectively use the large amounts of information it currently owns on water quality and water use to support groundwater assessment and management.

To enable it to collect and use the information needed to manage its groundwater resources, ***we recommend that the Province establish a comprehensive and coordinated aquifer mapping and inventory program.***

chapter 5:
small water systems are particularly vulnerable to the impacts of inadequate water-source protection

small water systems are particularly vulnerable to the impacts of inadequate water-source protection

Our audit work focused on medium to large drinking-water systems. However, while most of the population is served by a few medium to large systems owned by the major cities, most of the systems in the province are smaller ones supplying portions of the population in rural areas and smaller centres.

Officials in the Ministry of Environment, Lands and Parks and the Ministry of Health have stated that the most likely threats to drinking-water quality, and to human health from water-borne disease, lie in small water systems. To ensure that we obtained a picture of the range of drinking-water systems in the province and the level of protection provided for them, we included questions about drinking-water sources in the smaller communities and the rural areas in our interviews with provincial government officials. Our research of current literature on the protection of drinking-water supplies was also directed at the full range of systems.

Small water systems are common in the province

Approximately 500,000 people (one-seventh of the total British Columbia population) are known to get their drinking water from small systems. Sixty percent of these people use surface water and the rest rely on groundwater.

Small water systems can be classified into two categories:

1. individual systems that supply a single property or household; and
2. community water systems that supply two or more connections, or have a single connection providing drinking water to the public.

Included in this latter category are commercial operations such as motels and fishing resorts, some of which are situated in remote locations.

Individual systems are primarily installed in rural areas where few community systems exist. There are 24,000 domestic water licences that authorize the diversion of surface-water

sources to individual water systems. However, water licences are not always required for these systems and the Ministry of Environment, Lands and Parks officials estimate there are at least as many unlicenced individual systems using surface water.

Individual systems also use groundwater as a source. Although the total number of wells supplying individual households is not known, ministry officials suggest it could be comparable to the number of individual households using surface sources.

Community water systems are owned by the following types of agencies:

- cities, municipalities, towns
- regional districts
- improvement districts (which include irrigation districts)
- water users' communities
- privately owned utilities
- commercial operations such as mobile home parks, motels and resorts.

Of these, about 1,440 community water systems serve between 2 and 15 connections and 780 serve from 16 to 299 connections.

Small water systems face more threats than large ones

All of the issues we discussed in Chapter 3 regarding the management of land use to protect source waters apply to small systems as well as large ones. In Chapter 1, we noted that most of the major water systems we visited faced only a few of the potential threats to drinking-water quality that we had identified in our audit (see Exhibit 5). Small systems, on the other hand, have a high likelihood of being at risk from several of the threats. Small systems serve small developments and rural households, typically located in less developed areas. Because these areas are also more likely to support activities such as logging, agriculture, mining, grazing and outdoor recreation, there is a strong probability that these activities will occur near the drinking-water source of a small system.

In addition, small surface systems are more likely to rely on small water bodies, which have less capacity to dilute contaminants and greater natural variation in flow levels than larger bodies. This makes small surface drinking-water systems more vulnerable to any impacts that other resource users might have on the water source.

Less protection of water sources is available to small systems

Despite the greater vulnerability of small systems to water quality and quantity threats, there is less protection available for their water sources. For example, the "community watershed" designation under the Forest Practices Code is intended to protect surface-water systems from the impacts of logging on Crown land. While small-town water sources benefit from this protection, the designation does not apply to individual and very small community system sources because their water systems serve too few users to qualify as community watersheds. It also does not apply to commercial sources because their water licences are classed as industrial. Without this designation, the source watersheds of these systems have a lower level of protection as a result of reduced requirements for planning and monitoring of forest harvesting activities. Work has been done by the provincial government to adapt the community watershed type of protection to smaller domestic watersheds on a province-wide basis, but the resulting guidelines have not yet been implemented.

It is not a requirement to obtain a water licence to take surface water for domestic needs, provided this water has not already been legally allocated to another user. Nevertheless, many domestic surface water users are licensed. The benefit of this is that in water-short periods, the holder of a water licence is entitled to an allocation of water, subject to the conditions of the licence and the allocations of licences that were issued earlier. Despite this benefit, officials of the Ministry of Environment, Lands and Parks estimate that a significant number of individual surface system owners, particularly in rural regions, do not obtain licences—possibly as a result of the cost of a licence, the backlog within the ministry for issuing licences, and the growing number of restrictions on licences. Without a licence, the individuals operating these systems lack any priority rights to the water in periods of low supply.

Aversion to licensing may also be one factor responsible for the number of small systems that rely on wells, since there is currently no licensing requirement for using groundwater. However, an additional factor is the availability of surface water. In some rural areas, such as the Gulf Islands, groundwater is essentially the only natural water source available. And, where surface-water licences have been restricted in dry areas (such as Kamloops) because of summer shortages, groundwater has appeared to offer better chances for an uninterrupted water supply.

A third factor that has made groundwater an attractive source of drinking water for small systems is its reduced need for treatment relative to surface-water sources. Because of the protection of covering layers of soil and rock, groundwater can remain relatively uncontaminated by the impacts of other activities such as agriculture, mining, transportation and sewage disposal. However, with the growing intensity of these operations and the cumulative effects of ongoing contamination over time, groundwater quality is no longer as assured. Groundwater quantities are also in jeopardy in many areas and no legislation exists to prohibit groundwater depletion (see Chapter 4). Small groundwater systems are more vulnerable than large ones because they usually rely on a single well and their limited resources allow fewer choices for a well site.

Regardless of whether a supplier uses surface or groundwater, the responsibility to compensate an operator for damage to the water source from competing resource uses in the source area is rarely set out in legislation. For example, no provision exists in mining legislation to ensure compensation for small water supply systems if mining activity destroys either the quantity or the quality of their water source. The cost of proving responsibility for damage could be prohibitive for private systems, and difficult even for small towns and commercial systems to consider. At the same time, the system operator is required, by law, to maintain the quality of the drinking water at a level set by the local health authorities. This could entail funding the development of a new water source if the damage to the quantity or quality of the drinking-water source is long-lasting.

Small systems often lack resources for adequate tapwater protection

Any water supply system that provides water for public domestic use or for more than one single-family residence is required—under the Safe Drinking Water Regulation of the Health Act—to have an operating permit from the health authorities. Granting of the operating permit triggers a process for mandatory monitoring of the operation and of the tap water's bacterial quality. Since the monitoring program is intended to protect customers of the water purveyor, private water systems serving single residences do not require permits under this regulation and, as a result, are not protected by the regulation or the Health Act. The Ministry of Health does provide several educational packages to assist homeowners in establishing and maintaining safe tap-water systems. Nevertheless, this does leave individual household water supplies more open to health risks.

Enactment of the Safe Drinking Water Regulation in 1992 moved responsibility for monitoring tap-water quality from health authorities to the water purveyors. The intent was to introduce the requirements of the regulation gradually to give purveyors time to build monitoring into their operations. At this date, only large cities and towns have the staff and budget to carry this out. As a result, many purveyors still rely on health authorities who are not always able to maintain the required level of monitoring. Permitted systems, particularly in remote areas, may not be inspected on a regular basis because of health authorities' workloads, limited travel budgets, and pressure to give priority to inspections for new developments. For example, in one health unit, most systems with 14 connections or fewer are tested for bacteria a maximum of once per year, and usually in October rather than during spring run-off when the highest coliform levels would be expected in surface water. Chemical analyses of these systems are done, on average, only once every five years. Inspections of new and changed septic systems occupy health officials' time during spring, summer and fall, with the result that seasonal resorts, which close during the winter months, may not receive even one water system inspection per year. Health officials are also hampered in addressing the most critical needs for inspection, monitoring and assessment by the lack of a modern, user-friendly central water-sampling database system.

Small water systems lack dollars and staff to create their own protection processes. Large systems are able to employ full-time water-quality managers to monitor their systems, plan and implement ongoing preventative maintenance programs, and stay informed about water-quality threats and protection mechanisms. Small systems do not have this capability. Problems are often not foreseen, and when they occur, there is not enough money to correct them. Small operators also have difficulty accessing provincial funds for capital costs: the total provincial funding available is limited and only municipalities and regional districts are eligible. Other small unincorporated communities such as improvement districts and private or commercial systems do not qualify for current funding programs. Where there are measures that small systems could afford, such as chlorination, misconceptions about the associated risks and costs often deter their adoption.

Water-source quality receives limited consideration in development approvals

In the past, through lack of land-use planning, many small systems have developed where single or multiple large systems could have supplied a larger area more economically. In some cases, regional land-use bylaws have allowed the creation of small rural systems to allow higher density subdivisions without the need to provide a regional water-supply system. The Ministry of Environment, Lands and Parks, which regulates small utilities, has found it difficult to reject proposals for utilities to serve new developments because they have often already been approved by the regional government. Many of these small systems later prove not to be financially viable and suffer from a lack of trained operators to monitor water quality and maintain the system. In previous years, failed systems were taken over and managed by regional districts, with two-thirds of the costs of upgrades being funded by the provincial government. Approximately 100 private utilities have been transferred to local government ownership since 1972, but as provincial funding for this has shrunk, so has the willingness of local governments to take on this responsibility.

In many cases, existing surface-water sources for small systems were chosen because they were the handiest and cheapest for the community or the individual user to access. As a result of natural conditions or existing uses, these watersheds may have been poor-quality water sources in the first place, and therefore poor choices for added protection. Activities such as logging, mining, recreation, agriculture and grazing (all of which can impact water quality) may pre-date the issuance of the water licence for domestic use. And furthermore, these activities may produce economic benefits that significantly outweigh the benefits of reduced drinking-water treatment for the small population served by the small system.

Situations such as these underscore the need for integrated resource management in watersheds. They also suggest that where drinking water is not an appropriate priority for the watershed, domestic water licences should be issued only if there is no possible alternative. Where groundwater can be used with less impact on other economic activities, it may make sense to limit domestic water systems to groundwater even though accessing it will require a larger initial expense for the system owner. These kinds of options warrant closer consideration in watersheds where the number and average

size of systems is low, and the balance between resource extraction values and water treatment costs per domestic user shifts away from source-water protection.

Source-water protection should be balanced by system owner responsibility

While the measures identified above may help prevent future conflicts involving small systems, other steps may be necessary to address the problems of existing small system users.

We believe that these users should be able to expect some minimum level of source protection along with an appropriate level of information on the quality of their water source. However, where the minimum level of source protection cannot be achieved without excessive cost to the public or excessive loss to a competing economic activity, it may be necessary to consider some trade-offs between resource uses. For example, the owner of an existing water system might receive some of the benefits from a competing activity being established in the watershed to support the owner's costs of extra water treatment or of securing an alternative water source. Such trade-offs could be one issue addressed within an effective integrated resource management process, as described in Chapter 2.

At the same time, we believe that small system owners have a responsibility to be informed about preventative measures available to minimize the impacts of natural and human activities and to provide the best system within their resources. This responsibility could include a requirement to contribute to an overall system of protection, perhaps by providing a minimum level of treatment for their drinking water. In addition, we believe they have a responsibility to pursue opportunities to join in larger, more viable systems. As noted earlier, the provincial government has encouraged this through the transfer of private utilities to local governments. Similarly, since the mid-1960s, it has reduced the number of improvement districts from 300 to about 275 by encouraging transfers of water systems to regional districts, or by extending municipal boundaries to incorporate areas previously outside municipal water systems. Other measures which the government might consider revisiting to discourage the existence of small, uneconomical systems are the introduction of infrastructure or water works standards for small systems and an appropriate pricing structure for surface and groundwater.

Under the current system of drinking water management, the small water-system users are particularly vulnerable to destruction of their source-water quality and quantity. Accordingly, ***we recommend that the Province ensure that any examination of the rights and responsibilities of drinking-water system owners considers the special circumstances of small system users.*** A lead agency for drinking-water interests, as proposed in Chapter 2, could be considered as an appropriate body to lead and coordinate such a review.

chapter 6:
our recommendations

our recommendations

Note: The page number in brackets after each recommendation refers to the page where the recommendation is presented in the body of the detailed report.

Water-source management in British Columbia is not integrated

We recommend that the Province:

1. *Ensure that in integrated management processes dealing with drinking-water issues:*
   - *drinking-water consumers and suppliers are meaningfully represented;*
   - *decisions are grounded in sufficient reliable information about natural conditions in the watershed and the values and impacts of competing resource uses; and*
   - *findings and recommendations are handed off to elected or appointed officials with the authority to act on them. (page 53)*
2. *Designate within government a lead agency for drinking-water interests, to coordinate government policy and action on drinking-water issues. (page 54)*
3. *Report annually, at both provincial and local levels, on its protection of drinking-water sources. (page 56)*
4. *Issue a comprehensive set of guidelines for good drinking water, so that decision-makers and citizens can better understand the information they receive about drinking-water quality. (page 57)*
5. *Carry out a comprehensive evaluation of the rights of resource access of drinking-water suppliers, to determine if they are appropriate. (page 57)*

Improvements are needed in managing the effects of other resource uses on drinking-water sources

We recommend that the Province:

6. *Implement, as soon as possible, the requirements of the Forest Practices Code to have certain key examinations and judgments done by licensed professionals. (page 66)*
7. *Determine whether it has sufficient specialists on staff to support its approval processes for forestry operational plans appropriately. (page 67)*

8. *Examine and regularly report on both priorities for on-site inspections of operations in community watersheds and the frequency of inspections actually carried out. (page 67)*
9. *Develop water quality objectives for all community watersheds as a matter of priority, if such objectives are to remain the main legislated mechanism for results monitoring under the Forest Practices Code. (page 68)*
10. *Clearly assign responsibility for monitoring whether water quality objectives are being met, at all stages of forest development within community watersheds. (page 69)*
11. *Give consideration to widening the range of results-based monitoring in community watersheds required under the Forest Practices Code. (page 70)*
12. *Expand the range provisions of the Forest Practices Code to more effectively address risks from parasites. (page 74)*
13. *Consistently separate the responsibilities for developing range use plans and for enforcing them, or introduce compensating controls. (page 75)*
14. *Gather information on the impacts of recreation on drinking-water sources, as a basis for future policy development. (page 81)*
15. *Give priority to planning and building transportation routes and infrastructure in ways that will prevent the degradation of drinking-water sources. (page 90)*
16. *Continue to strengthen procedures to minimize damage to drinking-water sources from chemical spills and leaks, and to implement provisions to prevent wide-area (non-point source) contamination. (page 90)*
17. *Develop region-specific regulations for agricultural sources of nutrients. (page 94)*
18. *Strengthen compliance with the Code of Agricultural Practice for Waste Management through more outreach efforts to encourage voluntary compliance by farmers. (page 94)*
19. *Give priority to monitoring compliance with the Code of Agricultural Practice for Waste Management, and to enforcement actions that encourage compliance with the Code, in order to maintain the incentive for voluntary compliance. (page 94)*
20. *Consider giving approving officers the authority to take into account the cumulative impacts of septic tank systems when examining subdivision proposals. (page 97)*

21. *Determine whether there are areas of British Columbia in addition to the Okanagan Valley where nutrient-control provisions for septic tank systems could help reduce the need for investment in new drinking-water sources, or in higher levels of water treatment. (page 98)*

22. *Complete and implement the proposal to help local governments develop maintenance bylaws for septic tank systems. (page 98)*

The absence of groundwater management has resulted in increasing problems

We recommend that the Province:

23. *Ensure regular monitoring of groundwater usage and levels in all developed aquifers across the province. (page 106)*

24. *Ensure that monitoring of groundwater quality occurs regularly in all developed aquifers in the province, and more frequently in all vulnerable aquifers. (page 109)*

25. *Establish a comprehensive and coordinated aquifer mapping and inventory program. (page 112)*

Small water systems are particularly vulnerable to the impacts of inadequate water-source protection

We recommend that the Province:

26. *Ensure that any examination of the rights and responsibilities of drinking-water system owners considers the special circumstances of small system users. (page 122)*

chapter 7:
we asked provincial ministries and agencies to respond to this report

we asked provincial ministries and agencies to respond to this report

This report by the Auditor General highlights the importance of ensuring drinking-water sources are protected, details the challenges faced by water purveyors, touches on some of the efforts of the provincial government to protect drinking-water sources, and provides recommendations for improvements to those activities. Although existing drinking water quality throughout BC is generally very good, the Provincial Government agrees that various opportunities exist for improving measures to protect source waters. Improvements will be necessary to meet the drinking water needs of British Columbia as the population grows and economic activities expand.

This response represents the coordinated review of the report by the seven ministries and two agencies affected: the Ministries of Health, Environment Lands and Parks, Forests, Municipal Affairs, Highways, Energy and Mines, Agriculture and Food, plus the Land Use Coordination Office and the Environmental Assessment Office.

Government has been developing a drinking-water strategy that addresses many of the Auditor General's recommendations, along with other related issues. In response to the Auditor's report, an inter-agency committee was established to address the longer-term elements of the recommendations on source water protection, and to continue to encourage improvement of water treatment and distribution systems. All of the Auditor General's 26 recommendations are being reviewed to determine how policies and programs can be improved to better protect BC's drinking-water sources. The government has already taken action on some of the following items, or will be taking action shortly:

Improving Integration of Water Resource Management in British Columbia

A central recommendation of the audit is to ensure that the interests of drinking-water users are meaningfully represented in integrated land and resource decision making processes. The report acknowledges that appropriate representation has been achieved at the watershed level, but has been unclear at the strategic level. The Auditor General has recognized the efforts of the Kootenay-Boundary Land Use Plan and the Okanagan Land and Resource Management Plan (LRMP) in ensuring representation of drinking-water interests. Strategic level processes, such as LRMPs, and planning under the Forest Practices Code provide substantive opportunities for addressing drinking-water interests on Crown land. The provincial government has taken considerable effort to ensure that stakeholders are aware of these opportunities and has allowed for full participation of all groups at the strategic level.

The Auditor General notes that the strategic processes focus on Crown land only. The provincial government is aware that many critical drinking-water issues arise from activities on private land and that these activities may negate the benefits of best management practices undertaken on Crown land to protect drinking water quality. Opportunities for input to land use and management decisions on private land are generally not administered by the provincial government, but by local governments through land use planning processes such as Official Community Plans, Regional Growth Strategies and subdivision approvals. The province will explore how to assist local authorities by ensuring that all watersheds on both Crown and private land that are used or may be used as sources of drinking water are mapped and are easily identified.

Acquisition of private land may be critical to protecting drinking water in some cases. Significant benefits have been realized where local governments have chosen to purchase watershed land. Where purchase is not possible, land may be expropriated using a long-standing right under the Water Act (Section 27), available to holders of water licences for waterworks for domestic purposes, to prevent pollution of the water supply. Obviously, such a measure may be costly and controversial, and an act of last resort.

Water users, purveyors and regional health authorities will become more active and better informed participants in land use and resource management planning processes over time. Actions will be taken to ensure that staff in provincial agencies and local health authorities are better prepared to participate in these processes. Specific measures include: improving information access and data sharing, and promoting more extensive use of Geographic Information Systems (GIS) tools by those representing drinking-water interests. Guidelines and training for regional staff will ensure better collaboration between regional staff of the Ministry of Environment, Lands and Parks and regional health authorities.

The recommendation to establish a lead agency to represent drinking-water interests is served by the office of the Provincial Health Officer and the regional health authorities. The Provincial Health Officer is a credible voice for safe drinking water. This office produces an annual public report which includes an overview of the state of drinking-water supplies and provides expert advice on drinking water. Regional health authorities should increase their participation in local land use planning, along with their existing key roles in providing approvals and inspections of water treatment and distribution systems.

Improving the Management of Other Resource Uses in Drinking-Water Source Areas

Many of the recommendations directed at logging, grazing, mining, recreation, transportation, agriculture, and sewage disposal are generally supported by the ministries. In many cases, action has already been taken. Some examples and additional measures to address the recommendations are outlined in the following paragraphs.

Integrated land use planning provides an opportunity for recognizing and protecting drinking-water sources within community watersheds designated under the Forest Practices Code. Two recommendations refer to the need to set and monitor water quality objectives in community watersheds. The province is currently working to develop a more effective process to establish, monitor, enforce, and assign responsibility for water quality objectives.

The management of grazing in community watersheds is subject to regulations and guidelines. The issue, however, is complicated by the fact that wildlife and recreational activities may be contributing to health risks which are often attributed to livestock. Distinguishing between these various influences is technically difficult, and it is acknowledged that more information and further research is required. The province has recently initiated studies of the presence of pathogen indicators and parasites associated with recreational access to watersheds.

With respect to mining development, the recently enacted Mineral Exploration Code includes specific regulations to require sensitive exploration in community watersheds. The province will explore opportunities to improve communications with stakeholders to ensure effective participation in the Regional Mine Development Committee process. Larger developments are subject to review under the Environmental Assessment Act, which provides for stakeholder input prior to development approval.

The Auditor General suggests that region-specific regulations should be considered for those parts of the province sensitive to nutrient input from sources such as septic systems and agriculture. This is a useful approach, as sensitivity to nutrients does vary geographically. The province agrees with the Auditor's recommendation to focus on nutrient control provisions for septic systems in sensitive areas. Much is already known about which areas are of particular concern, so implementation of control measures can be initiated readily. Measures to be considered include improved maintenance of existing on-site disposal systems and use of alternative disposal methods.

The Auditor General also recommends taking a region-specific approach to regulating agriculture to protect drinking-water sources. The provincial government agrees with this approach. Although regulations are generally designed to be applied province wide, region-specific approaches to reduce agricultural impacts on drinking-water sources have been taken in recent years and further efforts are a priority. Steps already taken include the Manure Management Guidelines for the Lower Fraser Valley and a multi-agency consensus approach to developing compliance strategies for the Agricultural Code of Practice in sensitive watersheds. Designation of protected water supply areas and limits on livestock and poultry densities are also under active consideration for the Lower Fraser Valley. In addition, new guidelines for ditch maintenance and riparian management are being developed, and are expected to improve water protection in agricultural areas. Another new avenue for region-specific management of agriculture effects is applying the sensitive stream designation under the new Fish Protection Act.

The province agrees with the Auditor General's recommendations to give priority to planning and building transportation routes that prevent degradation of drinking-water sources and minimize chemical spills and leaks. Highways projects now routinely employ best management practices during both construction and maintenance. A recently issued Highway Environmental Assessment Process Manual will heighten awareness by ministry staff, contractors, agencies and stakeholders, of the environmental concerns and procedures around highway development. Typical measures include developing sediment, drainage and erosion management plans, installing temporary and permanent roadside water treatment ponds, and monitoring these facilities to assess performance.

Many of the concerns over protecting sources of drinking water raised by this audit are caused by contaminants which originate from diffuse sources; this type of pollution is referred to as non-point source (NPS) pollution. Point sources, such as discharges from sewage treatment plants or from industrial operations are closely regulated and effluent is treated to meet standards to prevent environmental degradation and minimize the risk to public health. NPS pollution is associated with urban storm water, runoff from forest or agricultural lands, or other sources where the individual contaminant levels are fairly low but the cumulative impact may be significant. This is an area where each individual can make a difference, and public awareness and education initiatives are under way to encourage action. The province has been working on several measures to address this type of pollution. Many initiatives are outlined here in response to specific recommendations, others will be initiated in the near future.

Improving Groundwater Management

The Auditor General notes that effective management of groundwater depends on gaining access to information such as well locations, volume of water used, well capacity and location of aquifers.

Several ongoing and new actions to improve the management of groundwater are being taken. Information on the location of aquifers is provided through voluntary submission of well records by well drillers while information on water levels in aquifers is obtained through a network of provincial observation wells. Classification and mapping of aquifers has been completed for the more densely populated regions and is ongoing for other significant areas. Additional measures being considered include the use of purveyor operation logs, installation of meters, and estimating usage based on the number of customers and licensed uses. Further improvements to the sharing of groundwater data among agencies will ensure more effective use of existing information.

Effective groundwater management also depends on cooperation between government agencies and local water users. In the Gulf Islands, for example, groundwater planning is being implemented through a pilot project involving a partnership between the Islands Trust, local community groups and the province to address water quality problems as well as concerns about low water supplies.

Presently, water purveyors who use groundwater or surface water, must comply with the Sanitary Regulation and the Safe Drinking Water Regulation under the Health Act. These regulations are potential tools for requiring submission of groundwater information. Recent efforts by the Ministries of Health and Environment, Lands and Parks to provide groundwater users with information to better protect their sources of drinking water includes publication later in 1999 of technical guidelines for well protection, referred to as the "Well Protection Toolkit." The "Toolkit," contains guidance to help communities get organized, define the area to protect, identify contaminants, implement management strategies, develop contingency plans in the event of spills, and monitor success.

Improving Protection for Small Water Systems

Small water system purveyors have the same responsibility to provide safe potable water to their customers as operators of larger sophisticated municipal systems. Given their resource limitations, the recommendation to pay particular attention to the needs of small system purveyors is strongly supported by the provincial government. Water systems serving a small number of customers are of particular concern as the economies of scale can preclude the installation of more comprehensive treatment technology. In many cases, small water

utilities cannot afford to retain professional operators. Opportunities for amalgamation of existing small systems, whether privately or publicly operated, to gain economies of scale within a geographical area will be promoted where possible.

Where treatment is minimal or non-existent, water consumers are very dependent on the quality of source waters making source protection measures most critical. It is important for purveyors to participate in local land use and resource planning and decision-making processes which have implications for the watershed or aquifer used as a drinking-water source. Training and support to small water system purveyors is an ongoing priority and further enhancements are being considered by the province.

Individual domestic water users must recognize that they have a responsibility to utilize a safe source as well as ensuring appropriate water treatment. Individual users need to be prepared to invest in water treatment measures, shift to a groundwater source, or both to protect the health of their household. Government recognizes that it has a responsibility to ensure that individual water users, whether they have a water license or not, have access to information about the risks to water sources and the need for appropriate treatment. Consideration will be given to increasing the general understanding of water quality guidelines applicable to source and tap water.

Other Considerations

Provincial programs which protect source water quality are only one component of government's responsibilities for assisting with the provision of safe drinking water. Other responsibilities involve the provision of medical expertise on health issues and the regulation of water treatment and distribution systems. These activities and those of local government, regional health authorities and the operators of private water utilities are not part of this audit.

As acknowledged by the Auditor General, the report is based on the premise that water source protection measures will reduce the cost of subsequent treatment. Emphasis on source water protection activities seems reasonable, but must take into account the broader financial and social impacts that enhanced source water protection could have on other economically important land uses. In some circumstances, a high level of source water protection may be entirely uneconomical, and alternative sources of drinking water or higher levels of treatment may be the only option. Nevertheless, the application of preventative measures to maintain the quality of source waters should always be considered as a fundamental part of the series of measures required to deliver safe drinking water. This series of measures is referred to as the "multi-barrier approach" and includes source protection, appropriate treatment, a well-maintained distribution system and regular monitoring. Complete

reliance on any one component, such as water treatment or source protection, may not be sufficient.

It is important to recognize that the quality of surface and ground water used as drinking-water sources is not only affected by human activity, but can also be affected by natural conditions. For example, even with range management practices in place, raw surface water can be rendered unsafe by the presence of parasites originating from wildlife. Turbid water is often a result of natural sediment movement associated with high flows which occur during spring thaw and heavy rains. Taste and odour problems may be due to normal levels of plankton growth. In fact, some contaminants may originate far from the watershed, being transported through the atmosphere for hundreds or thousands of kilometers. The effectiveness of source water protection will always be limited by such factors. This underlines the need for appropriate water treatment for all water supplies.

Protecting the quality of drinking-water sources is a matter of balancing risks and costs. Lowering risk is desirable, but striving for "zero-risk" solutions would be unreasonable. Risks and costs at the source also need to be balanced with risks and costs of water treatment and distribution systems, since efforts at the source can be thwarted by inadequate attention to these systems. Many of the Auditor General's recommendations would increase short term costs to government and the private sector, and may require more regulation. They also may accrue long-term savings. The government will continue to work with others to find a balance of risks and costs that provides safe drinking water as cost-effectively as possible.

Summary

Protecting drinking water quality is a priority. The provincial government will ensure that other land use needs are integrated with measures to protect drinking-water sources. In doing this, all provincial agencies, whether representing the interests of drinking-water users or managing other important provincial resources, and local government authorities, must recognize the high priority society places on protecting sources of drinking water. The ministries and agencies involved have made substantial progress in this respect over the past decade and will continue their efforts. The report's Exhibit 1, showing a decreasing trend in enteric diseases, is just one indicator of the effectiveness of past efforts.

Resource users, local government, private land owners, water purveyors and water users will need to work with the provincial government to ensure that efforts to provide safe drinking water are as effective as possible and deal realistically with the costs to purveyors and government.

glossary

glossary

Acid mine drainage

The seepage of sulphuric acid solutions from mines and their rock and tailings dumped at the surface. The acid is produced through natural reactions between exposed sulphide minerals, air and water (groundwater or percolating precipitation).

Approving officer

A person appointed under the Land Title Act to review and approve subdivision plans. In rural areas, approving officers are employees of the Ministry of Transportation and Highways. In municipalities, they are usually municipal employees.

Aquifer

An underground zone or stratum of permeable rock or loose material where water accumulates, and which can yield useful quantities of water to wells or springs. Aquifers can be confined or unconfined:

- A confined, or artesian, aquifer contains water under sufficient pressure that water levels in wells tapping it rise above the bottom of the upper confining cap. Because of the cap, these aquifers have less potential for contamination from surface sources.
- In an unconfined aquifer, the water level in the wells tapping it—the water table—is located within the formations making up the aquifer. Lacking an upper confining cap, these aquifers have higher potential for contamination from surface sources.

Artesian

Groundwater under sufficient hydrostatic head to rise above the aquifer containing it.

Bacteria

Single-cell microorganisms that lack chlorophyll. Some cause diseases, but others aid in pollution control by breaking down organic matter in air and water.

Best management practice

A practice that is determined by a regulating authority to be the most effective practicable (technologically, economically, and institutionally) means of preventing, or reducing to an acceptable level, pollution from a non-point source.

Blue-green algae

Single-celled organisms that have neither a distinct nucleus with a membrane nor other specialized organelles, found in many environments and capable of photosynthesizing. Also called cyanobacteria.

Coliform bacteria

A large group of bacteria, commonly found in topsoil, bodies of water and animal wastes.

Total coliforms: In drinking water, testing the level of total coliforms is used to indicate whether water has been contaminated from an unsanitary source.

Fecal coliforms: A sub-group of coliforms, found almost exclusively in the intestinal wastes of humans and animals, and seldom found elsewhere in the environment. If found in water they are a good indicator that the water has been contaminated with sewage or other intestinal wastes and may contain disease-causing organisms. Water containing fecal coliforms is unsafe to drink.

Commission on Resources and Environment (CORE)

An independent commission established by the provincial government in January 1992 to help resolve "valley-by-valley" conflicts over land use in British Columbia. CORE's mandate was to develop and implement a process to create a comprehensive land-use plan for British Columbia. The commission was also charged with initiating a regional process to resolve resource-use disputes.

Community watershed

The drainage area of a stream or river above the most downstream point at which water is diverted for human consumption. The diversion must be licensed under the Water Act for a waterworks purpose or for a domestic purpose by a water users' community. Alternately, the diversion can be licensed for another domestic or waterworks purpose if

specifically approved by both a Ministry of Forests regional manager and a designated Ministry of Environment, Lands and Parks official. Usually, the drainage area must be smaller than 500 km^2.

Community Watershed Guidebook

A guidebook developed by the Ministry of Forests and Ministry of Environment, Lands and Parks to help forest resource managers plan, prescribe and implement sound forest practices, in community watersheds, that comply with the Forest Practices Code. The recommendations in this and similar Code guidebooks are not mandatory requirements, but once a recommended practice is included in a plan, prescription or contract, it becomes legally enforceable.

Community watershed roundtable

A technical working group, organized by the Ministry of Forests and composed of appropriate agencies, licensees and resource specialists, that provides technical advice to the Ministry of Forests district manager on the recommendations arising from the watershed assessment procedure for a community watershed.

Contact time

The product of the concentration of disinfectant added and the length of time, in minutes, it takes drinking water to flow from the point of disinfection to the point where it enters the home of the nearest water consumer. Generally, the greater the contact time, the greater the disinfecting effect, for a given disinfectant.

Cryptosporidium, cryptosporidiosis

A small (4-6 micrometres in diameter) protozoan parasite with a complex life cycle. The species found most commonly in mammals, *Cryptosporidium parvum*, has the ability to infect a broad range of hosts. Infection of a suitable host species results from ingestion, or possibly inhalation, of the parasite in its transmissible stage, the oocyst. The illness, cryptosporidiosis, consists of watery diarrhea and, occasionally, vomiting. Diarrhea typically lasts for 10-14 days in people and cattle, but may last for several months.

Disinfection

A water treatment specifically designed to destroy or inactivate pathogenic organisms and thereby prevent water-borne diseases, which are the most significant health risk associated with drinking water. Primary disinfectants are added to water to disinfect it before it enters the water suppliers' distribution system. Secondary disinfectants are used to prevent regrowth of bacteria in the distribution system. The disinfecting agents most commonly used in water treatment today in British Columbia are chlorine and related compounds called chloramines, although there is increasing interest in the use of ozone as a primary disinfectant. Considerations in choosing disinfectants include disinfecting power, cost of use, and effects on taste and odour of drinking water. Minimizing of by-products associated with disinfectant use is also a concern. Some of these by-products are possibly carcinogenic, although research findings are not clear.

Distribution system

The pressurized piping system that carries water from a drinking-water water treatment facility to the premises of consumers.

District manager

The official appointed to manage one of the districts of the Ministry of Forests. District managers must, among other duties, review and approve operational plans for forestry activities in the Crown forest and for cattle grazing on Crown range.

Domestic purpose

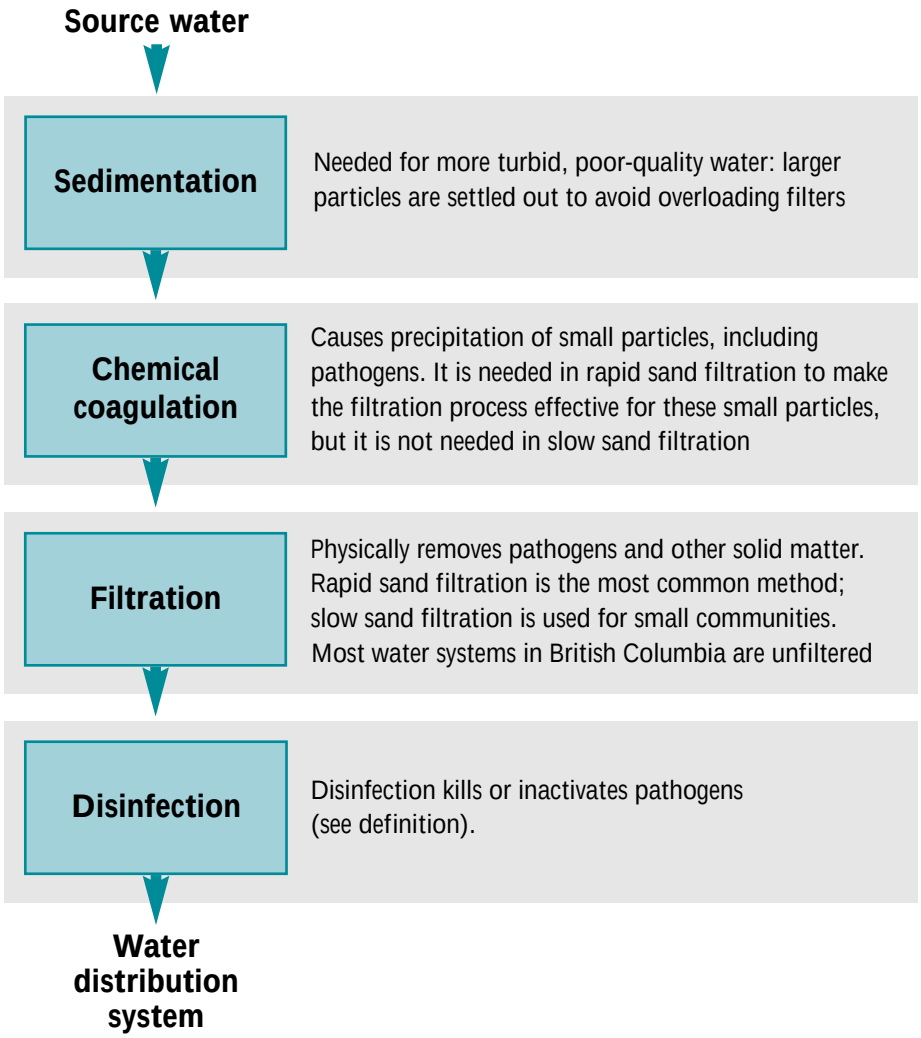
Under the Water Act, use of water for household requirements, sanitation and fire prevention, watering of domestic animals and poultry, or irrigation of a garden not exceeding 1012 m^2 adjoining and occupied with a dwelling house.

Domestic watershed

A watershed where there is a licence for domestic water use, but not a licensed community water user such as a municipality or water utility.

Drinking-water treatment

Processes used to render water safe for human consumption. Some common treatment steps are shown below:



Filtration

The removal of solid particles from water by passing the water through a filtering medium such as sand, anthracite or other filter medium.

Forest Practices Code

A comprehensive package of legislation, regulations and field guides to govern forest practices in British Columbia and ensure sustainable forests. The Code applies on all public land and all private land in tree farm licences (TFLs) and woodlot licences—more than 93% of British Columbia's forest land. The Code also applies to grazing on Crown range.

Forest Renewal BC

A Crown corporation set up in 1994 to plan and implement a program of investments to renew the forest economy of British Columbia by enhancing the productive capacity and environmental values of forest lands, creating jobs, providing training for forest workers, and strengthening local communities that depend on the forest industry.

Geomorphology

The study of the physical processes on the surface of the earth and their relationship to resultant landforms.

Geoscientist

In British Columbia, a professional whose work is directed towards the discovery or development of fossil fuels, metallic or non-metallic minerals, or water, or towards the investigation of surface or subsurface geological conditions, and whose practice requires the application of the principles of geology, geophysics or geochemistry.

Giardia, giardiasis

A protozoan parasite sometimes found in mammalian intestines. Infection with *Giardia*—a sickness called giardiasis, nicknamed "beaver fever"—can cause diarrhea, abdominal cramps, nausea or vomiting, weight loss and fatigue lasting up to three weeks. It can be carried by humans as well as by certain domestic and wild animals.

Groundwater

Water found underground in the saturated zone of an aquifer. Groundwater is a source of well water and often surface water (e.g., springs).

Guidelines for Canadian Drinking Water Quality

A comprehensive Canadian compilation of recommended limits for substances and conditions that affect the quality of drinking water, developed by the Federal-Provincial Advisory Committee on Drinking Water.

Hazard evaluation

Any of the following evaluations, as specified in the Forest Practices Code: terrain stability hazard mapping, landslide stream sedimentation hazard mapping, soil erosion hazard mapping, terrain stability field assessments, surface soil erosion field assessments, and soil erosion potential mapping.

Heavy metals

Metals with a high molecular weight, such as mercury, lead, cadmium and chromium. Heavy metals are generally toxic to plants and animals even in low concentrations. Some are also essential to life, such as copper and zinc.

Herbicide

A chemical that kills unwanted vegetation.

High risk aquifer

An aquifer that is vulnerable to contamination from diffuse surface sources. The level of risk is based on an assessment of factors such as depth to water table, aquifer permeability, surface soil type, and presence of potential contaminant sources.

Hydrology

A science dealing with the properties, distribution and circulation of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere.

Immunosuppressed

A condition whereby the body's immune system is compromised and is more susceptible to bacterial, viral and parasite infections.

Impermeable

Describes a layer of material, such as clay, through which there is little or no water flow.

Improvement district

Under the Municipal Act, a body incorporated by letters patent to provide local services such as water and fire protection to residents within a specified boundary. An improvement district has a locally elected governing body and the power to borrow, charge and regulate the services it provides, but does not have the broad powers granted in legislation to municipalities.

Infiltration

The movement of water from the ground surface into the spaces between particles of subsurface rock or soil.

Integrated land-use management, integrated resource management

Land management that considers both competing and complementary resource values in a comprehensive manner. The goal is to maximize social, environmental and economic benefits without causing undue harm to any one resource sector.

Land and resource management plan (LRMP)

A provincial planning process established to deal with Crown land planning issues and which covers sub-regional areas of approximately 15,000-25,000 km^2. Such a plan encompasses all Crown land and resources in the sub-region, including rivers and lakes, and addresses all Crown resources there, including wildlife, timber, water, range, fisheries, minerals, recreation and tourism. It does not deal with lands owned by municipalities or individuals. An LRMP establishes direction for land use and specifies broad resource management objectives and strategies.

Microbe

A minute living being, or micro-organism, especially a bacterium causing disease or fermentation.

Monitoring

A series of observations over time for the purpose of detecting change.

Multiple levels of protection, multiple barriers to contamination

The concept that water systems with multiple levels, or barriers, of protection are more likely to cost-effectively maintain a high quality of tap water. There are four primary means for maintaining good drinking-water quality:

- The first line of defence is a protected water source.
- The second line of defence is water treatment, which always includes disinfection.
- The next line of defence is a well-designed and operated water-distribution system with a continuous flow and pressurized pipes and the presence of residual disinfectant to counter bacterial regrowth.
- The final line of defence is comprehensive testing of drinking water.

Some authors include public education as another line of defence, using the argument that an uninformed public by either action or inaction can cause contamination of its water supply.

Nitrate

An essential plant nutrient. It is found in fertilizers and may be produced in the breakdown of organic wastes. Excessive fertilizer application, improper agricultural waste management and septic tank systems may increase nitrate levels in groundwater. Nitrates reduce the ability of blood to carry oxygen: a condition called methaemoglobinaemia. Infants under six months are particularly at risk from this condition.

Non-point source pollution

Diffuse sources of pollution, rather than pollutants discharged from a single, specific “point” source (a single, identifiable source of pollution, such as a pipe through which a factory releases wastewater and pollutants into a river). Non-point source pollution is the by-product of a variety of land use practices, including farming, timber harvesting, mining and construction. It also results when rain washes pollutants in urban areas into sewer systems and storm drains. Common pollutants include sediment, nutrients, bacteria and toxic chemicals. Non-point source pollution is largely unregulated because of the inherent difficulty of trying to control so many sources of pollution over a dispersed area.

Operational plan

Plans covering site-specific activities in forests and on rangeland, which are required of agreement holders under the Forest Practices Code. The types of operational plans are: range use plan, forest development plan, logging plan, access management plan, silviculture prescription and stand management prescription.

Parasite

An organism living in or on another and benefiting at the expense of the other.

Pathogen

A disease-causing agent, especially micro-organisms such as viruses, bacteria or fungi, which can be present in municipal, industrial and non-point source discharges.

PCB

Polychlorinated biphenyl—any one of several toxic hydrocarbons containing two benzene molecules in which hydrogens have been replaced by chlorine atoms. Because of their chemical stability and heat resistance, PCBs have been widely used in electrical and hydraulic equipment and in lubricants. Their release to the environment occurs as a result of fires, spills, and leakages from closed systems; evaporation or leakage from landfills or PCB storage sites; and incineration of waste containing PCBs. Canada restricted the use of PCBs to closed systems in the 1970s and banned the importation of all electrical equipment containing PCBs after 1980.

PCP

Pentachlorophenol—one of a group of toxic chemicals created by the chlorination of phenols. These chemicals are used in herbicides and insecticides and, most commonly, for wood preservation.

Pesticide

Any chemical used to kill pests such as insects and rodents, or used as a herbicide.

Proper functioning condition

Riparian or wetland areas in forests or rangeland are functioning properly when adequate vegetation, landform or large woody debris is present to:

- dissipate stream energy from high water flows, thereby reducing erosion and improving water quality;
- filter sediment, capture bedload, and aid flood plain development;
- improve floodwater retention and groundwater recharge;
- develop root masses that stabilize stream banks against cutting action;
- develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration and temperature necessary for fish production, waterfowl breeding and other uses; and
- support greater biodiversity.

The functioning condition of riparian or wetland areas is the result of the interaction among geology, soil, water and vegetation.

Upland range areas are in proper functioning condition when vegetation, soil surface, erosional processes and biological cycling are in proper balance. The following should be evident:

- water is not restricted from infiltrating the soil surface;
- organic matter protects the soil surface from raindrop impact and the evaporative effects of sun and wind;
- standing vegetation captures drifting snow, detains overland water flow, and traps sediment;
- the plant community is (or is becoming) consistent with the site's capability, and producing the kind, proportion and amount of vegetation necessary for meeting range use and other plans;
- ephemeral drainages (those which contain water during only part of the year) are stable, with no active downcutting or bankcutting; and
- the biological breakdown of plant residues is apparent.

Purveyor

A person, corporation, municipality or village municipality that is responsible for supplying water for domestic purposes.

Range use plan

A plan required by the Forest Practices Code, covering planned grazing activity in a range agreement area. It must take into account known information and the objectives set in higher-level plans, and must be approved by the Ministry of Forests district manager before range use may legally begin.

Regrowth

The process by which bacteria not eliminated during water treatment, or inadvertently allowed into a water-distribution system, begins to multiply in the distribution system.

Riparian area, riparian zone

The often-narrow strips of land that border creeks, rivers or other bodies of water. Because of their proximity to water, the plant species and topography of riparian zones differ considerably from those of adjacent uplands.

Safe Drinking Water Regulation

A 1992 regulation under the Health Act that requires drinking-water suppliers to disinfect the water they supply, to obtain construction and operating permits for their system from the local public health authority, and to monitor drinking-water quality in a way acceptable to that authority.

Septic tank system

A sewage disposal system centred around a water-tight vessel into which sewage is conveyed, in which solids within the sewage settle and anaerobic digestion of organic materials occurs, and from which an effluent is discharged to a soil absorption field.

Stormwater

Overland run-off from precipitation or snowmelt.

Turbidity

Cloudiness or haziness in water, usually due to suspended particles of silt or clay. Such particles affect the quality of drinking water by interfering with disinfection and impairing the appearance of the water.

Water cycle, hydrologic cycle

The endless circulation of water from the atmosphere to the earth, and its return to the atmosphere, through condensation, precipitation, evaporation and transpiration.

Water licence

A licence, issued under the Water Act, which entitles its holder to:

- divert and use, for the purpose and during the time stipulated, the quantity of surface water specified in the licence;
- store surface water;
- construct, maintain and operate the works authorized under the licence and necessary for the proper use of the water, or of power produced from it; and
- alter or improve a stream or channel.

Water quality objective

Measurable criteria of water quality, designed to protect the most sensitive designated water use at a specific location with an adequate degree of safety, taking local circumstances into account. Designated water uses are those for:

- drinking, public water supply or food processing
- aquatic life or wildlife
- agriculture (livestock watering or irrigation)
- recreation or aesthetics.

Water table

The top of the zone saturated with water in an unconfined aquifer; the height to which water will rise in wells drilled into an unconfined aquifer.

Water users' community

A group of six or more water licensees incorporated with the approval of the Comptroller of Water Rights to:

- acquire, hold and control property and licences;
- acquire, construct, maintain and operate water works; and
- levy assessments on its members and enforce payment of those assessments.

Water utility

Under the Water Utility Act, a person or entity not a local government entity such as a municipality or regional district that distributes or furnishes water to five or more persons, or to a corporation, for compensation.

Water-borne disease

A disease transmitted through or propagated by contaminated water.

Watershed

The entire area drained by a waterway, or that drains into a lake or reservoir. Also called catchment basin, or catchment area.

Watershed assessment

Either of two procedures (the Interior Watershed Assessment Procedure or the Coastal Watershed Assessment Procedure) specified in the Forest Practices Code. Each type of procedure considers the natural characteristics of the watershed, as well as rates of past harvesting and hydrological impacts from that harvesting over the entire watershed.

Waterworks

A system of water supply including its source, treatment, storage, transmission and distribution facilities, where water is offered for domestic purposes. A waterworks does not include a water supply serving only one single family residence.

Well protection plan

A plan designed to help properly manage activities within the capture zone areas of community wells and prevent water quality degradation. A capture zone is the land area around a well that contributes water to the well.

Yarding

Moving felled trees from where they were felled to where they are piled before being loaded for transportation.

appendices

appendix a

1998/99 Reports Issued to Date

Report 1

Follow-up of 1996 Performance Audits/Studies

Report 2

Managing the Cost of Drug Therapies
and Fostering Appropriate Drug Use

Report 3

Collection of Overdue Accounts Receivable

Report 4

A Review of the Estimates Process in British Columbia

Report 5

Protecting Drinking-Water Sources

appendix b

Office of the Auditor General: Performance Auditing Objectives and Methodology

Audit work performed by the Office of the Auditor General falls into three broad categories:

- Financial auditing;
- Performance auditing; and
- Compliance auditing.

Each of these categories has certain objectives that are expected to be achieved, and each employs a particular methodology to reach those objectives. The following is a brief outline of the objectives and methodology applied by the Office for performance auditing.

Performance Auditing

Purpose of Performance Audits

Performance audits look at how organizations have given attention to economy, efficiency and effectiveness.

The concept of performance auditing, also known as value-for-money auditing, is based on two principles. The first is that public business should be conducted in a way that makes the best possible use of public funds. The second is that people who conduct public business should be held accountable for the prudent and effective management of the resources entrusted to them.

The Nature of Performance Audits

An audit has been defined as:

> *…the independent, objective assessment of the fairness of management's representations on performance, or the assessment of management systems and practices, against criteria, reported to a governing body or others with similar responsibilities.*

This definition recognizes that there are two primary forms of reporting used in performance auditing. The first—referred to as attestation reporting—is the provision of audit opinions on reports that contain representations by management on matters of economy, efficiency and effectiveness.

The second—referred to as direct reporting—is the provision of more than just auditor's opinions. In the absence of representations by management on matters of economy, efficiency and effectiveness, auditors, to fulfill their mandates, gather essential information with respect to management's regard for value for money and include it in their own reports along with their opinions. In effect, the audit report becomes a partial substitute for information that might otherwise be provided by management on how they have discharged their essential value-for-money responsibilities.

The attestation reporting approach to performance auditing has not been used yet in British Columbia because the organizations we audit have not been providing comprehensive management representations on their performance. Indeed, until recently, the management representations approach to value for money was not practicable. The need to account for the prudent use of taxpayers' money had not been recognized as a significant issue and, consequently, there was neither legislation nor established tradition that required public sector managers to report on a systematic basis as to whether they had spent taxpayers' money wisely. In addition, there was no generally accepted way of reporting on the value-for-money aspects of performance.

Recently, however, considerable effort has been devoted to developing acceptable frameworks to underlie management reports on value-for-money performance, and public sector organizations have begun to explore ways of reporting on value-for-money performance through management representations. We believe that management representations and attestation reporting are the preferred way of meeting accountability responsibilities and are actively encouraging the use of this model in the British Columbia public sector.

Presently, though, all of our performance audits are conducted using the direct reporting model; therefore, the description that follows explains that model.

Our performance audits are not designed to question government policies. Nor do they assess program effectiveness. The Auditor General Act directs the Auditor General to assess whether the programs implemented to achieve government policies are being administered economically and efficiently. Our performance audits also evaluate whether members of the Legislative Assembly and the public are provided with appropriate accountability information about government programs.

When undertaking performance audits, auditors can look either at results, to determine whether value for money is actually achieved, or at management processes, to determine whether those processes should ensure that value is received for money spent.

Neither approach alone can answer all the legitimate questions of legislators and the public, particularly if problems are found during the audit. If the auditor assesses results and finds value for money has not been achieved, the natural questions are "Why did this happen?" and "How can we prevent it from happening in future?" These are questions that can only be answered by looking at the process. On the other hand, if the auditor looks at the process and finds weaknesses, the question that arises is "Do these weaknesses result in less than best value being achieved?" This can only be answered by looking at results.

We try, therefore, to combine both approaches wherever we can. However, as acceptable results information and criteria are often not available, our performance audit work frequently concentrates on managements' processes for achieving value for money.

We seek to provide fair, independent assessments of the quality of government administration. We conduct our audits in a way that enables us to provide positive assessments where they are warranted. Where we cannot provide such assessments, we report the reasons for our reservations. Throughout our audits, we look for opportunities to improve government administration.

Audit Selection

We select for audit either programs or functions administered by a specific ministry or public body, or cross-government programs or functions that apply to many government entities. There are a large number of such programs and functions throughout government. We examine the larger and more significant ones on a cyclical basis.

We believe that performance audits conducted using the direct reporting approach should be undertaken on a five– to six–year cycle so that members of the Legislative Assembly and the public receive assessments of all significant government operations over a reasonable time period. Because of limited resources, we have not been able to achieve this schedule.

Our Audit Process

We carry out these audits in accordance with the value-for-money auditing standards established by the Canadian Institute of Chartered Accountants.

One of these standards requires that the "person or persons carrying out the examination possess the knowledge and competence necessary to fulfill the requirements of the particular audit." In order to meet this standard, we employ professionals with training and experience in a variety of fields. These professionals are engaged full-time in the conduct of performance audits. In addition, we often supplement the knowledge and competence of our own staff by engaging one or more consultants, who have expertise in the subject of that particular audit, to be part of the audit team.

As performance audits, like all audits, involve a comparison of actual performance against a standard of performance, the CICA prescribes standards as to the setting of appropriate performance standards or audit criteria. In establishing the criteria, we do not demand theoretical perfection from public sector managers. Rather, we seek to reflect what we believe to be the reasonable expectations of legislators and the public. The CICA standards also cover the nature and extent of evidence that should be obtained to support the content of the auditor's report, and, as well, address the reporting of the results of the audit.

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