

City of Dawson Creek



KISKATINAW RIVER WATERSHED SOURCE PROTECTION PLAN



December 2007

DOBSON
Engineering Ltd.

File: 222-001
Project: 25044

TABLE OF CONTENTS

1. INTRODUCTION.....	2
1.1 PROJECT SCOPE.....	2
1.2 DESCRIPTION OF CITY WATER SUPPLY INFRASTRUCTURE	3
1.3 REPORT FORMAT	3
2. MODULE 1 – CHARACTERIZATION OF THE KISKATINAW RIVER SOURCE. 3	
2.1 DESCRIPTION OF PROJECT AREA	3
2.2 HYDROLOGIC CHARACTERIZATION OF SOURCE AREA.....	7
2.3 SOURCE HAZARDS TO DRINKING WATER QUALITY.....	7
2.4 SOURCE WATER QUALITY AND QUANTITY	11
2.5 INTEGRITY AND VULNERABILITY OF CITY INTAKE WORKS	12
3. MODULE 2 – RESULTS OF CONTAMINANT INVENTORY.....	12
3.1 OVERVIEW OF POTENTIAL CONTAMINANTS AND INVENTORY PROCESS	13
3.2 NATURAL SOURCES	14
3.3 PRIVATE LANDS	16
3.4 RANGE USE.....	16
3.5 RESOURCE DEVELOPMENT	16
3.6 HIGHWAYS.....	19
3.7 RECREATIONAL USE	19
3.8 CONSEQUENCE TO DRINKING WATER QUALITY	20
4. MODULE 7 – RISK CHARACTERIZATION.....	21
4.1 EVALUATION OF SOURCE PROTECTION BARRIERS	21
4.2 QUALITATIVE RISK ASSESSMENT.....	21
5. MODULE 8 – RECOMMENDATIONS TO IMPROVE DRINKING WATER SOURCE PROTECTION AND SUSTAINABILITY IN THE WATERSHED	27
6. INITIATION OF THE WATERSHED PROTECTION PLAN.....	30
7. REFERENCE MATERIAL	33



1. INTRODUCTION

In 2003 the *Drinking Water Protection Act* came into force in BC based on the “multi-barrier” concept. In 2003 the Drinking Water Protection Legislation also was released. In March 2005 the Ministry of Health Services and the Ministry of Water, Land and Air Protection released the draft *Comprehensive Drinking Water Source to Tap Assessment Guideline*. The objective of the assessment procedure was “to identify hazards and vulnerabilities that may threaten the safety and sustainability of the water supply and recommend risk management actions to address them”. The first barrier in the multi-barrier approach is the source area source protection.

The Kiskatinaw River watershed is the source of water for the City of Dawson Creek (City). This is a summary of the proposed source protection plan for the watershed. This plan builds on previous work carried out in the watershed including the Kiskatinaw River Integrated Watershed Management Plan (1991), the Kiskatinaw River Watershed Management Plan (2003), the Dawson Creek Land and Resource Management Plan (1999) and the Kiskatinaw River Watershed Assessment (2004).

2. DRINKING WATER SUPPLY

The Kiskatinaw watershed is a designated community water supply but not a “community watershed” due its large size. The City believes that it should be a community watershed since it provides drinking water to a community of about ~20,000 people. The Kiskatinaw River is the only source of supply for the City of Dawson Creek. There is no other feasible source of surface water or groundwater in the vicinity that the City can access. The water supply system was originally constructed in 1943. Since that time the City has invested millions of dollars upgrading the system including a state-of-the-art water treatment plant. Today the system provides drinking water for the 11,000 residents in the City plus the residents of Rolla and Pouce Coupe as well as many rural residents. The source water quality in the Kiskatinaw River is naturally poor due to high turbidity and suspended sediment load. It is not unusual for turbidity to exceed 2,000 NTU¹ at times during the period from April through September. The recommended turbidity level for raw water used for drinking water supply is 1 NTU. Since the City has no viable alternative, it depends upon the Kiskatinaw for its supply and in that regard it is very committed to protecting its source. In addition to water quality concerns, the City is also very concerned about water quantity. Low flows during the summer and in the late fall can result in diminished supply to the City reservoirs if it cannot pump from the river.

3. SOURCE PROTECTION OBJECTIVES

- Characterize the source area and land use activities
- Identify hazards and vulnerabilities that may threaten the safety and sustainability of the water supply
- Recommend risk management actions to address identified hazards

4. PROCESS

The *Comprehensive Drinking Water Source to Tap Assessment Guideline* recommends an eight module process to assess the entire water system from the source to the tap. For the purpose of assessing the source area only, the process will include the following four modules:

1. Module 1 - Delineate and characterize drinking water source(s)
2. Module 2 - Conduct contaminant survey
3. Module 7 - Characterize drinking water risks from source to tap
4. Module 8 - Recommend actions to improve drinking water protection

¹ NTU = Nephelometric Turbidity Units

The source area is that portion of the watershed upstream of the City intake on the Kiskatinaw River at Arras. GIS data from previous work in the watershed was used to provide a watershed map including industrial development in the watershed. All available reports on the watershed were reviewed and fieldwork, which included ground traverses and aerial overview flights, was carried out in 2005 and 2006.

5. RESULTS OF CONTAMINANT SURVEY AND RISK ANALYSIS

The contaminant survey was initiated by completing an office assessment of the known or suspected hazards to drinking water. The potential contaminants or hazards were assessed based on the following three broad categories as recommended by the Ministry of Environment Water Quality Guidelines and the Health Canada Canadian Drinking Water Guidelines; physical hazards, biological hazards, and chemical hazards. The physical hazards included natural sources of turbidity and sediment, sources of sediment related to industrial activity in the watershed, oil and gas development and forest development, and from transportation corridors. Other potential sources of sediment related to cattle grazing and recreation use. The biological hazards included sources of bacteria, protozoa and viruses. The biological hazards are typically linked to the fecal material related to presence of wildlife, cattle and humans (including dogs and cats) in the watershed. Chemical hazards that may be present in the source water are hydrocarbons, pesticides, herbicides and fertilizers. The presence of sources of all these potential hazards was then confirmed through field assessments and any additional hazards identified in the field were added to the list. A summary of the hazards/contaminants assessed is summarized in Table 1.

It was also important to consider the vulnerability of the City intake to the various hazards. Vulnerability for this assessment is defined as the “susceptibility of the intake to an identified hazard”. In the case of the City’s intake, it has been rated as **highly** vulnerable since it is a shallow intake located on the river and is exposed to any contamination in the passing river water that.

A qualitative risk assessment was undertaken for the hazards identified in Modules 1 and 2. The risk is assessed at the intake prior to treatment. The assessed risk at the intake will be different from the risk at the tap following treatment. The unabated risk would be the worst-case scenario, that is, in the event of a failure of the treatment system. As indicated previously the vulnerability of the intake is rated as **high** with regards to all contaminants. The estimated risk to the water at the intake is presented in Table 1.

Table 1. Risk Rating at Intake

Drinking Water Hazard/Contaminant	Source of Hazard	Likelihood of Detection at Intake	Consequence	Risk
Sediment	Natural	High	High	Very high
Turbidity	Natural	High	High	Very high
Sediment	Anthropogenic	Low	High	Moderate
Turbidity	Anthropogenic	Low	High	Moderate
Organic material	Natural	High	High	Very high
Organic material	Anthropogenic	Low	High	Moderate
Pathogenic organisms	Wildlife ¹	High	High	Very high
Pathogenic organisms	Cattle ¹	High	High	Very high
Pathogenic organisms	Anthropogenic ¹	High	High	Very high
Hydrocarbons	Anthropogenic	High	High	Very high
Pesticides/herbicides	Anthropogenic	Low	High	Moderate
Fertilizer	Anthropogenic	Low	High	Moderate

Note:

1. Details on the presence and extent of pathogenic organisms associated with these sources are not known. What is known is that pathogenic organisms have been identified in the watershed and in raw water at the intake.

6. ASSUMPTIONS

There is limited data available for the locations of some of the hazards, e.g. pathogenic organisms, pesticides etc or on the concentrations and pathways of the contaminants from their source to the intake. For the purposes of this project it has been assumed that if a contaminant does exist in the source area that, in the worst case, it would be detectable at the intake.

7. RECOMMENDATIONS FOR SOURCE WATER PROTECTION

The basis for the source water protection plan is the use of barriers to limit the exposure of drinking water to a particular hazard. The multi-barrier approach to source protection starts with barriers in the water supply area. It is recognized that the City does have a series of barriers between the intake and the consumer that include various detection systems, raw water reservoirs and finally the water treatment plant. These barriers do not replace the need for diligent protection of the water quality in the watershed.

In 2006 the seven provincial ministries and that have responsibilities for source protection, the Office of the Provincial Health Officer, and the five Health Authorities signed a Memorandum of Understanding (MOU) that commits the parties to inter-agency accountability and coordination for the protection of drinking water. In November 2007 the Northern Regional Drinking Water Team, a requirement in the MOU, was formed that includes representatives from the seven ministries and the Northern Health Authority. The proposed **Source Protection Plan** is based on the commitments made in the MOU, the support of the Northern Region Drinking Water Team, and the authorities in the *Drinking Water Protection Act* delegated to the Drinking Water Officer.

The intent of the **Source Protection Plan** is to recommend a process to address the hazards that are a threat to the safety and sustainability of the water supply for the City of Dawson Creek.

It is recommended that staff from the City of Dawson Creek, the Ministry of Environment and the Drinking Water Officer, Northern Health Authority schedule a meeting early in 2008 to develop strategies to address the three major drinking water hazards in the Kiskatinaw Watershed, high parasites and bacteria concentrations – specifically the extensive contamination from human waste throughout the watershed; sources contributing to the high total organic carbon levels; and anthropogenic sources of sediment and turbidity.

Regarding the identified threats and the risks to drinking water in the watershed, the following recommendations are provided to address specific hazards.

- I. ***Sediment/turbidity from anthropogenic activities***: The typical sources of sediment/turbidity are roads, soil disturbance associated with forest development, oil and gas development, and agriculture. The first barrier is planning, the second barrier is implementation, the third barrier is monitoring and the fourth barrier is revising the plan. The responsibilities are:
Stakeholder: It is the responsibility of the various stakeholders to plan, implement, monitor and revise their works consistent with the legislation, regulations and policies established under their permits/licenses for the protection of soils and water. Planning should also consider best management practices where these are available.
Regulators: The ministry/ministries that provide the authorities to the licensed stakeholders are responsible, in accordance with the MOU, for compliance monitoring to ensure that activities undertaken are consistent with their respective policies for source protection
- II. ***Pathogenic organisms***: Pathogenic organisms include bacteria, protozoa and viruses. These are typically associated with waste material (faeces) from warm-blooded animals, e.g. wildlife, cattle, humans. The results of the MOE research sampling in the watershed confirm that a variety of the organisms are present throughout the watershed and in the river at the intake. The ministry has undertaken some source tracking that will be reported separately. For the purposes of this plan the responsibilities are:
Stakeholder: Stakeholders should follow approved practices for the disposal of human waste products in the watershed. These apply to individuals working/recreating in the watershed to waste management at industrial work sites and camps.

- Regulators:* Regulating agencies need to provide education materials with guidance for disposing of human waste by individuals and to monitor industrial sites and camps for compliance with permits for the disposal of waste.
- III. **Hydrocarbons:** Currently there is only one oil pipeline identified as a potential hazard and it crosses the main stem of the river approximately 9 km upstream of the intake. Should there be a pipeline rupture and spill of oil into the river, the consequence could be very high if hydrocarbons reached the water treatment plant since they could cause a plant failure. The responsibilities of the various parties are:
- Pipeline owner:* The pipeline owner is to be in compliance with all the appropriate regulatory requirements related to the safety of the water supply. The pipeline owner should establish a communication protocol with the City regarding notification in the event of a spill.
- City of Dawson Creek:* The City has a hydrocarbon detection system installed at the intake that should be maintained and tested regularly to ensure that it is functioning to specifications.
- Regulators:* The OGC that regulate pipelines to ensure that the maintenance and operation and emergency procedures required by the operator meet the applicable policies.
- IV. **Pesticides/herbicides:** These chemicals are commonly used on agricultural lands and on Crown land (fertilizer is not used on Crown land). Although their use is carefully regulated there can be impacts to the water supply from cumulative impacts and spills. The responsibilities are:
- Applicator:* The applicator is expected to have the necessary permits and to use the product in accordance with the permit. In the event of a spill, the applicator must report the spill as required by the permit, and also report the details of the spill to the Water Manager at the City immediately.
- Regulator:* The agencies that regulate pesticides and herbicides are expected to apply their respective policies for the use of these products recognizing that the watershed upstream of Arras is a designated watershed used for community water supply.
- V. **Fertilizers:** Those applying fertilizers on private lands upstream of the intake should recognize the potential impacts on drinking water. The chemical constituents in fertilizers can be a hazard to drinking water through the increase in nutrients and the effects on biological processes in the water. The responsibilities are:
- Applicator:* Apply best management practices for the protection of surface water and groundwater when applying fertilizer.
- Regulator:* The Ministry of Agriculture and Lands should provide educational materials for the use of fertilizer and the protection of water sources.
- VI. **Monitoring:** Monitoring is an essential component of the **Source Protection Plan**. The Ministry of Environment implemented a raw water monitoring program in the watershed in 2002. The program established baseline monitoring and problem identification, and identified sources of water quality impacts. This program provides the basis for establishing a permanent long-term monitoring program for the watershed. The support for the permanent program is recommended to come from the ministries that signed the MOU, the City, and hopefully from the stakeholders. The current MOE program should be reviewed to confirm that it meets the needs of the **Source Protection Plan**, and revised if necessary. The sampling results should be reported to the Drinking Water Officer (DWO), MOU members and stakeholders annually. If, in the future the sampling program is run by a third party under contract, the sample results must be analyzed annually by qualified professionals to identify trends or issues and advise the DWO of any concerns.
- VII. **Compliance Reporting:** The **Source Protection Plan** must have an annual compliance reporting requirement. Based on the MOU there should be annual reports provided by the agencies in the MOU to the DWO that report on source protection. A summary report should be provided to the MOU members and the stakeholders and be reviewed at an annual watershed meeting. Based on the water quality monitoring report and the compliance report and the report on drinking water delivery by the City, appropriate changes can be made to the **Source Protection Plan**.

KISKATINAW RIVER WATERSHED SOURCE PROTECTION PLAN

1. INTRODUCTION

This watershed source protection plan report has been drafted using the *Comprehensive Drinking Water Source to Tap Assessment Guideline* released by the Ministry of Health Services & Ministry of Water, Land and Air Protection in 2005.

1.1 Project Scope

The Kiskatinaw River watershed is a major source of supply for the City of Dawson Creek (City). This report has been prepared using *Comprehensive Drinking Water Source to Tap Assessment Guideline* as general guidance. The key elements of the guidelines to be considered in this plan are:

Module 1

- Delineate the watershed and characterize the water source above the intake.
- Characterize of the watershed including the influences of past forest development and oil and gas development.
- All maps prepared for this project illustrating the location of the intake, source area, assessment area boundaries and bio-geophysical information are to be produced in a format using GIS.

Module 2

- Conduct contaminant source inventory.

Module 7

- Evaluate the multi-barriers in place in the watershed
- Complete a drinking water risk assessment based on the identified hazards and barriers

Module 8

- Develop recommendations to improve drinking water safety and sustainability

In 2006 the seven provincial ministries and that include responsibilities for source protection, the Office of the Provincial Health Officer, and the five Health Authorities signed a Memorandum of Understanding (MOU) the commits the parties to inter-agency accountability and coordination for the protection of drinking water. A copy of the memorandum is included in Appendix A. In November 2007 the Northern Regional Drinking Water Team, a requirement in the MOU was formed that includes representatives from the seven ministries and the Northern Health Authority. A copy of the drinking water team membership is also provided in Appendix A. In addition a copy of the working protocol for the Northern Regional Drinking Water Team is provided in Appendix A.

1.2 Description of City Water Supply Infrastructure

The current infrastructure that has been developed by City as part of its water supply system include:

- Water treatment plant
- Hart Reservoir
- Trail Reservoir
- Hansen Reservoir
- Pump station and intake at Arras
- Intake Pond weir at Arras

The general layout of the infrastructure components is provided in Figure 1

The City holds water licenses to store approximately 1357 ML in Bear Hole Lake where the storage works will be constructed by 2010. The City water license authorizes 789 ML of additional storage and 2763 ML for waterworks. It has storage for 625 ML in its three off-stream reservoirs between Arras and the treatment plant. Currently the City depends upon the run of the river for its water supply. There are concerns about low river flows that can place its supply at risk.

1.3 Report format

This report has been organized to present the results for module 1, 2, 7 and 8. A 1:100,000 scale map of the watershed detailing the hydrography, waterworks infrastructure, forest and oil and gas development and TRIM data is provided in Appendix B.

2. MODULE 1 – CHARACTERIZATION OF THE KISKATINAW RIVER SOURCE

2.1 Description of project area

Source Area

The Kiskatinaw River is a 5th order stream that is tributary to the Peace River with a watershed area of 412472 ha and a main stem length of 302 km. While the headwaters of the Kiskatinaw River drain the Rocky Mountain Foothills, most of the basin forms part of the Alberta Plateau that is characterized by gentler terrain. Stream gradients range from 5% in the upper reaches and decrease to less than 0.1% near Arras. The study comprises the Kiskatinaw River watershed upstream of the City's water intake at Arras and has a total area of approximately 284,607 ha.

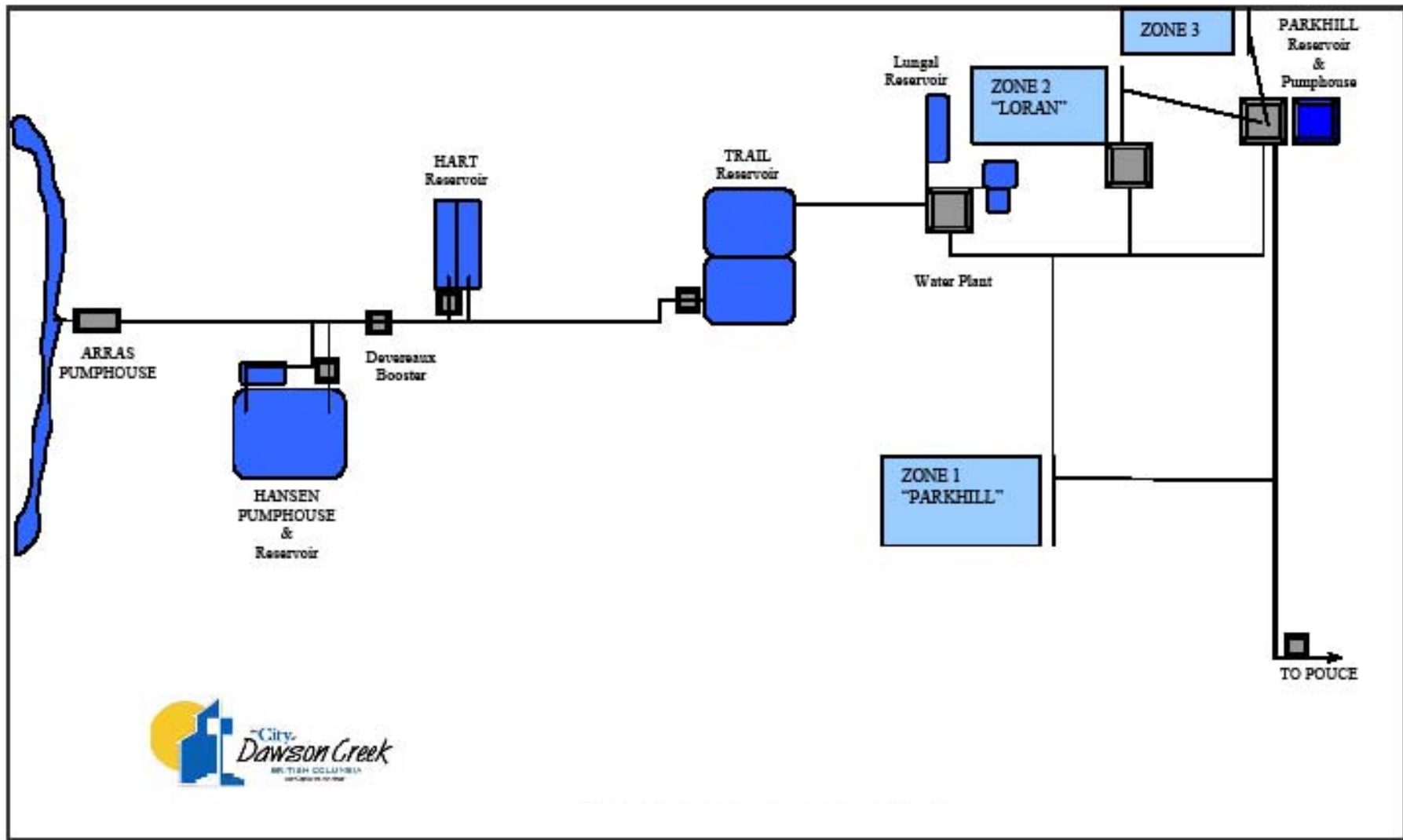


Figure 1. City of Dawson Creek water system schematic

For the purposes of the study, the area has been divided into five sub-basins:

- Main stem – 43,009 hectares
- East Kiskatinaw – 100,970 hectares
- West Kiskatinaw – 100,411 hectares
- Halfmoon-Oetata – 19,077 hectares
- Brassey – 21,140 hectares

Intake

The City intake on the Kiskatinaw River is located at Arras approximately 20 km west of the City. The works include an intake pond in the river formed by a sheet pile weir that was constructed following the very low flows that occurred in 1992. There is also a pump house on the east bank of the intake pond that pumps water into the Hansen Reservoir. The intake pond allows for bedload to settle along with the coarse suspended load. There is not sufficient settling time permit the finer suspended sediment of organic material to settle. The water is stored in the Hansen Reservoir so that most of the suspended sediment has time to settle before the water is pumped on to the Trail and Hart reservoirs.

Biophysical characterization of source area

The Kiskatinaw River watershed is located on the Alberta Plateau of northeastern British Columbia and is tributary to the Peace River. The water supply area rises from an elevation of 680 meters at Arras to 1,300 meters south at Bear Hole Lake. The western portion of the watershed is distinguished by steep slopes of the Rocky Mountain Foothills, while the eastern portion is characterized by undulating plains projecting into BC from Alberta (Kiskatinaw River IWMP, 1991).

The biogeoclimatic zones in the watershed are predominantly Boreal White and Black Spruce with a very minor component of Engelmann Spruce Sub-alpine Fir.

Bedrock Geology

The Kiskatinaw watershed is located near the margin between the Peace River Lowlands and Alberta Plateau physiographical units (Atlas of Canada 2004). The Alberta Plateau comprises most of the northwest portion of the Interior Plains, between the Rocky Mountains to the west and the Canadian Shield to the east. The plateau is comprised of rocks deposited in a shallow sea at the west margin of ancient North America and is characterized by low rolling hills, domes, plateaus, mesas, and cuestas controlled by the distribution and gentle folding of the underlying sandstone and shale bedrock (Holland 1976).

The Peace River Lowland is an area of broad, gently sloping valleys and flat-topped hills that parallel the Peace River within the Alberta Plateau (Robinson 2006). The flat-topped hills represent the eroded remains of the Alberta Plateau, left behind following erosion by the eastward flowing Peace River, its tributaries, and their pre-glacial ancestors.

Sedimentary rock of the Cretaceous Age (principally sandstone, shale, siltstone and conglomerate) comprise the bedrock geology within the watershed upstream of the intake. Rapid weathering of these materials produces high erodible sediment.

Surficial Geology and Soils

The surficial geology of the watershed can be defined broadly based on elevation bands as follows.

- Upland areas consist of silt and clay rich glacial till which are commonly overlain by silt eolian deposits. Glaciofluvial and colluvial deposits can be found locally.
- Colluvial deposits derived predominately from mass-wasting processes are found on mid slopes.
- Lower slopes and valley bottoms are predominately covered in thick sequences of fine-grained glaciolacustrine deposits. These soils are highly erodible and become easily suspended when mobilized by streams during periods of high flow.

Terrain Stability

Terrain stability mapping for the watershed was not available. As a basic filter for identifying slope stability concerns, slopes greater than 60% are considered potentially unstable. However, it is evident from both orthophoto and field investigations that significant instabilities can also be found on slopes with much lower gradients.

In 2003, West Fraser Mills Ltd. (WFM) and Louisiana Pacific Canada Ltd. (LP) contracted Forsite Consultants Ltd. (FCL) to undertake a watershed assessment with the goal of determining, in part, relative contributions of natural physical processes and the effects of land use changes on sediment production. They concluded “there have been substantial changes in stream stability within the Kiskatinaw watershed over the period since 1955. Channels are now frequently more laterally unstable, carrying higher sediment loads and, in many areas, un-vegetated channel widths appear to have become larger. Bank and valley wall instability also appears to have increased over the same period. The air photo analyses indicate that these widespread channel changes are the result of unusually large flood events that occurred in 1990 and 2001” (Forsite 2004).

Observations made during the field assessment conducted by DEL found the natural state of the Kiskatinaw River to be dynamic with frequent lateral movement of the channel within the valley bottom/ flood plain is common directly affecting turbidity levels. The most common mass wasting process occurring in the watershed is that of stream bank undercutting and the subsequent introduction of sediments to the river.

An estimation of the total amount a material being eroded on an annual basis was not included in the scope of the project. However, Church et al. (1989) indicated that the Kiskatinaw River's sediment load was 1.37 mg/km²/day, which is the second highest value for BC. Forsite (2003) concluded that "geomorphological changes to channel, banks and slopes did in fact occur concurrently, and as a result of, the noted extreme hydroclimatic events, particularly those of 2001, 1990 and 1996-97." A number of examples of sizable bank failures in the form of rotational slumps and earth flows were observed during the field study (photos 1 and 2, Appendix C). Mr. Wade Bassett, a long time resident and rancher, recounted a large (approx. 0.5 km in width) landslide occurring around 1987 that completely blocked the Halfmoon Creek. Mr. Bassett was able to point out one of the faults in the field that showed an obvious vertical displacement. Time did not permit an assessment of the landslide to determine the failure method, size or type.

2.2 Hydrologic characterization of source area

The Kiskatinaw River is a rain dominated hydrologic system with peak flows occurring from late June to early July. On average, the watershed receives 499 mm of precipitation during the year. Rain accounts for about 328 mm of the total precipitation. On average, about 179mm of the total precipitation falls as snow. Hydrometric records are available for the Kiskatinaw River near Farmington (Water Survey of Canada Station No. 07FD001) from 1917 to present. Mean daily discharge is 9.95 m³/s and maximum daily discharge was estimated at 600 m³/s recorded on July 20, 2001. The runoff hydrographs for normal, low and high flow periods are illustrated in Figure 2.

2.3 Source hazards to drinking water quality

Identification of the source hazards is the key to the development of the source protection plan for the watershed. This is initially an office based exercise that draws from the knowledge and experience of the water purveyor, the raw water quality and stream sediment sampling program initiated by the Ministry of Environment and from the Northern health Authority. The hazards identified in Module 1 provide the basis for the contaminant inventory work undertaken in Module 2 where the hazards are confirmed, additional hazards added and details summarized regarding the location, extent and severity of the hazard in the source area and the vulnerability of the drinking water.

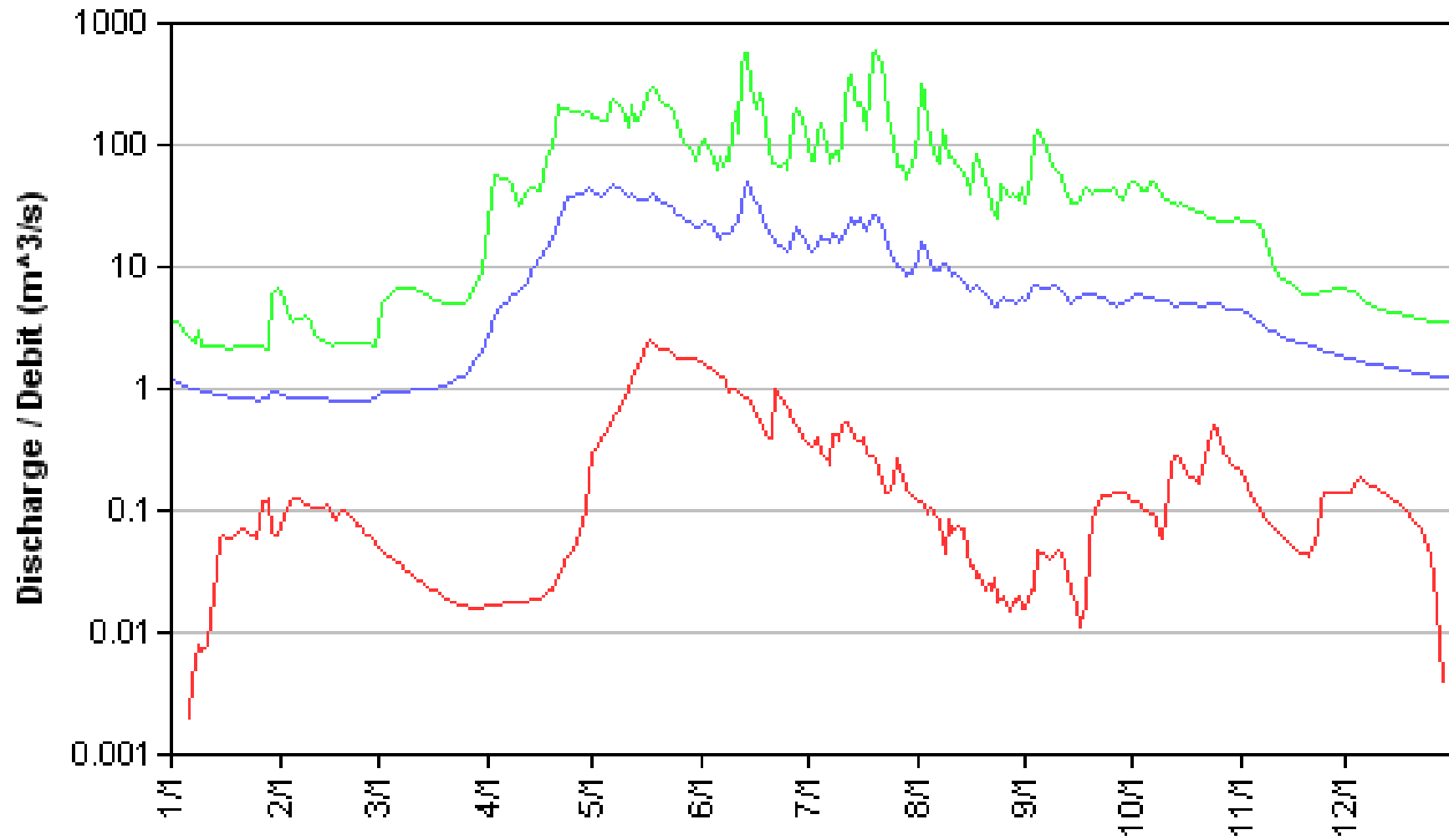


Figure 2. Kiskatinaw River at Farmington Annual Hydrograph (Water Survey of Canada Station # 07FD001)

The hazards to drinking water quality in the Kiskatinaw watershed are high turbidity and sediment loads primarily due to natural causes but also from industrial activities in the watershed, fecal coliform and E. coli bacteria associated with wildlife, cattle, and humans, hydrocarbon contamination as a result of a ruptured oil pipeline, industrial contamination related to the extensive industrial activity in the watershed, contamination from herbicides/pesticides applied on private farmlands and on the crown land and contamination from fertilizers used on farmland. The intake is located downstream of the Crown land/private land interface and there is active farming upstream of the intake. The activities within the watershed area include, forest development, range use, oil and gas development, wind farm exploration, coal mining exploration and recreation. Based on the preceding information the identified hazards to the drinking water in the watershed are summarized in Table 2-1.

Table 2-1: Module 1 Hazards to Drinking Water Quality

Hazard Type	Drinking Water Hazard	Possible Effects
Physical	Sediment - Natural sediment load from channel erosion and mass wasting	Exceedance of turbidity threshold of 1 NTU in treated water Compromised disinfection process Risk to human health
	Sediment - Sedimentation from industrial roads and road crossings	Increased sediment load resulting in exceedance of turbidity threshold of 1 NTU in treated water Compromised disinfection process Risk to human health
	Sediment - Sedimentation from cattle activity in and around streams and road crossings	Increased sediment load resulting in exceedance of turbidity threshold of 1 NTU in treated water Compromised disinfection process Risk to human health
	Turbidity – Increased turbidity from natural and human activities	Exceedance of turbidity threshold of 1 NTU in treated water Compromised disinfection process Risk to human health
	Organic material (Total Organic Carbon)	Reaction of organics (total organic carbon) with water disinfection resulting in formation of trihalomethanes (THMs) in drinking water Risk to human health
	Single source	Loss of drinking water supply
Biological	Bacteria - Bacteriological contamination from wildlife/cattle/human presence in and along streams	Contravention of DWP Regulation for fecal coliform bacteria, E.coli, and total coliforms in drinking water Risk to human health
	Protozoa – presence of Giardia, Cryptosporidium	Contravention of DWP Regulation for fecal coliform bacteria, E.coli, and total coliforms in drinking water Risk to human health
	Viruses - presence	Contravention of DWP Regulation for fecal coliform bacteria, E.coli, and total coliforms in drinking water Risk to human health
Chemical	Hydrocarbons -Petroleum contamination from an industrial fuel spill or vehicle accident	Failure of water treatment plant Contamination of drinking water Risk to human health
	Pesticides/herbicides/fertilizer - from applications on private and Crown lands	May exceed maximum acceptable concentrations established in Guidelines for Canadian Drinking Water Quality Contamination of drinking water

2.4 Source water quality and quantity

Water Quality

The City monitors raw water quality at the intake. There are naturally high levels of suspended sediment and turbidity in the river water. There are also concerns about increases in the turbidity resulting from anthropogenic activity in the watershed (this includes grazing impacts). The maximum turbidity levels for the period April – September at the intake can exceed 2000 NTUs.

The following comments on source water quality have been provided by the Ministry of Environment. *MOE implemented a raw water quality and stream sediment monitoring program at selected communities in the Omineca-Peace Region in 2002. The Dawson Creek raw water intake was included in this program. The results indicated that most measured parameters were clearly within drinking water guidelines; however, contamination with parasites, bacteria, organic carbon, suspended solids and turbidity in the source water (before treatment) was detected.*

In an effort to help the City of Dawson Creek in directing watershed management activities to the most important manageable contaminant sources, MOE designed a contaminant source identification project in the Kiskatinaw watershed upstream of the community water intake. The study was designed in co-operation with the City of Dawson Creek, Northern Health and the BC Center for Disease Control. Fieldwork commenced in 2004 and includes flow based water and sediment quality sampling, with sample sites spatially segregating the watershed by tributaries, stream sections and land use activity types. In addition to water and sediment analysis for a total of 70 contaminants, specific source tracking methods, such as molecular based bacteria and parasite source tracking methods were employed. Latter focuses on sections with highest bacteria and parasite concentrations and is planned to conclude in 2007. Results will be presented during stakeholder meetings under Dawson Creek's watershed management process.

Water Quantity

Water quantity is an increasing concern to the City as a result of the apparent trend towards lower late summer and fall flows. At present the City must pump from the river throughout the clearer flow periods in order to keep its reservoir capacity at a safe level. As occurred in 1992 the river has a history of very low flows approaching zero at times over the year. When there is insufficient flow to maintain a supply at the intake during pumping the City must cease pumping.

The City holds a storage license on Bear Hole Lake for 1357 ML. The City is in the process of having the storage control works designed and securing the necessary approvals to permit

construction by 2010. The purpose of the stored water would be to supplement late fall and early winter flows when the flows are very low (possibly under drought conditions) to reduce the risk of the river freezing completely resulting in a possible loss of supply at the intake.

The City has a long-term goal to construct sufficient off-stream storage near the water treatment plant to store one year of supply. At the present time it has the off-stream capacity is approximately 22% of the long-term demand. When the City has the required off-stream capacity in place it will provide the opportunity for improved system operation and improved sustainability since it will have greater flexibility on the timing of extractions from the river. The storage will also provide a significant safety factor for the supply should the City lose the source through some catastrophe as was experienced by Chetwynd.

2.5 Integrity and Vulnerability of City intake works

In its present configuration the intake is vulnerable to direct contamination from the raw water in the intake pond since the intake is located on-stream as opposed to off-stream. The intake is also vulnerable to impacts from any impacts that affect the stream immediately upstream of the intake such as contamination from an oil pipeline failure or increased sediment and debris loads due to landslide into the channel near the intake. The City has installed a hydrocarbon detection system at the intake to detect the presence of hydrocarbons at the pump house so that the pumps can be stopped before contaminated water could affect the storage reservoirs but more important the treatment plant.

The City also has online turbidity monitoring at the intake that is tied into the SCADA system that will alert the plant operator when turbidity exceeds 500 NTU. Pumping from the river is stopped when the turbidity exceeds 500 NTUs due to the excessive wear on the pumps from the high suspended sediment concentrations.

3. MODULE 2 – RESULTS OF CONTAMINANT INVENTORY

The objective of Module 2 is to inventory the land uses and impacts within the community watershed and inventory the potential sources of contamination associated with these land uses that could affect drinking water quality within the watershed. The combination of the watershed characterization provided in Module 1 and the contaminant inventory (hazard identification) will be used to evaluate the risks to the drinking water supply required in Module 7.

3.1 Overview of Potential Contaminants and Inventory Process

The potential contaminants to drinking water are a function of natural sources and land use. The Kiskatinaw River has high suspended sediment loads, turbidity levels and organic loads that originate from natural sources such as steep unstable cut banks created as the river erodes down through the plateau. The land uses within the Kiskatinaw River watershed include; water supply, forest development, agriculture and grazing, industrial access, highway corridors and recreation. The primary contaminants associated with these land uses are:

- Sedimentation to streams from industrial access roads;
- Sedimentation/turbidity to streams from cattle disturbance at road crossings and along stream banks;
- Contamination by pathogenic organism from wildlife, cattle and human activity around streams;
- Hydrocarbon contamination related to the oil pipeline that traverses the watershed and crosses the main stem upstream of the intake;
- Pesticide and herbicide contamination for applications on private and Crown land;
- Fertilizer contamination from application on agricultural lands.

The risk of all these contaminants entering the drinking water supply increases with increased activity. The most likely points of contamination are those sites that permit direct access to the stream network at stream crossings. The high sediment load and turbidity issues in the river at the intake are well documented by the City. The results of raw water sampling undertaken by the Ministry of Environment since 2002 confirm that there are fecal coliform and E.coli levels that exceed the provincial guidelines for raw drinking water across the watershed. Parasites, Giardia cysts and Cryptosporidium oocysts were also identified at the City intake. Sediment samples were analyzed for organic carbon, hydrocarbons and pesticides. Although a variety of compounds were detected, the levels were all below the BC Approved Water Quality Guidelines. Hydrocarbons specifically the risk of a failure of the oil pipeline that crosses the main stem approximately 9 km upstream of the intake is a concern. The impacts of a failure are well documented following the spill in the Pine River in August 2000. Should hydrocarbon contamination reach the water treatment plant, it could result in a plant failure. The City has installed a hydrocarbon sensor at the intake that should allow sufficient warning to shut the pumps off, preventing serious contamination of its off streams supplies should contamination be detected.

The contaminant inventory process involved the following four-step process:

- Step 1 – Office review of past reports, the updated changes in forest development and oil and gas development since last assessments and review of updated watershed maps indicating the general locations of development.

- Step 2 – Preparation of new field maps indicating all road crossings and updated development.
- Step 3 – Field reconnaissance, including an aerial overview, to identify and record potential sources of contamination related to natural e.g. unstable stream banks, unstable channels, and wildlife activity, and anthropogenic activities in the watershed, e.g. roads, stream crossings, channel conditions, recreational use, recent logging oil and gas development.
- Step 4 – Evaluate and summarize results.

Since stream crossings represent the most likely point source for contamination especially from sediments and road runoff, stream crossings quality was rated at selected sites through out the watershed for sediment production and sediment delivery. The condition of roads regarding intercepting and diverting runoff and sediment was noted for all roads assessed. In addition channel assessments were undertaken during the overview flight and for selected reaches where practical. Riparian condition was also assessed within the sub-basins during the overview flight. Finally recreational use was noted throughout the assessments with additional emphasis placed on areas of concentrated use around lakes and along accessible river reaches.

3.2 Natural Sources

Sediment

The Kiskatinaw River is a naturally dynamic river system with frequent movement of the channel within the valley bottom/floodplain as well as extensive areas of active cutbanks that provide sediment to the river. The most common mass wasting process occurring in the watershed is stream bank undercutting and the introduction of sediments to the river (photo 1, Appendix C). In addition to the mainstem, all the tributaries contribute sediment to the mainstem including Brassey, Halfmoon/Oetata sub-basins and the West and East Kiskatinaw main stems (refer to Watershed Map, Appendix B).

In terms of impacts on the quality of drinking water, the natural sediment yields are considered a high hazard. Episodic events such as rain generated peak flows in the summer and fall also contribute to the water quality issues at the intake.

Forest Health

Mature lodgepole pine comprises a significant extent of the stands in the southern portion of the watershed and is under attack by the mountain pine beetle. As the mature pine die, (as currently projected by the MOFR), the hydrology of the affected sub-basins and the watershed will change will change. There will be more runoff, more frequently, and it will occur more quickly resulting

in increased sediment loads at the intake. While wildfire is a natural hazard in all BC forests, the likelihood of occurrence is expected to increase as fuel-loading increases with the mortality of beetle infected lodgepole pine stands. Depending on the severity of the wildfire, there could be significant increases in erosion and significant changes in hydrology of the affected areas. In 2006 there was a fire in the Hourglass Creek sub-basin. Fortunately the impacts on the water quality were limited (photo 13, Appendix C). The hydrologic impacts from the loss of the mature lodgepole pine are expected to persist for at least the next 30 – 40 years.

Wildlife

The watershed contains a diversity of habitats for a number of wildlife species and healthy populations are likely in the watershed. One of the most abundant species is beaver that inhabit the mainstem as well as the tributaries constructing dams and ponds. There have been as many as 300 dams across the mainstem between the intake and Bear Hole Lake (pers. com. R. Harmon). Wildlife, particularly beaver can be a source of Giardia, and Cryptosporidium. Raw water sampling by the Ministry of Environment confirm that the presence of Giardia and Cryptosporidium cysts in the river water at the intake. During the fieldwork very little evidence of wildlife impacts were noted, other than beaver. Some deer prints and coyote/dog/wolf tracks and bear tracks were noted at a few sites. Wildlife movement in the watershed is unknown. The greater the road density the easier it is for ungulates to move throughout the watershed. Details on wildlife presence in the watershed are provided in the Ministry of Environment reports previously cited.

Climate Change Impacts

Climate change is likely to cause detectable impacts to the watershed and to the water supply. One of the most obvious impacts currently affecting the watershed, that has already been discussed, is the expansion of the mountain pine beetle and the likely loss of most if not all the mature lodgepole pine in the watershed. The affected areas will provide greater water yields for the next several decades that could result in significantly increased peak flows as well as a shift in the timing of the runoff earlier in the spring.

The potential impacts of the shifts in climate on the water supply and the water demand require more study to determine what the impacts may be. In summary the research results suggest warming summers resulting in increased water demand by agriculture and less snow (but perhaps more rain) during the winter that may result in less runoff. The climate models also indicate a shift in the snowmelt period by two weeks earlier.

Combining the impacts of the loss of forest cover to the pine beetle and climate change, there may be some benefits from less snow in the short-term that might offset the potential increase in peak

flows associated with the loss of forest cover. Over the long-term the indications are that there will be less water yield from the watershed compounded by an increased demand.

3.3 Private Lands

There are approximately 25,800 hectares of private lands upstream of City intake along the mainstem and the Halfmoon Creek and Oetata Creek sub-basins that are used for farming. Water quality hazards include leakage from sewage lagoons, spills of various contaminants (particularly hydrocarbons), cumulative impacts from the use of fertilizers, pesticides and herbicides, and increased sedimentation resulting from the removal of riparian vegetation, alteration of property drainage, and tilled fields.

3.4 Range Use

Cattle activity was noted throughout the watershed. According to the information provided by the Ministry of Forests and Range there are currently four grazing tenures issued over the watershed with a total of 8,102 AUMs¹. The dates of use vary but in general cattle are permitted to graze in the watershed from June 1 through October 30. Each tenure holder has a Grazing License issued by the Ministry of Forests and Range. The watershed has been divided into eight separate grazing areas. The presence/absence of cattle impacts were noted at each road crossing assessed. It was noted that cattle were contributing sediment and fecal material to streams at 65 of the 83 sites assessed. Additional details on the presence and concentrations of fecal coliforms from ruminants is available in the Ministry of Environment reports for the watershed released in 2003² and 2006³.

3.5 Resource Development

Resource Roads

There are approximately 1,071 km of secondary and resource based roads upstream of the intake. Roads can be a significant source of sedimentation within the watershed. Sediment is easily delivered to watercourses during wet periods where roads and drainage ditches intersect stream channels. Generally, unless road ditches are disconnected from streams, the greater the number of stream crossings, the greater the number of sites where sediment can readily be delivered to channels.

Fine-grained soils like those encountered in many of the sub-basins are particularly sensitive to surface erosion. The erosion and transport of sediment from roads is aggravated by the reduced

¹ AUM = Animal unit month of grazing. An AUM is equivalent to a cow with one calf.

² Jacklin, J., French, T. and Carmichael, B. 2003. *Assessment of the City of Dawson Creek's Drinking Water Supply (Kiskatinaw River): Source Water Characteristics*. Ministry of Water, Land and Air Protection.

³ Matscha, G., Jacklin, J. and Sutherland, D. 2006. *Water Quality Source Identification in the Kiskatinaw Watershed near Dawson Creek, B.C.* Interim Report. Ministry of Environment.

infiltration capacity of mineral soils on cut banks, running surfaces, and fill slopes, caused by compaction and the loss of organic horizons. Soil erosion and sediment delivery increase significantly during wet periods, which is why it is important to limit vehicle use during spring break-up. In an effort to reduce the impacts of roads in sensitive areas, the oil and gas industry uses oak mats (photo 10, Appendix C).

Observations made during the field visits in 2005 noted a number of concerns with road construction and maintenance, particularly the lack of cross drainage resulting in excessive ditch line erosion and coupling to surface drainage (photos 11 and 12, Appendix C). Several culverts were found that were either partially or completely blocked with sediment. Table 3-1 provides a summary of roads and stream crossings within the watershed.

The following list categorizes the common sedimentation sources noted during the field review:

- Road surface and ditch line erosion.
- Road construction disturbances occurring in proximity to watercourses.

Table 3-1: Roads summary and stream crossings within the Kiskatinaw River Watershed

	Total length of roads in km
Highway	78
Secondary Road (undifferentiated)	1,071
Seismic Line	2,857
Total	4,006
	Total number of stream crossing
Highway	24
Secondary Road (undifferentiated)	291
Seismic Line	1,030
Total	1,345

Forest Development

A sample of cut blocks and forest roads throughout the watershed were inspected by helicopter and vehicle. During field investigations, only one significant slope failure (photo 6, Appendix C) was noted as originating within a cut block. This failure was found in the Jackpine Creek sub-basin. It did not appear that sediment from the failure was deposited into the lower stream channel.

Forest access roads that had vegetated ditch lines and right of ways with adequate crossdrains were low rated as low hazard. However there were some roads where the ditch lines and the right of way had been graded removing all the vegetation, exposing large areas of soil, damaging the crossdrains and removing ditchblocks permitting sediment laden runoff to flow directly into

streams. These roads were rated as high hazard. Other than the slope failure within the one cut block, the harvested areas were generally rated as low hazards.

Oil and Gas Development

Oil and gas development continues to represent an important and growing resource development activity in the watershed. Information provided by the Oil and Gas Commission (OGC) for 2005 indicates that 586 well sites are located within the water supply area (refer to Watershed Map, Appendix B). This represents an increase of 310 wells from previously reported. Table 3-2 presents a summary of oil and gas well sites. An extensive oil and gas pipeline network is located within the watershed (refer to Watershed Map, Appendix B). A summary of pipelines and corresponding stream/river crossings is provided in Table 3-3. In addition to the clearing of well sites and pipeline right-of-ways, a network of roads have been constructed that add the network of resource roads in the watershed that are a potential source of sediment.

Table 3-2: Summary of oil and gas well sites

Well Commodity	Number of Well sites	Estimated Clear-cut Area (ha)	Number of Wells Within 250 metres of a stream
Oil	17	271	43
Natural Gas	188	72	14
Multi-zone Gas	50	88	15
No attributes	61	24	4
Undefined	239	344	64
Total	555	799	140

Table 3-3: Summary of oil and gas pipelines upstream of intake

Pipeline Commodity	Total Length of Pipeline (km)	Total Stream Crossings
Oil	36.5	11
Sour Gas	14	8
Natural Gas	723	249
Other	6.3	1
Total	779.8	269

The majority of well development in the watershed is natural gas however there are 36.5 km of oil pipeline that crosses the watershed through the Brassey and lower mainstem sub-basins.

Well site clearings average 1.44 ha, however, a number of larger sites were noted that accommodated multiple wells (4-6). Field observations found that many of the sites were situated on gentle to moderate slopes and were surrounded with berms and/or ditching. Soils in most instances were left un-vegetated. In a number of instances the perimeter of the sites were earth berms to control runoff with a single outlet constructed for drainage (photos 7 and 8, Appendix C).

It was not evident that there was much consideration given to ensure downslope sedimentation was avoided.

Utility Right-of-Ways and Seismic lines

The watershed has an extensive network of utility right-of-ways (oil & gas pipelines and electrical transmission lines) and seismic lines that are potential sediment sources. Standard pipeline right-of-way width is 15 meters. When the pipeline runs adjacent to an access road the right of way can be 25meters wide. Recent seismic lines have a minimal width and are typically low impact as compared to the conventional straight cut lines of the past.

3.6 Highways

Highway 52 traverses the east and west sides of the watershed and is the connection between Dawson Creek and Tumbler Ridge with approximately 73 km of road within the watershed. The greatest hazard to the City's source water is contamination from dangerous goods being transported on the highway in the event of an accident causing a spill. Salt management, which includes de-icing, anti-icing and winter abrasive agents, has recently been the focus of concern by Environment Canada. The cumulative impact from the extended use of salts can impact water quality. Although studies suggest harmful chloride concentrations are rarely generated from highway de-icing, high concentrations can occur road sides during spring runoff, as well as from leaking salt storage facilities and large snow disposal sites (Buchanan, 2004).

Currently there are no regulations regarding the sources of sediment and chemicals that wash off road surfaces annually that are non-point source contaminants. Studies have shown a correlation between vehicle transportation corridors and increases in the levels of trace metals such as lead, copper, zinc and manganese in the surrounding sediments. Some trace metals can present health risks if introduced into the drinking water supply. The proximity of the highway to the river and its tributaries must be considered when assessing the potential for contaminants to be delivered to the intake.

3.7 Recreational Use

The Kiskatinaw River watershed has considerable recreational value. The area is used by local residents for snowmobiling, off-road vehicle use, snowshoeing, cross-country skiing, water sports, camping, fishing, horseback riding, hunting and photography. Recreational user days are not known but according to City staff familiar with the watershed, recreational use is extensive (pers. com. R. Harmon). Bear Hole Lake Provincial Park is located in the headwaters of the east branch of the river and includes recreation campsite and boat launch into Bear Hole Lake. One Island

Lake Provincial Park provides day use and camping, and a variety of recreational opportunities. There are also a number of cabins around the lake.

Most recreational activities that occur within the watershed are of low risk to drinking water quality. Chronic sedimentation from ATV use along the river and on some of the large cutbanks is a concern. The greatest likelihood of water contamination arising from recreational groups is from fecal matter (both from humans and their pets), hydrocarbon spills, and soil erosion from motor vehicle use. It was also noted that there is dispersed recreational activity (hunting traffic, ATVs, etc) throughout the watershed. Vehicle use of deactivated roads and seismic lines is a concern at stream crossings where sediment can be introduced into the water.

Recent results from the raw water sampling by the Ministry of Environment indicate that fecal coliforms from humans is present in the water throughout the watershed and this is a concern. It is typically humans that introduce many of the pathogenic organisms into the watershed that subsequently infect the wildlife that consume either waste material that was not properly buried, or ingest the cysts from the water. Once the wildlife is infected, the presence of these organisms in the watershed can become endemic.

3.8 Consequence to Drinking Water Quality

The previous sections summarize the potential impacts from the natural sources as well as the various licensed and non-licensed uses in the watershed on drinking water quality. These results will be used in a risk assessment as the source area “hazards” that could affect the drinking water quality. The intent of this section is to address the issue of the “consequence(s)” to the drinking water quality that will be used in Module 7 to estimate the “risks”. *Consequence* may be defined as the effect on human well-being, property, the environment, or other things of value or a combination of these (adapted from CSA 1997). Conceptually, in the case of drinking water, consequence is the change, loss, or damage to the water quality caused by contaminants.

The consequences to drinking water quality result from:

- increased sediment loads;
- increased fecal material/increased pathogen loading;
- increased organics (THM precursors); and/or
- increased nutrients (algal growth, taste and odor problems and THM precursors)

The consequence at the City intake will be high. With the present configuration of the intake increases in any one of these hazards, or a combination of more than one may have significant impacts on the current treatment processes and thereby put public health at risk.

The consequences to the drinking water from natural sources are already high. This plan will have very little effect on the natural hazards that the City has to address to provide safe drinking water. The intent of the source protection plan is to limit the impacts from human activities on the hazards that can be controlled.

4. MODULE 7 – RISK CHARACTERIZATION

4.1 Evaluation of Source Protection Barriers

The barriers currently in place in the watershed include, but not limited to, varying levels of source protection as set out in the *Forest and Range Practices Act*, *Oil and Gas Commission Act*, *Petroleum and Natural Gas Act*, *Pipeline Act*, *Water Act*, *Land Act* and the *Drinking Water Protection Act* and related regulations. However, regardless of the intent by the regulating agencies and the licensed stakeholders to comply with the legislation and regulations and to implement best management practices, the reality is that there is increased contamination of streams dispersed throughout the watershed from roads and industrial development, from disturbance from cattle and from recreational use. In addition there are those “natural” hazards such as contamination from wildlife, increased runoff due to the loss of forest cover to the mountain pine beetle and impacts from climate change for which the only effective barrier will be improved water treatment. This is not to suggest that barriers to contamination such as improved sediment control practices at forest road stream crossings, improved cattle management, improved education for all watershed users should be ignored. To the contrary, recognizing all the challenges to water quality and quantity that the City must address, suggests that all the agencies and stakeholders in the watershed should make every effort to limit the impacts on the water supply. The better the raw water quality that arrives at the intake, the less risk to the public who depend upon this source for their drinking water.

4.2 Qualitative Risk Assessment

A qualitative risk assessment has been undertaken for the hazards identified in Modules 1 and 2 (intrinsic watershed hazards and contaminant sources, respectively). The risk is assessed at the point of intake on the Kiskatinaw River prior to treatment. Therefore, the assessed risk at the intake will be different from the risk “at the tap” following treatment. This “unabated” risk is a worst-case scenario, e.g. in the event of a failure of the treatment process.

Assessment of Likelihood

As described in Module 7 of the Assessment Guideline, risk is the product of likelihood of a hazard effecting the intake and consequence. Qualitative measures of likelihood are presented in Table 4-1, as provided in the Assessment Guidelines. A time horizon of 10 years is suggested in the guidelines when attributing likelihood of occurrence to identified hazards.

Table 4-1: Qualitative Measures of Likelihood.

Level of Likelihood	Descriptor	Description	Probability of Occurrence in Next 10 Years
A	Almost certain	Is expected to occur in most circumstances.	>90%
B	Likely	Will probably occur in most circumstances.	71-90%
C	Possible	Will probably occur at some time.	31-70%
D	Unlikely	Could occur at some time.	10-30%
E	Rare	May only occur in exceptional circumstances.	<10%

Reproduced from Module 7 of the “Comprehensive Drinking Water Source to Tap Assessment Guideline” (BC Ministry of Health Services and Ministry of Water, Land and Air Protection 2005).

Modules 1 and 2 have identified the hazards to drinking water quality that are summarized in Table 2-1, section 2.5. Assessment of likelihood for the hazards is summarized below.

Physical Contaminants - Sediment/Turbidity

The maximum recommended turbidity level in raw drinking water is 1 NTU⁴. As previously indicated, turbidity levels at the intake commonly exceed 2,000 NTU during the spring runoff. During the watershed inspections it was evident that additional sediment is being contributed to watercourses as a result of resource development activities that increase the amount of soil exposure and disturbance. Although the majority of the sediment/turbidity is from natural sources, the likelihood of sediment/turbidity affecting the intake from all sources is rated as an “A” based on Table 4-1.

Biological Contaminants - Fecal Coliform/E.Coli

Wildlife and livestock in the watershed are potential pathogen and turbidity sources. Livestock/wildlife activity was noted at most of the assessed stream crossings where they enter

⁴ H. Singleton, 2001. *Ambient Water Quality Guidelines(Criteria) for Turbidity, Suspended and Benthic Sediments*. Ministry of Water, Land and Air Protection.

watercourses to drink, and there are few barriers to access. Livestock and wildlife activity erodes stream bank and bed material, and may contribute to erosion of fine sediment. Pathogens enter the river network from manure, evidence of which was noted in the proximity of many watercourses during the field assessment.

Water quality sampling conducted at the intake and various other points in the watershed indicates that pathogens (*Escherichia coli* and fecal coliforms) are found throughout the stream network. The Health Canada Drinking Water Guideline for *E. coli* and fecal coliforms is 0 present per 100 mL of water. Water quality samples collected at the intake and at selected points throughout the watershed since 2002 confirm that fecal coliform and *E. coli* are present at the intake and at each sampling site in the watershed. Summaries of the data collected by the Ministry of Environment are available in the reports cited in section 3.5. Based on the MoE sampling results, the likelihood of the hazard of fecal coliform and *E. coli* being present in drinking water at the intake is rated as almost certain, that is “A”, from Table 4-1).

Chemical

Hydrocarbons

The potential impacts on drinking water from a hydrocarbon spill is a concern since there is an oil pipeline that crosses the main stem of the Kiskatinaw River approximately 9 km upstream of the intake. The impacts from a pipeline rupture to drinking water were confirmed by the failure of the Pembina pipeline in the Pine River watershed in 2000 that resulted in the loss of the Pine River as a source of supply for nearly two years.

The treatment plant is not able to remove a variety of dissolved chemicals or hydrocarbons. Hydrocarbons would foul the filters and cause a plant failure. Some dissolved chemicals would pass through the filters unimpeded. In the event of a spill, the City would shut down the intake pumps and/or the treatment plant. Since the City has no alternate supply, if the reservoirs were contaminated, the situation for the residents would be very serious. Contamination of the river would affect not only the water system operation but also the community in general.

Herbicides and Pesticides

The Ministry of Environment included selected pesticides in its raw water sampling programs since 2002. The results were all below any thresholds and not considered to be an issue at this time. For more details refer to the ministry reports cited in section 3.5.

Total Organic Carbon (TOC)

Total organic carbon can be a concern during the disinfection process as it can produce a by-product known as trihalomethanes that can be carcinogenic. Sample results by the Ministry of Environment confirm that the TOC levels in the raw water collected at the intake during the period 2004-2007 ranged from 10 – 17.7 mg/L exceeding the BC Guideline for source water that will be chlorinated of 4 mg/L.

Consequence

Consequence is the second part of the risk calculation, and describes the nature and potential degree of effects that may result from a given hazard. Consequences include unacceptable water quality at the point of intake, and the potential for health impacts for water consumers.

Consequence should consider the severity of the impact, the duration and the proportion of the population that would be affected. Qualitative measures of consequence are presented in Table 4-2, as provided in the Assessment Guidelines.

The three main drinking water hazards present in the Kiskatinaw River watershed are (1) turbidity and (2) pathogens and bacteria, and (3) total organic carbon as confirmed by G. Matscha in her presentation of sampling results at the December 12, 2007 stakeholder meeting. High levels of turbidity can render water treatment less effective, and therefore increases the chance that pathogens and bacteria can enter the drinking water system. Pathogens can be harmful in extremely small concentrations, and ingestion can result in short and long-term illness, and possibly death for vulnerable individuals (e.g. the very young, very old, or those with a compromised immune system). The Kiskatinaw River provides drinking water for the City of Dawson Creek and surrounding communities, that is assumed to be a “small population”, as described in Table 4-2.

Given the potential for serious health impacts due to pathogens, and the size of the population, the consequence of the hazards presented in Table 4-3 is assumed to be major (‘4’, Table 4-2). The consequence of having trihalomethanes in the drinking water as a result of elevated total organic carbon levels is also considered to be major (‘4’, Table 4-2). Finally, the consequence of turbidity events is assumed to be somewhat less severe since the fine sediments are not directly harmful but can compromise the disinfection process and therefore the consequence is assumed to be at least moderate (‘3’, Table 4-2).

Table 4-2: Qualitative Measures of Consequence.

Level	Descriptor	Description
1	Insignificant	Insignificant impact, no illness, little disruption to normal operation, little or no increase in normal operating costs.
2	Minor	Minor impact for small population, mild illness moderately likely, some manageable operation disruption, small increase in operating costs.
3	Moderate	Minor impact for large population, mild to moderate illness probable, significant modification to normal operation but manageable, operating costs increase, increased monitoring.
4	Major	Major impact for small population, severe illness probable, systems significantly compromised and abnormal operation if at all, high level monitoring required,
5	Catastrophic	Major impact for large population, severe illness probable, complete failure of systems.

Reproduced from Module 7 of the “Comprehensive Drinking Water Source to Tap Assessment Guideline” (BC Ministry of Health Services and Ministry of Water, Land and Air Protection 2005).

Risk Assessment to Drinking Water

Risk is the product of likelihood (Table 4-1) and consequence (Table 4-2) using the risk matrix presented in Table 4-3. The assessed risk for each identified hazard is presented in Table 4-4.

Table 4-3. Qualitative Risk Analysis Matrix

Likelihood	Consequence				
	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
A (almost certain)	Moderate	High	Very High	Very High	Very High
B (likely)	Moderate	High	High	Very High	Very High
C (possible)	Low	Moderate	High	Very High	Very High
D (unlikely)	Low	Low	Moderate	High	Very High
E (rare)	Low	Low	Moderate	High	High

Reproduced from Module 7 of the “Comprehensive Drinking Water Source to Tap Assessment Guideline”. (BC Ministry of Health Services and Ministry of Water, Land and Air Protection 2005).

Table 4-4. Kiskatinaw River Watershed Qualitative Risk Assessment to Drinking Water

Drinking Water Hazard	Likelihood Level	Consequence Level	Risk Level	Assumptions / Comments
Natural Watershed Hazards				
Sediment/turbidity:				
Mass wasting	B	1	Moderate	Frequent and extensive ravelling cutbanks along mainstem of the Kiskatinaw River.
Channel instability	B	1	Moderate	Potential for future increased peak flows related to MPB infested forests resulting in increased ECAs.
Biological* Wildlife	A	2	High	Pathogen sources. Distribution and population levels of beaver along the mainstem is high and for other wildlife assumed to be moderate.
Contaminant Sources in Watershed				
Sediment/turbidity:				
Mass wasting from resource activities	C	1	Low	Only one potentially resource related mass wasting event noted in watershed.
Resource roads	B	1	Moderate	Extensive road network with observed examples of sediment delivery to streams.
Cumulative, non-point sources	B	1	Moderate	Increasing development shown to be directly related to increased sediment generation.
Riparian removal	B	1	Moderate	Riparian vegetation has been removed on much of the private agricultural lands along mainstem and lower reaches of tributaries. Brassey Creek has extensive eroding banks through private lands where riparian vegetation has been removed and cattle trample banks.
Channel instability generated from peak flows	D	1	Low	ECAs likely to increase as a result of resource development.

Table 4-4 cont'd. Kiskatinaw River Watershed Qualitative Risk Assessment to Drinking Water

Drinking Water Hazard	Likelihood Level	Consequence Level	Risk Level	Assumptions / Comments
Biological*				
Livestock	A	2	High	Bacteriodes from ruminant waste identified throughout the watershed.
Human	A	2	High	Bacteriodes from human waste identified throughout the watershed.
Chemical				
Hydrocarbons	D	4	High	The potential for a petroleum spill from an oil pipeline rupture.
Pesticides/ herbicides/ fertilizers	D	2	Low	Various users. Unknown chemical composition and distribution.
Total Organic Carbon	B	1	Moderate	Current TOC levels at the intake exceed guidelines.
Alternative Water Sources				
Loss of Primary Water Source	D	5	High	The City has no alternate supply of water if it were to lose the Kiskatinaw River. The off-stream supply in its reservoirs would supply the City for a maximum of three months if rationed for minimum use.

* Includes bacterial, parasitic, and viral pathogens.

5. MODULE 8 – RECOMMENDATIONS TO IMPROVE DRINKING WATER SOURCE PROTECTION AND SUSTAINABILITY IN THE WATERSHED

The basis for the source water protection plan is the use of barriers to limit the exposure of drinking water to a particular hazard. The multi-barrier approach to source protection starts with barriers in the water supply area. It is recognized that the City of Dawson Creek does have a series of barriers between the intake and the consumer that include various detection systems, raw water reservoirs and the water treatment plant. These barriers do not replace the need for diligent protection of the water quality in the watershed.

In 2006 seven provincial ministries, the Office of the Provincial Health Officer, and the five Health Authorities signed a Memorandum of Understanding (MOU) that commits the parties to inter-agency accountability and coordination for the protection of drinking water. In November 2007 the Northern Regional Drinking Water Team, as required in the MOU, was formed with representation from the seven ministries and the Northern Health Authority. The Kiskatinaw River Watershed Source Protection Plan is

based on the commitments made in the MOU, the support of the Northern Region Drinking Water Team, and the authorities in the *Drinking Water Protection Act* delegated to the Drinking Water Officer. A copy of the MOU, Northern Regional Drinking Water Team working protocol and contact list is provided in Appendix A.

The intent of the Source Protection Plan is to recommend a process to address the hazards that are a threat to the safety and sustainability of the City of Dawson Creek's water supply. The following recommendations are provided to address specific hazards:

The basis for the source water protection plan is the use of barriers to limit the exposure of drinking water to a particular hazard. The multi-barrier approach to source protection starts with barriers in the water supply area. It is recognized that the City does have a series of barriers between the intake and the consumer that include various detection systems, raw water reservoirs and finally the water treatment plant. These barriers do not replace the need for diligent protection of the water quality in the watershed.

In 2006 the seven provincial ministries and that have responsibilities for source protection, the Office of the Provincial Health Officer, and the five Health Authorities signed a Memorandum of Understanding (MOU) that commits the parties to inter-agency accountability and coordination for the protection of drinking water. In November 2007 the Northern Regional Drinking Water Team, a requirement in the MOU, was formed that includes representatives from the seven ministries and the Northern Health Authority. The proposed **Source Protection Plan** is based on the commitments made in the MOU, the support of the Northern Region Drinking Water Team, and the authorities in the *Drinking Water Protection Act* delegated to the Drinking Water Officer.

The intent of the **Source Protection Plan** is to recommend a process to address the hazards that are a threat to the safety and sustainability of the water supply for the City of Dawson Creek. The City of Dawson Creek has no authority to implement a Source Protection Plan unilaterally. The authority for source watershed protection is the responsibility of the Ministry of Environment. The Drinking Water Officer with the Northern health Authority is responsible for providing regulatory oversight of water suppliers, educate and identify priority areas for improving safety of water systems, and to undertake other means necessary to safeguard water quality and public health⁵.

It is recommended that staff from the City of Dawson Creek, the Ministry of Environment and the Drinking Water Officer, Northern Health Authority schedule a meeting early in 2008 to develop strategies to address the three major drinking water hazards in the Kiskatinaw Watershed, high parasites and bacteria concentrations – specifically the extensive contamination from human waste throughout the watershed; sources contributing to the high total organic carbon levels; and anthropogenic sources of sediment and turbidity.

⁵ Dr. Shawn Peck, Deputy Provincial Health Officer, Ministry of Health Services, BC's Drinking Water Action Plan, <http://bcgwa.org/ppt/Peck.ppt>.

Regarding the identified threats and the risks to drinking water in the watershed, the following recommendations are provided to address specific hazards.

5.1 *Sediment/turbidity from anthropogenic activities:* The typical sources of sediment/turbidity are roads, soil disturbance associated with forest development, oil and gas development, and agriculture. The first barrier is planning, the second barrier is implementation, the third barrier is monitoring and the fourth barrier is revising the plan. The responsibilities are:

Stakeholder: It is the responsibility of the various stakeholders to plan, implement, monitor and revise their works consistent with the legislation, regulations and policies established under their permits/licenses for the protection of soils and water. Planning should also consider best management practices where these are available.

Regulators: The ministry/ministries that provide the authorities to the licensed stakeholders are responsible, in accordance with the MOU, for compliance monitoring to ensure that activities undertaken are consistent with their respective policies for source protection.

5.2 *Pathogenic organisms:* Pathogenic organisms include bacteria, protozoa and viruses. These are typically associated with waste material (faeces) from warm-blooded animals, e.g. wildlife, cattle, humans. The results of the MOE research sampling in the watershed confirm that a variety of the organisms are present throughout the watershed and in the river at the intake. The ministry has undertaken some source tracking that will be reported separately. For the purposes of this plan the responsibilities are:

Stakeholder: Stakeholders should follow approved practices for the disposal of human waste products in the watershed. These apply to individuals working/recreating in the watershed to waste management at industrial work sites and camps.

Regulators: Regulating agencies need to provide education materials with guidance for disposing of human waste by individuals and to monitor industrial sites and camps for compliance with permits for the disposal of waste.

5.3 *Hydrocarbons:* Currently there is only one oil pipeline identified as a potential hazard and it crosses the main stem of the river approximately 9 km upstream of the intake. Should there be a pipeline rupture and spill of oil into the river, the consequence could be very high if hydrocarbons reached the water treatment plant since they could cause a plant failure. The responsibilities of the various parties are:

Pipeline owner: The pipeline owner is to be in compliance with all the appropriate regulatory requirements related to the safety of the water supply. The pipeline owner should establish a communication protocol with the City regarding notification in the event of a spill.

City of Dawson Creek: The City has a hydrocarbon detection system installed at the intake that should be maintained and tested regularly to ensure that it is functioning to specifications.

Regulators: The OGC that regulate pipelines to ensure that the maintenance and operation and emergency procedures required by the operator meet the applicable policies.

5.4 *Pesticides/herbicides:* These chemicals are commonly used on agricultural lands and on Crown land (fertilizer is not used on Crown land). Although their use is carefully regulated there can be impacts to the water supply from cumulative impacts and spills. The responsibilities are:

Applicator: The applicator is expected to have the necessary permits and to use the product in accordance with the permit. In the event of a spill, the applicator must report the spill as required by the permit, and also report the details of the spill to the Water Manager at the City immediately.

Regulator: The agencies that regulate pesticides and herbicides are expected to apply their respective policies for the use of these products recognizing that the watershed upstream of Arras is a designated watershed used for community water supply.

5.5 Fertilizers: Those applying fertilizers on private lands upstream of the intake should recognize the potential impacts on drinking water. The chemical constituents in fertilizers can be a hazard to drinking water through the increase in nutrients and the effects on biological processes in the water. The responsibilities are:

Applicator: Apply best management practices for the protection of surface water and groundwater when applying fertilizer.

Regulator: The Ministry of Agriculture and Lands should provide educational materials for the use of fertilizer and the protection of water sources.

5.6 Monitoring: Monitoring is an essential component of the **Source Protection Plan**. The Ministry of Environment implemented a raw water-monitoring program in the watershed in 2002. The program established baseline monitoring and problem identification, and identified sources of water quality impacts. This program provides the basis for establishing a permanent long-term monitoring program for the watershed. The support for the permanent program is recommended to come from the ministries that signed the MOU, the City, and hopefully from the stakeholders. The current MOE program should be reviewed to confirm that it meets the needs of the **Source Protection Plan**, and revised if necessary. The sampling results should be reported to the Drinking Water Officer (DWO), MOU members and stakeholders annually. If, in the future the sampling program is run by a third party under contract, the sample results must be analyzed annually by qualified professionals to identify trends or issues and advise the DWO of any concerns.

5.7 Compliance Reporting: The **Source Protection Plan** must have an annual compliance-reporting requirement. Based on the MOU there should be annual reports provided by the agencies in the MOU to the DWO that report on source protection. A summary report should be provided to the MOU members and the stakeholders and be reviewed at an annual watershed meeting. Based on the water quality monitoring report and the compliance report and the report on drinking water delivery by the City, appropriate changes can be made to the **Source Protection Plan**.

6. INITIATION OF THE WATERSHED PROTECTION PLAN

In fulfilling their obligations under the *Drinking Water Protection Act (DWPA)*, the City of Dawson Creek is required to provide a water source assessment. The purpose of the assessment is to identify, inventory and assess the source area of the water supply, including land use and other activities and conditions that may affect the source and monitoring requirements for the drinking water source (Sec.18, DWPA). The previous sections have summarized the results of the source assessment and provide the basis for a strategic plan to be developed over the coming months in co-operation with the Northern Health Authority and the Ministry of Environment. The objectives of the plan should be to:

- 1) Provide assurance that activities conducted on the watershed land base are carried out in a manner that does not cause a negative impact to the water source;
- 2) Initiate a monitoring program that addresses potential threats identified within the watershed assessment; and
- 3) Create additional barriers to existing and potential threats of source contamination where required.

The goal of the plan is to protect the source water. To accomplish this goal the plan should:

- Help educate the supplier, regulatory agencies, licensed stakeholders and the public in better understanding the water source and potential problems that need to be addressed;
- Be developed such that costs and impacts on individuals, land owners, businesses, industries and governments are responsible, achievable and economically sustainable;
- Provide flexibility to address changing conditions (i.e. global warming, increased urban development); and,
- Foster and promote the highest source water quality possible through stewardship and involvement of the broader community.

As stated previously, the City cannot implement the plan on its own, but it can initiate the process by establishing communication with the Drinking Water Officer, indicating its willingness to become involved and the importance of moving the process forward. The City proposes to meet with representatives from the Northern Health Authority and the Ministry of Environment to address the following items:

1. Watershed Stewardship

The City of Dawson Creek would like to develop a watershed stewardship plan for the Kiskatinaw watershed that would be implemented by a full time watershed steward. The City has initiated discussions with the District of Chetwynd regarding this proposal and the opportunity for the two communities to implement the program in the Kiskatinaw River and Pine River watersheds and to share the watershed steward. The District is interested in this proposal. It is proposed that the City, the District, the Ministry of Environment and the Northern health Authority would develop the watershed stewardship program jointly. It is also proposed that the program be funded through a co-operative agreement between the seven agencies that signed the MOU, the City and the District and stakeholders. This idea has been informally discussed with several agency and stakeholder representatives with positive responses. The City would like to have this program in place for 2008.

2. Raw Water Quality and Stream Sediment Monitoring Program

In 2002 the Ministry of Environment implemented a raw water quality and stream sediment-monitoring program in the Kiskatinaw watershed to characterize the source drinking water quality and identify potential hazards that may pose a risk to human health. The City supports this work and would like to establish a permanent monitoring program that would be a component of the Watershed Stewardship Program. Expanded monitoring of source water quality is key in developing a baseline data set that will provide an indication of trends. Results of the monitoring can be used as a tool to assess the current state of activities occurring on the land base. Collection and analysis of data should be summarized and available to the stakeholders, regulators and the public in a format that is simple to understand and identify areas where further research is needed.

3. Stakeholder Education

A relatively simple and cost effective barrier to avoiding increased risk of contamination to the source drinking water is through education. The goal is to increase the knowledge and awareness in all stakeholders, and the public, of the value of water and the sensitivity of the watershed area. Key strategies should include:

- Making all stakeholders aware of the importance of the watershed and the water supply to City of Dawson Creek.
- Informing the public so that it is aware of the value of the water supply and the sensitivity of the water supply area.
- Develop a partnership program with stakeholders, agencies and the public to promote water and watershed education.
- Raise awareness of responsibility towards water beyond the watershed including recognition of downstream users.
- Develop and implement a watershed signage plan.

D. A. Dobson, PEng

Reviewed by: M. E. Noseworthy, PGeo, EngL

7. REFERENCE MATERIAL

- Alberta Energy and Utilities Board (EUB), 1998. Alberta Pipeline Performance in Alberta - 1980-1997.
- BC Water & Waste Association, 2005. Comprehensive Drinking Water Source to Tap Assessment Pilot Program.
- BC Water & Waste Association, 2005. Windermere Water Works Comprehensive Source to Tap Pilot Assessment – Modules 1 & 2.
- British Columbia. Provincial Health Officer. (2001). Drinking water quality in British Columbia: The public health perspective. A report on the health of British Columbians. Provincial Health Officer's annual report 2000. Victoria, B.C.: Ministry of Health Planning.
- Buchanan B., 2004. Salt Management Guide. Ministry of Transportation. Engineering Branch. Geotechnical, Materials and Pavement Engineering Section. Victoria, BC.
- Donahue W.F. 2006. Power point presentation given at 2006 Water Summit.
<http://www.fsin.com/landsandresources/downloads/2006WaterSummit-Presentations/donahue.pdf>
- Fraser Basin Council. 2005. Authorities Affecting Source Water Protection in British Columbia: Research Paper. Prepared for Environment Canada.
- Freeze R.A., Atwater J., and Liebscher H., 1999. Ground Water Resources of British Columbia. Ministry of Environment, Water Stewardship Division
- Hanson C. 2002. Excerpt from speaking notes for the Honourable Colin Hansen, Minister of Health Services, April 28, 2002. BC Water and Wastewater Association AGM.
- Health Canada, 2003. Public Health Initiatives Related to Drinking Water Quality in Canada.
- James Jacklin, Todd D. French and Bruce Carmichael. 2003. Assessment of the City of Dawson Creek's Drinking Water Supply (Kiskatinaw River): Source Water Characteristics. Ministry of Water, Land and Air Protection.
- Lane, B., 2006. Exploration and Mining in British Columbia 2006. EMPR.
- Lord T.M. and Green A.J., 1986. Soils of the Fort St. John – Dawson Creek area, British Columbia. Report No. 42. Land Resource Research Centre, British Columbia Soil Survey, Agriculture Canada.
- Matscha G., 2007. Personal communication. Ministry of Environment. Environmental Quality Section.
- Gabi Matscha, James Jacklin and Dave Sutherland, 2006. Water Quality Source Identification in the Kiskatinaw Watershed near Dawson Creek, B.C. Interim Report. Ministry of Environment.
- McConnel M., Ministry of Forests, Personal Communication, facsimile to Piero Galvagno, December 12, 2001.
- McMechan, M.E. 1994: Geology and structure cross-section, Dawson Creek, British Columbia; Geological Survey of Canada, Map 1858A, Scale 1:250,000
- Miller B., Nov.30, 2005. Personal communication. Office of the BC Auditor General.
- Ministry of Agriculture, Food and Fisheries, Agriculture Land Commission Act
<http://www.agf.gov.bc.ca/ministry/legsum/lrco.stm>

Ministry of Energy, Mines and Petroleum Resources, *Petroleum and Natural Gas Act*
http://www.qp.gov.bc.ca/statreg/stat/P/96361_01.htm

Ministry of Environment, Lands and Parks, March 1999. *Tackling Non-Point Source Water Pollution in British Columbia: An Action Plan*. <http://www.env.gov.bc.ca/wat/wq/bmps/npsaction.html>

Ministry of Forests, *Range Manual*, 1999. <http://www.for.gov.bc.ca/hfp/range/manual/TablCont.htm>

Ministry of Forests, *Forest Practices Code Act*
<http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpact/contfpc.htm>

Ministry of Forests, *Forests Act*
<http://www.for.gov.bc.ca/tasb/legsregs/forest/foract/contfa.htm>

Ministry of Health Planning, October 2001. *Drinking Water Quality in British Columbia: The Public Health Perspective*. Provincial Health Officer's Annual Report 2000.
<http://www.healthservices.gov.bc.ca/pho/pdf/phoannual2000.pdf>

Ministry of Health Services & Ministry of Water, Land and Air Protection, 2005. *Comprehensive Drinking Water Source to Tap Assessment Guideline -Draft*.

Ministry of Sustainable Resource Management, *Dawson Creek Land and Resource Management Plan*, 1999. <http://srmwww.gov.bc.ca/rmd/lrmp/dawson/>

Ministry of Transportation, *Highways Act*. <http://srmwww.gov.bc.ca/wat/wrs/wateract/wtrconsl.htm>

Ministry of Water, Land and Air Protection, *Land Act*
http://www.qp.gov.bc.ca/statreg/stat/L/96245_01.htm

Ministry of Water, Land and Air Protection, *Waste Management Act*

Ministry of Environment, *Water Act*
<http://srmwww.gov.bc.ca/wat/wrs/wateract/wtrconsl.htm>

Minnesota Pollution Control Agency, 1999. *Effects of Septic Systems on Ground Water Quality - Baxter, Minnesota*.

Morfitt, G.L., 1999. *1998/99: Report 5 on Protecting Drinking-Water Sources*. Office of the Auditor General of British Columbia. <http://oag.bc.ca/pubs/1998-99/report-5/sec-1.htm>

Muller J.E., 1961. *Geology, Pine Pass, British Columbia*. Geological Survey of Canada, Map 11-1961, Scale 1 inch to 4 miles

Oil and Gas Commission, 2005. *Report on the Oil and Gas Construction Compliance Audit*

Pett R. J., 2001. *Environmental Assessment of the Pembina Pipeline Oil Spill to the Pine River Near The City, BC: Volume 1 – Sediment Quality*. AMEC Earth & Environmental Limited

Pett R. J., 2001. *Environmental Assessment of the Pembina Pipeline Oil Spill to the Pine River Near The City, BC: Volume 2 – Water Quality*. AMEC Earth & Environmental Limited

Ryan C., et al., 2000. *Water Quality Impacts by Septic Systems in Bragg Creek: Current Assessment and Resident's Views*.

Schindler D.W. and Donahue W.F., 2006. *An impending water crisis in Canada's western prairie provinces.* Proceedings of the National Academy of Sciences 103(19): 7210-7216.

Selim A., Skorseth K., 2000. *Gravel Roads: Maintenance and Design Manual.* U.S. Department of Transportation. Federal Highway Administration.

Sierra Legal Defense Fund, 2005. *This Land is Their Land – An Audit of the Regulation of the Oil And Gas Industry in BC.*
http://www.sierralegal.org/reports/05_07_This_Land_Report.pdf

Stevenson, John, Ministry of Forests, Personal Communication, e-mail to Piero Galvagno, January 7, 2002.

Strelieff W., 2003. *Information provided to the Select Standing Committee on Public Accounts regarding the follow-up of recommendations in 1998/1999 Report 5: Protecting Drinking-Water Sources.* Office of the Auditor General of British Columbia. <http://www.bcauditor.com/AuditorGeneral.htm>

U.S. Environmental Protection Agency, 1992. *Framework for Ecological Risk Assessment.*

Whiting P.J., 2003. *Estimating TMDL background sediment loading from existing data - Final Report to the Great Lakes Commission.* Department of Geological Sciences, Case Western Reserve University.

Wise, M.P., G.D. Moore, and D.F. VanDine (editors). 2004. *Landslide risk case studies in forest development planning and operation.* B.C. Min. For., Res. Br., Victoria, B.C. Land Manage. Handbook No.56.

STATEMENT OF LIMITATIONS

This document has been prepared by Dobson Engineering Ltd. (DEL) for the exclusive use and benefit of the City of Dawson Creek for the Kiskatinaw River Watershed Source Protection Plan. No other party is entitled to rely on any of the conclusions, data, opinions, or any other information contained in this document.

This document represents DEL's best professional judgement based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by members of the engineering profession currently practising under similar conditions. No warranty, express or implied, is made.

PROPRIETARY AND CONFIDENTIALITY NOTICE

This document is submitted in confidence as provided under Section 21 of the Freedom of Information and Protection of Privacy Act (BC). Dobson Engineering Ltd. considers the information contained in this document to be proprietary. The City of Dawson Creek shall not disclose this document to any other party and shall not duplicate or use it, in whole or in part, for any purpose other than to evaluate the document itself.

COPYRIGHT NOTICE

These materials (text, tables, figures and drawings included herein) are copyright of Dobson Engineering Ltd. (DEL). The City of Dawson Creek is permitted to reproduce the materials for archiving and for distribution to third parties only as required to conduct business specifically relating to the Kiskatinaw River Watershed Source Protection Plan. Any other use of these materials without the written permission of DEL is prohibited.

Appendix A

**Memorandum of Understanding Regarding
Inter-Agency Accountability and Coordination
on Drinking Water Protection**

-
Northern Regional Drinking Water Team

-
Working protocol for the Northern Regional Drinking Water Team

MEMORANDUM OF UNDERSTANDING

BETWEEN

Ministry of Agriculture and Lands
Ministry of Energy, Mines and Petroleum Resources
Ministry of Environment
Ministry of Community Services
Ministry of Health
Ministry of Forests, Range and Housing
Ministry of Transportation
Office of the Provincial Health Officer
Fraser Health Authority
Interior Health Authority
Northern Health Authority
Vancouver Coastal Health Authority
Vancouver Island Health Authority

REGARDING

INTER-AGENCY ACCOUNTABILITY AND COORDINATION ON DRINKING WATER PROTECTION

VERSION 7: OCTOBER 16 · 2006

1 Background

- 1.1 In March, 2002 the Province adopted an *Action Plan for Safe Drinking Water in British Columbia* which sets out a multi-faceted and multi-agency approach to the protection of public health as it relates to drinking water quality.
 - 1.2 The Action Plan sets out government's commitment to an integrated approach for drinking water protection. The ADMs' Committee on Water and the Directors' Inter-Ministry Committee on Drinking Water are the facilitating bodies for the Action Plan.
 - 1.3 The Action Plan also states the accountability of different ministries for the coordination of source protection, land use planning and infrastructure:
 - (a) The Ministry of Environment will be responsible for source water quality standards, monitoring, compliance and enforcement, and resource ministries will continue to be responsible for protecting drinking water sources under their legislated mandates.
-

- (b) The Ministry of Agriculture and Lands will work with communities to help make appropriate land use decisions that carefully consider drinking water protection.
 - (c) The Ministry of Community Services will work in partnership with federal and local governments to help ensure required infrastructure is in place.
- 1.4 The *Drinking Water Protection Act* (DWPA) is one element of the Action Plan. It is the principal statute concerning drinking water protection.
- 1.5 Many other statutes deal with matters of relevance to drinking water protection, and through which government seeks to achieve various legislative objectives related to matters such as resource extraction, land use and environmental practices. Many of these statutes contain their own provision for drinking water protection, most particularly source water protection.
- 1.6 The role of drinking water officers under the DWPA complements the roles of statutory officials under other statutes, and the DWPA contains numerous provisions to balance respect for other statutory mandates while at the same time ensuring that public health protection respecting drinking water is achieved.
- 1.7 The DWPA requires the Provincial health officer to perform an oversight and accountability function regarding the administration of the DWPA. This includes a duty to report to the Minister of Health and potentially to Cabinet any situation that
- (a) in the opinion of the Provincial health officer, significantly impedes the protection of public health in relation to drinking water, and
 - (b) arises in relation to the actions or inaction of one or more ministries, government corporations or other agents of the government.
- 1.8 In light of all the above, the parties to this MOU have entered into this understanding with a view to ensuring each agency's accountability in respect of their actions concerning drinking water protection.
- 1.9 This MOU is not intended to address issues of consultation and/or coordination between the parties to this agreement and federal agencies.

2 Guiding principles

2.1 In fulfilling the terms of this MOU the parties¹ will be governed by the following guiding principles:

Constructive – The parties will foster constructive working relationships.

Proactive – The parties will work to ensure that any potential concerns regarding inter-agency cooperation are identified in a proactive manner and that steps are taken to avoid them, or to address them as soon as possible.

Information sharing – Each agency, through either the ADMs' or the Directors' Committees, will share with the other agencies information relevant to the matters covered by the MOU. This will include:

- sharing of information respecting the development or amendment of legislation, policy, practices, etc. that may affect drinking water protection (in advance where possible)
- sharing information from the ADMs' and Directors' Committees with officials² responsible for implementing the regional protocols (discussed below)
- clear communication regarding the goals and purposes of the various regulatory mandates, particularly those which are results based.

Respect for mandates – All of the parties will recognize and respect the mandates and statutory decision-making functions of the other parties.

Partnership – The parties will give effect to this MOU in manner that reflects a sense of partnership and shared responsibility for drinking water protection and risk management.

Efficiency and Practicability – The parties seek to ensure that the goals of the MOU are achieved in a manner that minimizes the need for the development of additional referrals systems and other activities that will impose significant resource requirements on staff. The parties will also support an appropriate degree of flexibility among regions in implementing the regional protocols (discussed below), so as to reflect the particular needs and circumstances of the various regions. Communication and referrals on resource activities that are part of the regional protocol will be based on best available information at the time of the application.

¹ "Parties" means the agencies as represented on the ADMs' Committee on Water.

² i.e., officials from any agency.

3 Establishment of regional drinking water teams

- 3.1 For each region, a regional drinking water team will be established, with representation from each agency that is party to this agreement, as well as representation from local governments that wish to participate.
- 3.2 The members of the regional drinking water teams will serve as the principal contact for discussion of regional inter-agency drinking water issues.
- 3.3 Each health authority will designate a drinking water officer to serve as a coordinator of the respective regional drinking water teams. The coordinator will maintain an up-to-date contact list for members of the regional drinking water team and make that available to all team members.
- 3.4 Regional drinking water teams may communicate by whatever means is considered the most efficient and effective and all may meet, in whole or in part, at times mutually agreeable to all the members. The coordinator for each team will schedule at least one meeting each year to which all members of the regional drinking water teams will be invited to attend. If a subset of the membership meets, the coordinator of the drinking water team will communicate the outcome of the meeting to all members within a week of the meeting.

4 Commitment to the establishment of regional protocols

- 4.1 Each of the Parties to this MOU will participate in the development of regional protocols to give operational effect to the purposes of this MOU.
- 4.2 For the purposes of the regional protocols, the regions will be defined by the geographic areas of each of the five health authorities, as set out in Appendix A. Due to the absence of coincident boundaries among the agencies, discussions may need to occur among multiple offices to identify appropriate committee membership for each regional protocol.
- 4.3 The regional protocols will be developed by the regional teams, and they will set out the types of decisions that should as a general rule be the subject of some form of coordination or consultation, recognizing however that the decision whether or not to undertake inter-agency coordination in any particular case is ultimately a matter for the discretion of officials³ (unless some legal requirement to do so exists).
- 4.4 Regional drinking water teams may develop whatever form of protocol they determine appropriate to achieve the goals and meet the requirements of this MOU, but they are encouraged to consider using the form of protocol set out in Appendix B, and to consider coordination regarding those activities set out in Appendix C that are relevant to that

³ i.e., officials from any agency.

region. Regional protocols may include strategies for engaging local stakeholders interested in community drinking water issues.

- 4.5 Regional protocols must be developed for each region no later than October, 2007. A copy of such protocols must be provided to the Directors' Inter-agency Committee on Drinking Water when it is completed, and at any time it is amended.
- 4.6 Nothing in this MOU or any regional protocol developed under it is intended to be legally binding, and neither creates any legal rights or duties. Moreover, nothing in this MOU or a regional protocol shall be taken to limit or constrain the exercise of discretion by a party in respect of a statutory power or decision.

5 Commitment to include drinking water coordination activities within each ministry and agency

- 5.1 Each agency that is party to this MOU will undertake the necessary internal steps to ensure its commitment to inter-agency coordination of drinking water issues and the implementation of this MOU.

6 Process for review and performance management

- 6.1 On or before June 30 of each year, beginning June 2008, each drinking water team will provide to the Directors' Inter-agency Committee on Drinking Water a summary report of its activities for the previous fiscal year.
- 6.2 The Directors' Inter-agency Committee on Drinking Water will review the reports of the regional drinking water teams and provide an annual overview report to the ADMs' Committee on Water.
- 6.3 The Directors' Inter-agency Committee may at any time provide recommendations to the regional drinking water teams, with a view to ensuring the effective and efficient implementation of this MOU.

7 Process for dealing with disagreements or unresolved issues

Disagreements or unresolved issues in implementation of regional protocols

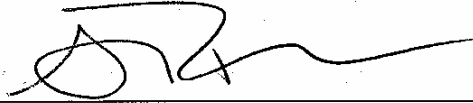
- 7.1 Responsibility for addressing disagreements or unresolved issues concerning implementation of the regional protocols rests with the regional team members and their supervisors as appropriate. If however the regional teams draw to the attention of the Directors' Inter-agency Committee on Drinking Water any disagreements or unresolved issues arising in relation to the implementation of a regional protocol, the Directors' Committee may review and discuss the matter, with a view to recommending to the ADMs' Committee any amendments to this MOU that may prevent such occurrences from occurring in future.

Disagreements or unresolved issues in implementation of this MOU

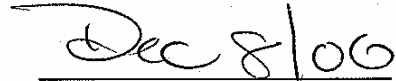
7.2 If any disagreements or unresolved issues arise in the implementation of this MOU, the relevant members of the Directors' Inter-agency Committee on Drinking Water will discuss the matter and attempt to resolve it. If that does not prove successful, those parties will refer the matter to the relevant members of the ADMs' Committee. In the event that the Assistant Deputy Ministers of the agencies concerned are unable to resolve the disagreement in a mutually acceptable manner, they will refer to matter to the Deputy Provincial health officer, who may consult with the parties with a view to resolving the matter.

8 Costs

8.1 Each agency will bear its own costs of undertaking the activities associated with this MOU.



Grant Parnell, Assistant Deputy Minister, Crown Land Administration, Ministry of Agriculture and Lands



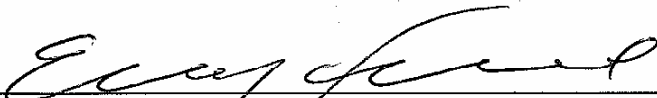
Date



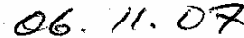
Harvey Sasaki, Assistant Deputy Minister, Risk Management and Competitiveness, Ministry of Agriculture and Lands



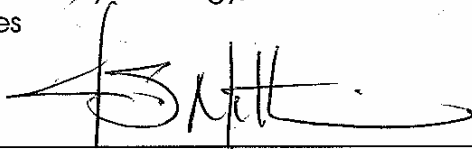
Date



Eric Partridge, Assistant Deputy Minister, Mining and Minerals, Ministry of Energy, Mines and Petroleum Resources



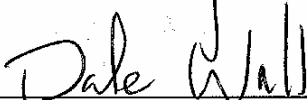
Date



Jim Mattison, Assistant Deputy Minister, Water Stewardship, Ministry of Environment



Date



Dale Wall, Assistant Deputy Minister, Ministry of Community Services



Date

Andrew Hazlewood, Assistant Deputy Minister,
Population Health and Wellness, Ministry of Health

Nov 03/06.

Date

Jim Snetsinger, Chief Forester, Ministry of Forests,
Range and Housing

Dec 12/06

Date

for Peter Millsburn, Assistant Deputy Minister, Highways
Department, Ministry of Transportation

06/12/11

Date

Dr. Perry Kendall, Provincial Health Officer, Office
of the Provincial Health Officer

31/05/2008

Date

Dr. Roland Guasparini, Chief Medical Health
Officer, Fraser Health Authority

24 January 2007

Date

Dr. Rob Parker, Chief Medical Health Officer,
Interior Health Authority

Dec 28 /2006

Date

Dr. David Bowering, Chief Medical Health Officer,
Northern Health Authority

Jan 9 /2007

Date

for Dr. John Blatherwick, Chief Medical Health Officer,
Vancouver Coastal Health Authority

02/NOV/2006

Date

Dr. Richard Starwick, Chief Medical Health Officer,
Vancouver Island Health Authority

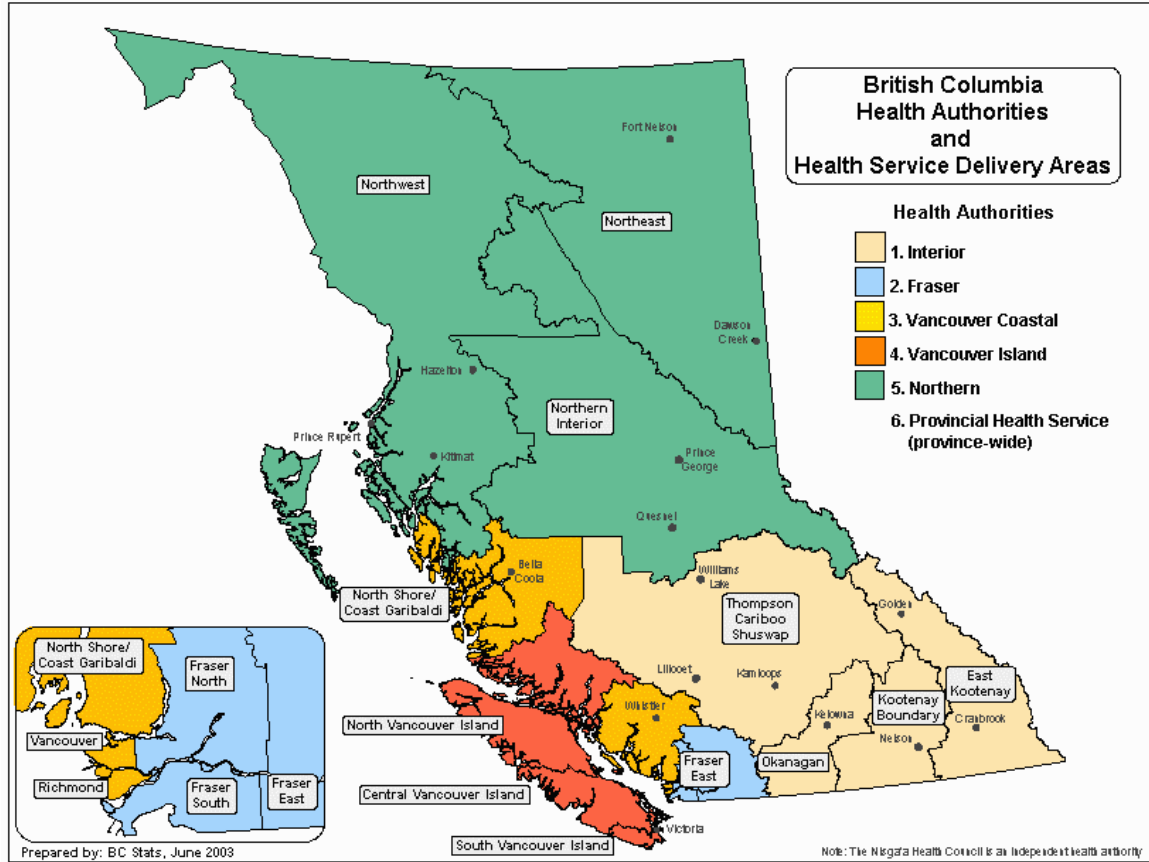
Jan 17/07

Date



Appendix A

Map of Health Authorities



Appendix B

Suggested template for Regional Protocols

REGIONAL DRINKING WATER TEAM

The members of the ____ Regional Drinking Water Team, including contact information and the names of alternate members, are set out in the attached table.

Each agency will bear the costs of its participation in the Regional Drinking Water Team and the meetings referred to below.

MEETING SCHEDULE

Regular meetings

The Regional Drinking Water Team will hold a regular meeting at least [*SPECIFY FREQUENCY*]. Such meetings will be arranged by [*SPECIFY DRINKING WATER OFFICER OR OTHER PERSON*] upon at least 3 weeks notice to all the other parties. All parties will send a representative to such meetings.

Parties will attempt to participate in regular meetings in person, but may arrange to participate by conference call if personal attendance is not practicable.

The team members will rotate the responsibility for organizing and hosting regular meetings, and in preparing minutes that result from such meetings.

Additional meetings

Additional meetings may be held at any time that any of the team members wishes to propose and organize such a meeting. In providing notice of additional meetings, the person proposing the meeting should give as much notice as is reasonable in the circumstances, and must indicate the purpose of subject matters(s) to be addressed in the meeting. The other parties may attend such additional meetings at their discretion.

Parties may participate in additional meetings in person or by teleconference.

Matters for consideration at meetings

The Regional Drinking Water Team will establish its own agendas for regular and additional meetings. This may include, but is not limited to:

- Discussion of routine consultation and activities taken pursuant to the protocol (see next section)
- Proactive identification of drinking water protection issues that may warrant inter-agency consultation and coordination even before a specific statutory decision or function is contemplated

- Consultation with local stakeholders interested in community drinking water/watershed protection issues
- *[Others?]*

MATTERS FOR WHICH COORDINATION AND CONSULTATION WILL BE ROUTINELY CONSIDERED

Staff of the parties to the protocol will, as a general matter, apply the principles set out in the following chart concerning inter-agency consultation when exercising their statutory functions relevant to drinking water protection.

However, in any case where an official from an agency determines that some other approach is more appropriate on the facts of any particular case, he or she may adopt the principles that are considered appropriate.

[Insert chart based on proposal set out in Appendix C of MOU⁴, but tailored to needs and circumstances of the region.]

DEALING WITH DISAGREEMENT OR UNRESOLVED ISSUES

In the event issues arise about which the team members disagree, or cannot be resolved, and which have potential impact on drinking water protection and related matters, the team members involved will refer the matter to their immediate supervisors for consideration and direction.

If as a result of the referrals discussed above a team members considers that a matter is not resolved to the mutual satisfaction of the agencies concerned, he or she must advise the person from that agency that is a member of the Directors' Inter-agency Committee on Drinking Water.

COMMUNICATION STRATEGIES

The parties will adopt the following communication techniques and strategies to ensure open and effective communication regarding drinking water protection issues:

- Copies of this protocol and the related MOU will be provided to [specify]
- The parties will share information in a timely way regarding developments within their respective agencies that are relevant to the matters covered in this protocol.
- *[Others?]*

⁴ Appendix C is a table including agencies' decisions related to drinking water and the associated legislation.

PREPARATION OF AN ANNUAL REPORT

8.2 On or before June 30, beginning June 2008, of each year, each drinking water team will provide to the Directors' Inter-agency Committee on Drinking Water a summary report of its activities for the previous fiscal year. Responsibility for preparing the report will rotate annually among members of the Regional Drinking Water Team.



Appendix C

Please note: THE FOLLOWING EXAMPLE IS FOR ILLUSTRATIVE PURPOSES ONLY. This chart is intended to be completed by the regional drinking water teams. The actual contents of the chart would need to be discussed and considered by relevant ministry staff.

Chart of key statutory decisions for which regional inter-agency coordination may be appropriate

ACT	DECISION OR ACTION BEING CONSIDERED OR TAKEN	AGENCIES WITH WHICH TO COORDINATE*									
		DWO	MAL	MCS	MEMPR	MOFR	Local Gov't	MOE	MOT	PHO	
		"c" - consider consulting and pursue as appropriate "r" - request input before decision-making "i" - share for information purposes (*May be departed from where the official concerned views the type or degree of coordination set out below is not appropriate in the circumstances)									
Dike Maintenance Act											
Drinking Water Protection Act	Construction permits										
	Operating permits										
	Hazard Abatement Orders										
	Public reporting requirements (e.g., boil water notices)										
	Assessment (technical committee)										
	Assessment response plan										
	Emergency Plans										
	DWPP (request for)										

ACT	DECISION OR ACTION BEING CONSIDERED OR TAKEN	AGENCIES WITH WHICH TO COORDINATE*									
		DWO	MAL	MCS	MEMPR	MOFR	Local Gov't	MOE	MOT	PHO	
		"c" - consider consulting and pursue as appropriate "i" - share for information purposes "r" - request input before decision-making (*May be departed from where the official concerned views the type or degree of coordination set out below is not appropriate in the circumstances)									
Environmental Assessment Act											
Environment Management Act	Pollution abatement order										
	Pollution prevention orders										
	Pollution information order										
	Waste discharge (Schedule 1)										
	Area-based planning										
	Substitution orders										
	Remediation orders (CS)										
	Animal Waste Control Regulation										
	Organic Matter										
	Recycling Regulation										
Farm Practices Protection Act	Farm bylaws through the local government act										
Fisheries Act											
Fish Protection Act	Riparian Area Regulation										
Forest Act	Tenure/licence award										

ACT	DECISION OR ACTION BEING CONSIDERED OR TAKEN	AGENCIES WITH WHICH TO COORDINATE*										
		DWO	MAL	MCS	MEMPR	MOFR	Local Gov't	MOE	MOT	PHO		
Forest Practices Code	Road construction permits											
	Watershed Assessments in community watersheds(until 2006)											
	Forest Development Plan Approval											
	Cutting permits											
	Setting water quality objectives (known)											
Forest and Range Practices Act	Forest Stewardship Plans											
	Range Stewardship Plans											
	Range Use Plan											
	Woodlot Regulation											
	Community Watershed designation (MSRM)											
Geothermal Resources Act	Tenure (MEM)											
	Exploration and Development Approvals (MEM?)											

ACT	DECISION OR ACTION BEING CONSIDERED OR TAKEN	AGENCIES WITH WHICH TO COORDINATE*										
		DWO	MAL	MCS	MEMPR	MOFR	Local Gov't	MOE	MOT	PHO		
		"c" - consider consulting and pursue as appropriate "i" - share for information purposes "r" - request input before decision-making (*May be departed from where the official concerned views the type or degree of coordination set out below is not appropriate in the circumstances)										
Integrated Pest Management Act	Service license approvals (including conditions)											
	Directives and orders											
	Selective permitting											
Land Act	Plan approvals and objectives											
	Fee simple											
Land Amendment Act	Water Objectives (MSRM)											
Lands, Parks and Housing Act	Same powers under both (Land Act LWBC) Land Act: application-based, proactively look for opportunities (e.g., sale of Crown land)											
	Crown Land Allocation Framework (CLAF)											
	Recreational Lot Sales Strategy											
Livestock Act	Fencing											
	Land clearing											
Local Government	Regional Growth Strategies											

ACT	DECISION OR ACTION BEING CONSIDERED OR TAKEN	AGENCIES WITH WHICH TO COORDINATE*										
		DWO	MAL	MCS	MEMPR	MOFR	Local Gov't	MOE	MOT	PHO		
		"c" - consider consulting and pursue as appropriate "i" - share for information purposes "r" - request input before decision-making (*May be departed from where the official concerned views the type or degree of coordination set out below is not appropriate in the circumstances)										
Act/ Community Charter	OCPs											
	Subdivision zoning bylaws											
	Variances											
	Borrowing powers regarding water DWO determines non-potable											
	Liquid Waste Management Plans											
	Amendments to municipal boundaries											
	Adoption of OCP											
	Adoption of Zoning Bylaws											
Local Government Grants Act	Infrastructure funding											
Local Services Act	Subdivision regulation (unserved areas within RDs, approval by MOT)											
Mines Act	Sand and gravel, placer, and hardrock. mining											
	Approvals and permits											

ACT	DECISION OR ACTION BEING CONSIDERED OR TAKEN	AGENCIES WITH WHICH TO COORDINATE*										
		DWO	MAL	MCS	MEMPR	MOFR	Local Gov't	MOE	MOT	PHO		
	Remediation orders											
	Dumps											
	Dams											
	Remediation for acid rock drainage											
	Gravel pits											
Parks Act	Water supplier provisions											
	Park Use Permits											
Petroleum and Natural Gas Act	Tenure (MEM)											
	Exploration and Development Approvals											
Range Act												
Transportation Act	New highway development											
	Road maintenance standards and agreements for 10 years											
	Permit to construct works on Crown lands											
	Transportation of Dangerous Goods											
Water Act	Water licences											
	Dam building											

ACT	DECISION OR ACTION BEING CONSIDERED OR TAKEN	AGENCIES WITH WHICH TO COORDINATE*										
		DWO	MAL	MCS	MEMPR	MOFR	Local Gov't	MOE	MOT	PHO		
	Storage											
	Water Users' Communities											
	Section 9 approvals: "changes in and about a stream"											
	Issuance of permits over Crown land (pipes);											
	Dam and dyke approvals. (Potential for flooding of intake works for wells or surface intakes.)											
	Flood proofing of wells											
	Well construction											
	Water Management Plans (MSRM/MWLAP)											
Water Utilities Act	Excludes sections strictly for energy utilities											
	Certificate of public convenience and necessity											
Water Utilities Commission Act												

ACT	DECISION OR ACTION BEING CONSIDERED OR TAKEN	AGENCIES WITH WHICH TO COORDINATE*									
		"c" - consider consulting and pursue as appropriate					"i" - share for information purposes				
		"r" - request input before decision-making (*May be departed from where the official concerned views the type or degree of coordination set out below is not appropriate in the circumstances)									
		DWO	MAL	MCS	MEMPR	MOFR	Local Gov't	MOE	MOT	PHO	
Weed Act	Spraying										
Wildfire Act											
Wildlife Act											



Appendix B
Watershed Map

Appendix C
Photographs