Project: 060851

Prepared for:

Municipality of the County of Annapolis

FINAL REPORT

Bear River Water Supply Feasibility Study

August 2007

CBCL LIMITED

Consulting Engineers

ISO 9001

Registered Company

30 August 2007

Mr. Laurie Emms
Municipal Engineer
Municipality of Annapolis
PO Box 9, 396 Main Street
Lawrencetown, NS B0S 1M0

Dear Mr. Emms:

RE: Bear River Water Feasibility Study – Final Report

We are pleased to submit our Final Report for the Bear River Water Feasibility Study.

The assessment of water resources in the Bear River area identified a potential groundwater source, which could be used to supply central water to the Community of Bear River.

The bedrock aquifer underlying the area between Riverview Road and Lansdowne Road, located in Digby County in close proximity to the identified priority area for servicing, was determined to have the highest potential to supply the Community of Bear River.

Based on a review of available water quality information, the groundwater quality from the source meets the requirements of the Guidelines for Canadian Drinking Water Quality (GCDWQ) for all parameters analyzed, and the yield appears to be adequate given the Community of Bear River's limited water demands.

A water supply concept from the identified groundwater source and opinions of probable construction and operational costs were generated, and compared to the estimated individual well owner costs for upgrading/maintaining their water supplies.

As requested, we have included opinions of probable construction and operational costs for the portion of the project identified as Phase 1. Please refer to section 7.3 and Appendix D in the final report.

Thank you for the opportunity to work on the project.

Yours very truly,

CBCL Limited

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Contents

List of Tables

List of Figures

Appendices

Chapter 1 Introduction

1.1 Project Background

The Community of Bear River is an unincorporated community located along the eastern and western sides of the Bear River. The eastern portion of the community is located within the Municipality of the County of Annapolis, and the western portion is located within the Municipality of the District of Digby. The Community location is indicated in Figure 1-1.

The Community of Bear River is presently serviced only with wastewater collection and treatment systems. Discussions with County of Annapolis officials indicate that there are approximately 140 existing service connections, and that the District of Digby is currently considering the extension of the collection system to service an additional 60 homes. Private dwellings and commercial businesses within Bear River are supplied by private dug or drilled wells.

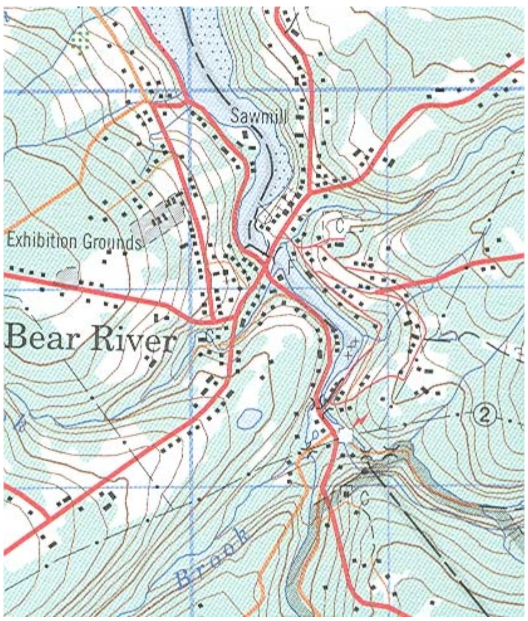

Figure 1-1: Location of Bear River

Bear River is located in the South Mountain physiographic region, with surface drainage from the South Mountain towards Bear River, which flows south to the Annapolis Basin. The community is underlain by Devonian metamorphic bedrock units of the Torbrook Formation, and Silurian metamorphic/igneous bedrock of the White Rock Formation. All groundwater stored and flowing in these bedrock units is through fractures, resulting in highly variable well yields. The water quality of wells drilled into the bedrock units is can be associated with elevated concentrations of bedrock mineral constituents, such as iron and manganese. Bear River is a tidal river, and therefore drilled wells intercepting bedrock aquifers located immediately adjacent to the River may be vulnerable to the effects of salt water intrusion. Dug wells are used where sufficient groundwater resources are available from surficial aquifers.

Residents and businesses in Bear River have advised the municipalities that their water supplies are generally inadequate from both yield and water quality perspectives. Local water supply issues include the contamination of dug and drilled wells due to improper well siting, construction and maintenance, and insufficient groundwater yield and poor water quality in various areas of the community.

Improper well siting, construction and maintenance can result in high bacteria counts, especially in areas that are not serviced with a sewer collection system. Improperly constructed wells are vulnerable to contamination from surface and shallow groundwater. As a result of the typically smaller lot size requirement in wastewater serviced areas compared to unserviced areas, groundwater withdrawals are more concentrated in these areas, and therefore there is greater pressure on the groundwater resource. More concentrated groundwater withdrawals can result in a local depression of the water table causing shallow dug wells to go dry during extended dry periods.

In response to the water supply concerns expressed by the residents and businesses of Bear River, the Municipalities requested an investigation into the feasibility of servicing the community with a central water system. A number of homes and businesses in the downtown area (Digby County) are currently serviced by a small communal water supply system, which is referred to as the Hillsborough Water Society system.

The objective of the Feasibility Study is to identify water supply sources that could be used to supply water to the community of Bear River, to identify water treatment processes that may be required to provide water that meets the Guidelines for Canadian Drinking Water Quality (GCDWQ), and to provide estimated capital and operating costs of the proposed treatment, storage and distribution infrastructure.

1.2 Regulatory Framework

1.2.1 Guidelines for Canadian Drinking Water Quality

Nova Scotia has adopted the Guidelines for Canadian Drinking Water Quality (GCDWQ) as the basis for provincial drinking water quality standards and objectives. The GCDWQ were first published in 1978 superseding the previously created Canadian Drinking Water Standards and Objectives published in 1968. Since their establishment, the GCDWQ have been periodically updated and revised. The latest Summary of Guidelines for Canadian Drinking Water Quality was released in March 2007.

1.2.2 NSEL Treatment Standards

In October of 2002, the Province of Nova Scotia released a comprehensive drinking water strategy that established clear standards for the provision of safe, clean drinking water to all Nova Scotians.

A “Groundwater Treatment Standard” was developed as part of the Strategy, requiring all municipal Public Water Supplies using groundwater sources to evaluate the potential for the source to be under the direct influence of surface water according to the criteria established by the Nova Scotia Department of Environment and Labour. These criteria include the well setting and proximity to surface water, well construction, and water quality data. Groundwater under the direct influence of surface water (GUDI) wells are more susceptible to waterborne diseases that can have a profound impact on the health, environment and economy of municipalities.

All municipal water supplies using surface water, or groundwater sources under the direct influence of surface water (GUDI), are required to comply with the “Surface Water Treatment Standard”. The general requirements of the Standard establish the “theme” as follows:

- Filtration is required for all surface water treatment facilities;
- Treatment facilities are required to have a minimum of two filters to ensure that unfiltered water does not enter the water distribution system;
- Treatment facilities are required to have a minimum of two disinfection units to ensure that non-disinfected water does not enter the water distribution system; and
- A combination of filtration and disinfection has to provide specified treatment efficiencies.

Municipal water supplies are required to comply with the appropriate Treatment Standards by April 01, 2008.

1.2.3 Atlantic Canada Guidelines for Drinking Water Systems

CBCL Limited prepared the *Atlantic Canada Guidelines for the Supply, Treatment, Storage, Distribution and Operation of Drinking Water Supply Systems* (*Water Supply Manual*) under the direction of a Steering Committee comprised of representatives of the four Atlantic Canada Environment Departments and two large utilities. The *Water Supply Manual* has been adopted by the Nova Scotia Department of Environment and Labour (NSEL). The requirements at the “Pre-Design” stage have been significantly expanded from previous “pre-design” requirements. The *Water Supply Manual* outlines key components of a “pre-design” evaluation that should be submitted to NSEL, including Site Selection of Treatment Facility, and the Conceptual Layout of Treatment Plant.

1.2.4 Public Drinking Water Supplies

The *Guidelines for Monitoring Public Drinking Water Supplies* (GMPDWS) define a *Public Drinking Water System* as a water supply, including any source, intake, treatment, storage, transmission or distribution, that is intended to provide the public with potable, piped water that:

i) Has at least 15 service connections; or
ii) Regularly serves 25 or more persons per day at least 60 days per year.

It is the responsibility of the owner to meet all of the requirements that apply to the water supply. The GMPDWS outlines the roles and responsibilities of owners, as well as the minimum water quality sampling, testing and monitoring requirements, acceptable to NSEL.

The *Owner* means a person who owns, operates or maintains a public water works supply. The owner may designate an operator to conduct the day-to-day operations of the water supply.

The latest Guidelines for Monitoring Public Drinking Water Supplies were released on 12 December, 2005.

1.2.5 Well Construction Regulations

The NSEL Well Construction Regulations, attached as Appendix A, provide guidelines for the proper construction of water supply (domestic groundwater) wells. Improperly constructed wells can result in surface and/or contaminated shallow groundwater entering the well and impacting well water quality.

Requirements for new drilled wells include:

- A minimum inside well casing diameter of 152 mm;
- A minimum of 6.1 m of casing (which in many cases should be more);
- A minimum of 152 mm of casing extending above the ground surface;
- A drive shoe attached to the bottom of the well casing; and
- A vented, pitless, vermin proof well cap.

Requirements for new dug wells include:

- A minimum of 152 mm of casing extending above the ground surface;
- A concrete apron at least 152 mm thick (constructed below the frost line) extending a minimum distance of 914 mm from the perimeter of the well;
- Watertight joints above the concrete apron; and
- An annular seal above the apron completed to ground surface.

The proper construction of groundwater wells is part of a multi-barrier strategy for protecting public health from waterborne disease. In some hydrogeological conditions, drilled wells should also be grouted (annular seal) to provide additional protection from contaminated surface and shallow groundwaters in the area. At the present time, the NSEL Well Construction Regulations do not require more than 6.1 m of casing or the use of annular grout for drilled wells. Most hydrogeologists, however, do specify a minimum of 12.2 m of casing and the use of grout as a precautionary measure and added assurance to prevent groundwater contamination.

Chapter 2 Methodology

2.1 Research and Review of Existing Data Sources

CBCL Limited collected and reviewed available information including watershed mapping, land ownership, geological mapping, available groundwater quality and groundwater level monitoring data, NSEL pumping test and well record databases, applicable legislation and regulations, and relevant reports, such as 'Groundwater Resources and Hydrogeology of the Western Annapolis Valley, Nova Scotia' (Trescott, 1969). Knowledge gaps with respect to available water resource information were identified during this task.

Local well drillers, such as DJ's Well Drilling Ltd and W.R. Robar and Sons Well Drilling were interviewed to obtain information on groundwater resources. Records submitted to the NSEL by well construction contractors for wells installed in the Bear River area were reviewed and summarized.

Available water quality results and estimated production rates from wells servicing registered water supplies (e.g. Hillsborough Water Society) were also compiled and reviewed.

2.2 Community Water Supply Survey

A questionnaire was developed by CBCL Limited, with assistance from the Steering Committee, to collect pertinent information regarding individual water supplies and local concerns. A copy of the questionnaire is attached in Appendix A. The questionnaires were delivered to the residents and businesses of Bear River by County of Annapolis staff.

CBCL conducted a site visit from March 12-13, 2007 to obtain additional information from community groups and interested stakeholders. Raw water quality samples were collected at strategic locations within the Community, including the Oakdene Centre, the Bear River Fire Department, and the Hillsborough Water Society system to characterize bedrock water quality.

2.3 Identification of Priority Areas for Water Servicing

Initial input on priority servicing areas was obtained from the Steering Committee. The input was supported by field visits conducted to determine the locations of non-residential water users, and to consult with interested stakeholders, such as the Bear River Economic Development Society (BREDS), the Bear River Innovation, Development and Growth

Society (BRIDGS), the Bear River Board of Trade, the Hillsborough Water Society, and other local groups. Mapping was prepared showing the location of development in the Bear River area.

Wastewater collection system mapping provided by the Steering Committee was also reviewed in consideration of priority areas for water servicing.

2.4 Determination of Water Use Requirements

Water use requirements, and therefore the sizing of transmission mains, distribution mains, and water storage reservoirs required for a municipal water supply system are generally determined by the flow requirements for fire flow water. Where fire flow water is not required, an assessment of water use is needed to determine pipe sizes and storage requirements.

Water use requirements for residential units were determined as per the *Atlantic Canada Guidelines for the Supply, Treatment, Storage, Distribution, and Operation of Drinking Water Supply Systems.*

The *Water Supply Manual* indicates that the projected water demand, if not known, should be estimated from reliable records of present consumption in similar facilities serviced by water meters. Where data is not available, the *Water Supply Manual* recommends that provincial “water use” tables be consulted. The flow requirements for residential units in the community were determined by using the water use figures provided in the *Water Supply Manual*, whereas, the flow requirements for commercial units were determined by considering the use of the building and the building occupancy.

Maximum day and peak hour demands were determined as per the *Atlantic Canada Guidelines for the Supply, Treatment, Storage, Distribution, and Operation of Drinking Water Supply Systems.*

Estimated water use figures were compared to measured wastewater flows and observed population densities, and the applicability of the recommended *Water Supply Manual* figures for the community of Bear River was discussed.

2.5 Identification of Potential Water Resources

Potential water resource options were initially identified by discussing local water resources with the Steering Committee. Input received from the Steering Committee on issues such as past and current use of the watershed/ aquifers was used to determine which options would be investigated further.

Groundwater supply potential was assessed based on geological mapping, existing hydrogeological reports, a review of the ‘2005 NSEL Well Logs’ and Pumping Test databases, available water quality information, land use and source water protection considerations, and discussions with local well drillers and stakeholders.

2.6 Evaluation of Water System Feasibility

To comparatively evaluate each potential water supply source for their relative advantages and constraints, the following criteria were considered:

1. The ultimate water volume potential of the resource;
2. Raw water quality;
3. The capital costs associated with developing any proposed supplies including treatment, transmission and storage infrastructure;
4. 25-year operational costs;
5. Security and reliability of the water supply;
6. Total development time;
7. Regulatory requirements and realities;
8. Residential and commercial development benefits of strategically located water supply development and water main placement; and
9. Feasibility of source water protection measures.

Based on the evaluation of the potential resource options, a preferred water supply option was recommended to meet the water supply demands of all users within the proposed serviceable boundary over the next 25 years.

A conceptual plan was prepared showing the approximate extent of the serviceable boundaries for the highest potential water supply option. A discussion on the feasibility of the preferred water supply option based on costs and probable subscription to service in the context of other NS Utilities was also provided.

3.1 Results of Community Water Supply Survey

Community water supply concerns were investigated through a questionnaire distributed to the residents of Bear River and a site visit to interview interested stakeholders. A total of 30 responses to the questionnaire were received, of which it was estimated that 5 respondents are presently supplied by the Hillsborough Water Society system. The majority of the survey respondents supplied by the Hillsborough Water Society system reported that they were satisfied with their water supply.

Based on 25 responses, the average household density is approximately 2.6 persons per household. Typical water supply problems reported on the questionnaire included insufficient yield during extended dry periods in the summer (54%), unavailability of a domestic water supply source in the downtown area (10%), and bacterial/ chemical quality concerns (14%).

A summary of questionnaire responses is provided below:

Table 3-1: Summary of Water Supply Questionnaire Responses

Criteria	Number of Responses	Results	Percentage
1. Respondents that do not use water for drinking	28	5	18%
2. Respondents that reported water quality concerns as the reason for non-potable use	28	3	11%
3. Respondents that have a shared water supply	25	4	16%
4. Respondents that are supplied by Hillsborough Water Society system	25	5	20%
5. Respondents that reported insufficient yield	24	13	54%
6. Respondents that are concerned about the unavailability of domestic water in the downtown area	30	3	10%
7. Respondents that disinfect their water supply (includes Hillsborough customers)	29	7	24%
8. Respondents that consider water quality to be poor	28	5	18%
9. Respondents that cited bacterial/ chemical concerns	28	4	14%
10. Respondents supplied by a dug well/reservoir	28	11	39%
11. Respondents supplied by a drilled well	28	17	61%

During the March site visit, representatives from the following groups were consulted:

- Bear River Board of Trade;
- Bear River Economic Development Society (BREDS);
- Bear River Innovation, Development, and Growth Society (BRIDGS);

- Bear River Legion;
- Hillsborough Water Society;
- County of Annapolis Public Works;
- Bear River Fire Department;
- Bear River Trading Centre (Restaurant);
- Bear River Health Centre; and
- Exhibition Fairgrounds.

3.2 Non-Residential Water Users and Priority Service Areas

The results of the water supply questionnaire, site visits to observe building densities and commercial centres, discussions with interested stakeholders, and a review of population distribution mapping found that the majority of water users and water shortages/ problems are located in the community downtown area, which corresponds approximately to the area serviced by the wastewater collection system. Flow requirements were therefore determined for this priority area.

The following non-residential water users within the community were identified during the site visit:

- Cherry Brook Grocery Store;
- Bear River Trading Centre (includes farmers market, financial centre and Restaurant with 20 seats);
- Bear River Seniors Complex;
- Bear River Legion and associated buildings (~1 event per week up to 100 persons);
- Flight of Fancy Gallery (up to 200 persons in the summer);
- Oakdene Centre (includes hairdresser);
- Service Station;
- Tourist Centre (7,000 visitors per season);
- Fire Department (~2 meetings per month, and 1 large event per month in the summer consisting of 100-150 person, system is registered with the Nova Scotia Department of Fisheries and Agriculture);
- Post Office;
- Churches (Baptist, United, and Anglican);
- By the Brook Bed and Breakfast; and
- Medical Centre.

As discussed previously, due to typically smaller lot sizes in wastewater serviced areas compared to unserviced areas, groundwater withdrawals are more concentrated in these areas, and therefore there is greater pressure on the groundwater resource. The provision of central water would mitigate the potential for insufficient water yield in dug wells, which provides further validation for the consideration of the existing wastewater serviced area as a priority area for servicing with central water.

In terms of municipal planning, the provision of both central water distribution and wastewater collection systems could promote development, resulting in higher household densities within the serviceable boundaries, and in greater cost efficiency for central systems.

3.3 Flow Requirements

As indicated in Chapter 2, water use requirements of 1000 Lpd per residential unit were used, and maximum day and peak hour demand were determined as per the *Water Supply Manual*.

A total of approximately 25 commercial units were identified (a partial list is provided in Section 3.2). The commercial units were not surveyed to determine the occupancy, but a review of the list indicates that water use will vary per unit, with some units using less than 1000 Lpd, and some units using more than 1000 Lpd. For purposes of this report, it is assumed that the commercial units will use an average of 1000 Lpd each, for a total of 25,000 Lpd. A more detailed investigation of uses within commercial units would be required prior to the design of a central water system.

It is our understanding that the Bear River wastewater collection system currently has a total of 140 service connections. There is, however, a proposal to extend servicing by an additional 60 service connections, for a future total of 200 service connections. Assuming water use figures of 1000 Lpd for the residential and commercial units, a future water use requirement of 200,000 Lpd is estimated.

The design figure of 1000 Lpd for residential units, as outlined in the *Water Supply Manual*, however, is based on occupancy of 6 persons per home, or 167 Lpd per person. Population figures reported in the community survey, and in similar rural communities, however, indicate that the population density may be closer to 2.2 persons per home. Using the population data and the pro-rated water use data, the water use is estimated to be 370 Lpd per residential unit. Therefore, assuming 175 residential water units at 370 Lpd per unit, and 25 commercial units at 1000 Lpd per unit, the total water use is estimated at 90,000 Lpd (450 Lpd per unit).

The estimated water use was compared to the measured wastewater flows at the Bear River Wastewater treatment facility. The design capacity of the Bear River wastewater treatment facility is reported to be 70,000 Lpd. The average wastewater flow in 2006 was reported to be approximately 36,000 Lpd, and dry weather (June to September) wastewater flow averaged approximately 27,000 Lpd from 2001 to 2006. Using the average 2006 wastewater flow of 36,000 Lpd, and 140 existing service connections, current wastewater generation is calculated to be 257 Lpd per unit. This figure is considerably less than the 1000 Lpd design figure recommended in the *Water Supply Manual*, and approximately 60 percent of the 450 Lpd per unit figure, as adjusted for the assumed population density.

Comparison of the water use figures required by NSEL, and the measured wastewater flow data, indicates a significant difference in water use and wastewater generation. This finding is supported by data obtained by CBCL from other similar rural community projects, which show that water use and wastewater flows are less than 1000 Lpd per unit when homes are serviced by on-site wells with a limited water supply. The water use, and therefore wastewater generation, may increase when a central water supply is provided.

The water use figure of 1000 Lpd per residential unit, as required by the *Water Supply Manual*, appears to be very conservative in view of the wastewater use data, and would allow for significant community growth over the next 25 years. Historical population figures, however, show that the population of Bear River is stable or decreasing, and discussions with the Steering Committee have indicated that there is no sign that the trend will reverse.

Based on the above, it is recommended that the flow requirements for both residential and commercial units be established at 100,000 Lpd, or 500 Lpd per unit. This figure reflects a 94% increase over the 2006 calculated average wastewater flow of 257 Lpd per unit.

4.1 Groundwater Sources

4.1.1 Hydrogeological Overview

Existing and readily available information on the major bedrock hydrostratigraphic units, as previously mapped within the study area, was reviewed. Four major bedrock units are mapped in the study area as follows:

- Torbrook Formation rocks of Devonian age, referred to as the Torbrook Hydrostratigraphic Unit (HU),
- White Rock Formation rocks of Upper Silurian age, referred to as the White Rock Hydrostratigraphic Unit (HU),
- Meguma Group (Halifax Formation) rocks of Cambro-Ordovician age, referred to as the Meguma Hydrostratigraphic Unit (HU), and
- Granite rocks of Middle to Late Devonian age, referred to as the Granite HU.

The Granite HU is mapped to the south of the study area and forms part of the South Mountain Batholith. The granite rocks include Scragg Lake Granodiorite and Monzogranite (Ham, 1994). The Torbrook and White Rock HU's underlie the community of Bear River, with southwest-northeast trending geological boundaries. The older metamorphic rocks of the Meguma HU Halifax Formation underlie the northern portion of the study area. The geologic profile based on the work done by Trescott (1969) is shown conceptually in Figure 4-1.

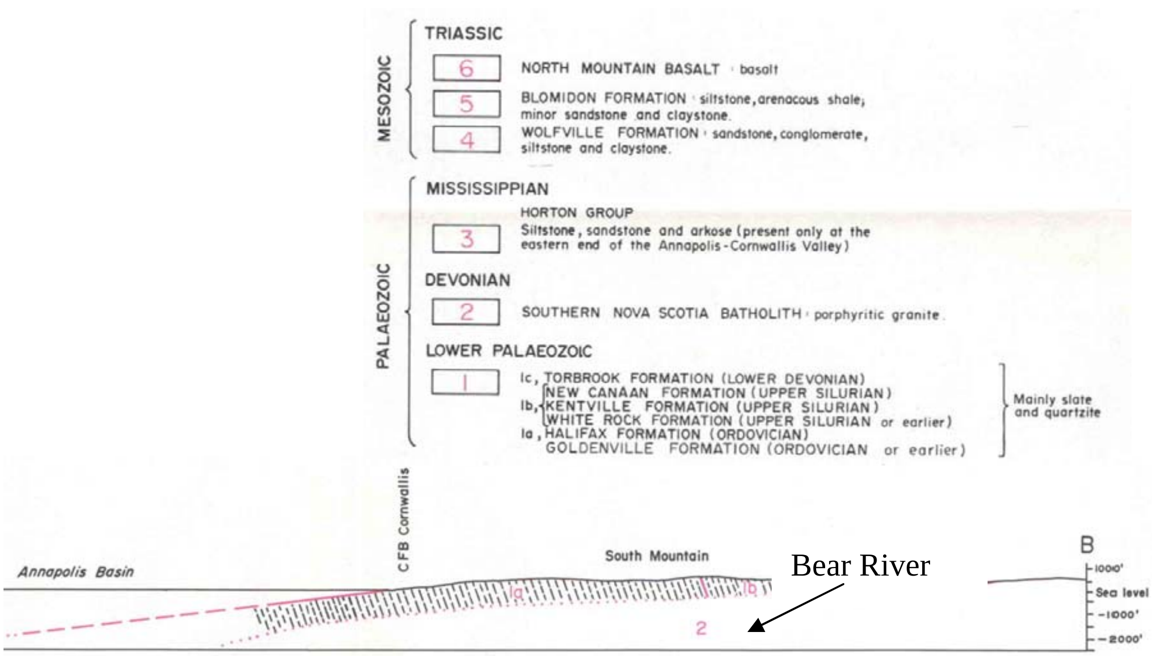

Figure 4-1: Conceptual Geologic Profile in the Bear River Area (from Trescott, 1969)

The most recent bedrock geology map of the area, published by the Nova Scotia Department of Mines & Energy (Ham, 1994), shows the extent of the HU's in the Bear River area at a scale of 1:50,000. The bedrock geology of the area is shown in Figure 4-2.

Existing and readily available information on the Quaternary hydrostratigraphic units, or surficial aquifers, as previously mapped within the study area was also reviewed. Three major surficial units are mapped in the study area, deposited during the Pleistocene Epoch, two of which are classified as till units. Clay till occurs throughout the majority of the Bear River area, and Granite till underlies the southern margin of the study area (Figure 4-2). The Clay and Granite tills are referred to as the Till Hydrostratigraphic Unit (Till HU).

Although the Bear River area is predominantly covered by glacial till material, small scale localized deposits of glaciofluvial materials consisting of ice-contact stratified drift are mapped in the Bear River East and Clementsvale areas. The approximate locations of these deposits are shown in Figure 4-2. The ice-contact stratified drift deposits are referred to as the Quaternary Hydrostratigraphic Unit (Quaternary HU).

4.1.2 Water Well Records

Records submitted to NSEL by well construction contractors were reviewed and summarized. A total of 214 well records were reported in the community of Bear River. Only one dug well record was identified during the well record search. Table 4-1 shows a summary of water well data as recorded in the NSEL database for drilled wells within the study area.

Table 4-1: Summary of NSEL Drilled Water Well Data

	Well Depth (m)	Depth of Casing (m)	Depth to Bedrock (m)	Depth to Static Water Level (m)	Preliminary Well Yield (Lpm)
Minimum	9.1	3.0	0.9	0	0.5
Maximum	131.1	54.9	22.6	32.9	454.0
Average	53.0	10.2	7.5	6.8	20.2
Median	48.8	8.2	6.2	6.1	9.1
N	213	199	50	129	204

The drilled water well records for this area indicate a wide range of well depths, from 9.1 m to 131.1 m. Water yields vary considerably, from 0.5 to 454 Lpm (0.1 to 100 igpm). The water level varies from ground surface, or flowing artesian wells, to water depths of 32.9 m. The average well depth for well records reported in the Bear River area is 53.0 m, and the average preliminary well yield is 20.2 Lpm (4.4 igpm). The mean depth of casing was 10.2 m, compared to a mean depth to bedrock of 7.5 m. The

FIGURE 4-2: Bedrock & Surficial Geology Bear River Area

Data Source: 1: 10000 Digital Data; Service Nova Scotia & Municipal Relations; Projection: UTM NAD 83 Zone 20
Bedrock Geology - 1:50 000 MacDonald & Ham 1994;
Surficial Geology - 1:500 000 Stea et al 1992

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highest preliminary well yield reported in the database is associated with a private well in Bear River, Digby County. The well yield is reported to be 454 Lpm, with the well intercepting shallow bedrock fractures.

It should be noted that the information contained in this database is inherently biased, and requires considerable interpretation. For example over 95% of the drilled wells reported in the database are for domestic water supply purposes where the desired yield is 20 to 50 Lpm (5 to 10 igpm). When this yield is obtained, drilling is suspended at a depth sufficient for pump installation while allowing for drawdown under producing conditions. A groundwater exploration project would target hydrogeologic units that have a potential and capacity to yield high rates of flow on a sustainable basis.

4.1.3 Groundwater Hydrographs

Groundwater level fluctuations throughout Nova Scotia have been monitored on a discontinuous basis since 1964, and a partial record of a time series of groundwater hydrographs from the 1960's to the early 1990's can be found in various databases maintained by NSEL. To date, no groundwater observation wells have been established or operated in the Bear River area. The nearest representative data is located at Sharpe Brook, Kings County, from a monitoring well drilled into the Meguma HU. These data were published in a 1984 NSEL report by McIntosh, titled 'Groundwater Hydrographs in Nova Scotia 1965-81'. A summary of the published hydrograph data from McIntosh (1984) for the observation well located at Sharpe Brook is shown in Table 4-2. It is expected that water level fluctuations in the HU's in the Bear River area will follow the same trend and magnitude of groundwater fluctuations in the Meguma HU in the Sharpe Brook area.

Table 4-2: Summary of Groundwater Level Data in Meguma HU

Well No. & Location	Well Depth (m)	Period of Record	Maximum Water Level (m ASL)	Minimum Water Level (m ASL)	Range of Fluctuation (m)
011 (TH417) Sharpe Brook	30.5	1971-1981	133.7	131.1	2.6

4.1.4 Pumping Test Data

In addition, values of well depths and safe yields have been summarized from the Pumping Test Database provided by NSEL. Twelve (12) data sets for high capacity or public water supply wells located in Annapolis or Digby Counties are available from the database for the Meguma HU (Halifax Formation). The highest safe yield was estimated to be 753 litres per minute (Lpm) from a well drilled in the Meguma HU in Kejimikujuk National Park. A summary of water well data for wells that have been pump tested and are drawing water from the Meguma HU, according to the database, are provided below.

Table 4-3: Summary of Pumping Test Data – Meguma HU

County	HU	Depth Range (m)	Yield Range (Lpm)	SC Range (m^2/d)	Mean Depth (m)	Mean Yield (Lpm)	Mean SC (m^2/d)
Annapolis	Meguma n=8	54.9 to 99.1	15.9 to 753	0.9 to 43.0	75.3	170.70	14.0
Digby	Meguma n=4	29.9 to 121.9	0.5 to 154.4	0.09 to 30.7	60.2	71.28	11.4

There were no pumping test results available for the White Rock HU in Annapolis or Digby Counties. One data set for the Torbrook HU and one data set for the Granite HU in Annapolis County were found in the Pumping Test database, and the results are summarized below.

Table 4-4: Summary of Pumping Test Data – Torbrook and Granite HU

Well Owner	HU	Depth (m)	Q_{20} Yield (Lpm)	Specific Capacity (m^2/d)
NS Housing Commission – Bear River Seniors Complex (Riverside Manor)	Torbrook	120.7	2.3 (0.5 igpm)	0.21
Marshalls Motel	Granite	76.0	4.5 (1.0 igpm)	0.21

4.1.5 Bedrock Aquifers

This area is underlain primarily by various metamorphic bedrock units of the Halifax, White Rock and Torbrook Formations (Figure 4-2). The Torbrook Formation is the youngest, and is composed of sedimentary interbedded shales, siltstones, quartzites, with minor limestones and iron formation. The Torbrook Formation is underlain by the White Rock Formation, which consists mainly of slates, siltstones and quartzite. The Halifax Formation is the oldest of the series of metamorphic rocks, and consists mainly of slate and siltstone (Ham, 1994). The geological contacts between these three rock units are described by Trescott (1969) as east-west trending gradational contacts, located to the north and south of the community of Bear River. To the south, the bedrock type underlying the study area consists of a younger igneous rock of the South Mountain Batholith, which is classified as the Granite HU.

The Meguma Group – Halifax Formation rocks tend to show structural trends with a northeast strike and sub-vertical dip to the southeast. The White Rock and Torbrook Formations are present in a synclinal structure. Large-scale geological features are shown in Figure 4-2 however, local structural patterns and sub-geologic units are not mapped in the study area. Based on available geological mapping, there are no major fault systems identified in the study area.

All of the HU's within the study area are inherently devoid of natural or primary porosity and therefore do not contain groundwater unless it is stored in fractures that occurred in the rocks since they were deformed. The wide range of well yields in the area show that structural patterns and/or fractures do occur.

A groundwater resource evaluation of the Bear River area was conducted by Trescott in 1969. The investigation found that there was limited potential for high capacity groundwater development from bedrock aquifers in the Bear River area.

4.1.6 Quaternary Aquifers

The shallow Quaternary surficial materials deposited during the Pleistocene Epoch by melting glaciers has been mapped in two dimensions at a reconnaissance scale by Stea and Grant (1982) at a scale of 1:100,000, and Finck et al. (1993) have developed preliminary mapping of the glacial and till clast geology at a scale of 1:50,000 of the Bear River area. The depth, stratigraphy, subsurface extension, and distribution of older deposits are not known. Water well records and pumping test data, however, suggest a complex system of interstratified deposits of different ages underlying the Bear River area.

According to the available mapping, three types of surficial materials underlie the Bear River study area, including a Clay till facies, a Granite till facies (both of the Beaver River Till unit), and glacial outwash deposits. The surficial geology of the Bear River area is shown in Figure 4-2 at a scale of 1:500,000, based on mapping by Stea et al. (1992).

The Clay till materials are described as olive grey, compact, fissile clasts, and the Granite till materials are described as grayish orange to yellowish brown, loose, sandy, angular, cobble-sized clasts (Stea and Grant, 1982). The till units are generally thin and mantled over bedrock topography. Clast lithology contains up to 95% of the local bedrock types. Thicknesses of the Granite till facies is reported to vary from 1 to 10 m with an average of 3 m, and the thickness of the Clay till facies are reported to vary from 1 to 5 m. Comparatively, the depth to bedrock in the Bear River area, as interpreted from available NSEL well records, ranges from 0.9 m to 22.6 m below grade level, with an average thickness of 8.5 m (Table 4-1).

Several meltwater channels and ice contact deposits are shown on the mapping produced by Finck et al. (1993) in the Bear River East and Clementsvale areas, indicating glacial outwash activity and the potential occurrence of sand and gravel deposits at depth. The ice contact deposits mapped by Finck et al. (1993) are described as silty sand, gravel and boulders with a thickness of 1 – 15 m. Similarly, Trescott (1969) identified Pleistocene glacial drift deposits in the Bear River East and Clementsvale areas, including kame and kame complexes consisting of stratified sand with interbedded silt, gravel and boulders in varying amounts depending on the nature of the source material.

Water wells constructed in Till deposits (Till HU) can yield sufficient quantities of water for domestic purposes, small farm supplies, and small commercial operations. However, Quaternary deposits of sand and gravel that are buried, saturated, and with significant saturated thickness, typically constitute excellent sources of water for municipal and industrial uses (Quaternary HU). The glacial outwash deposits shown in the Bear River East and Clementsvale areas offer some potential for a source of public water supply development.

4.1.7 Water Quality

Water quality is affected by both natural and anthropogenic factors. In bedrock units of the Granite, Meguma, Torbrook and White Rock HU's, minerals of concern are present that constrain domestic, and public drinking water supplies.

The sulphide mineral components of the associated mineral deposits may be a source of other chemicals such as iron, manganese, and arsenic, due to the potential of the sulphides to generate acid rock drainage when exposed to oxygenated groundwater. These components are very mobile in an acidified groundwater flow system, and can move downgradient in the flow system. Groundwater quality can change significantly over a very short horizontal and or vertical distance because of the influence of minerals in the host bedrock or overburden materials serving as the water supply aquifer. A distinctive difference between water from the Granite and Meguma HU's is often the presence of high iron and manganese in the latter HU. Under acidic conditions, other mineral constituents, such as aluminum, copper, lead, zinc, cadmium, and uranium, can also be introduced into the groundwater supply from wells penetrating mineralized zones in the bedrock.

These mineral constituents are present in many parts of Nova Scotia, although, the highest sulphide concentrations are generally found near the base of slate bedrock units of the Halifax Formation, and consist mainly of pyrite, pyrrhotite, and minor arsenopyrite. Arsenopyrite mineralization is a natural source of arsenic in groundwater and can result in groundwater concentrations exceeding the Guidelines for Canadian Drinking Water Quality (GCDWQ). Arsenic is classified as being carcinogenic to humans, and on the basis of a carcinogenic risk of arsenic compounds to humans, Health Canada has recently approved a Maximum Acceptable Concentration (MAC) for arsenic of 0.010 mg/L.

Uranium is a naturally occurring element associated with mineralization in various rock types found in Nova Scotia, such as granites. The MAC for uranium in drinking water, as derived from the acceptable daily intake of the compound, is 0.020 mg/L. The Canadian Drinking Water Quality interim guideline for uranium was approved in 2001.

Appendix B shows the areas of naturally occurring arsenic and uranium in ground waters in Nova Scotia, which includes the Bear River area.

Bear River is a tidal river, and therefore wells drilled in the downtown area are vulnerable to saltwater influence. It was reported during the site visit that a drilled well north of the Legion building encountered brackish groundwater. It was similarly reported that brackish groundwater was encountered on the Digby side of the Bear River.

Background groundwater quality data in the Bear River area was collected and reported by Trescott (1969), as part of the report on 'Groundwater Resources and Hydrogeology of the Western Annapolis Valley, Nova Scotia'. Other sources of groundwater quality information are available from Registered Public Water Supplies located within the community. A summary of available groundwater quality results is presented in Table 4-5 for the hydrostratigraphic units occurring under the areas of interest to this study. The parameters selected for comparison as shown in Table 4-5 are pH, total hardness (T.H.), iron (Fe), manganese (Mn), arsenic (As), uranium (U), sulphate (SO_4), chloride (Cl), total dissolved solids (TDS), and nitrate-nitrogen (NO_3-N).

There were no groundwater quality results available for review from the Quaternary HU. Groundwater quality from the Quaternary HU in other areas of the province is typically of good quality and meets all of the drinking water guidelines for public drinking water supplies.

Available water quality data for selected parameters, including the water quality results for samples collected by CBCL in March 2007, are provided in Table 4-5. More detailed water quality results and laboratory reports for the March 2007 water quality sampling are provided in Appendix C.

Table 4-5: Summary of Raw Water Quality from Local Water Supplies

Source (Sampling Date, HU)	**pH**	**T.H. mg/L**	**Fe µg/L**	**Mn µg/L**	**As µg/L**	**U µg/L**	**SO_4 mg/L**	**Cl mg/L**	**TDS mg/L**	**NO_3-N mg/L**
GCDWQ	***6.5 to 8.5***	-	***< 300***	***< 50***	***< 10***	***< 20***	***< 500***	***< 250***	***< 500***	***< 10***
Oakdene Centre (April 2006, Torbrook)	6.76	140	**660**	30	-	-	11	200	443	0.71
Oakdene Centre (March 2007, Torbrook)	7.3	110	<50	5	<2	12	11	97	265	0.52
TH37 Clementsvale (July 1969, Torbrook)	7.7	32.4	ND	ND	-	-	8	3.5	-	-
Hillsborough Water Society (March 2005, White Rock)	8.0	77.5	<20	<2	<2	<2	-	-	-	-
Hillsborough Water Society (March 2007, White Rock)	7.56	130	<50	<2	<2	0.2	10	52	182	0.45
Seniors Complex (July 2003, Torbrook)	7.8	59.4	<20	<2	<2	-	11.0	24.0	-	0.13
Seniors Complex (July 2005, Torbrook)	7.8	46.4	<20	2	-	-	7.2	26.0	-	0.11
Bear River FD (March, 2007, Torbrook)	7.87	130	60	10	4	1.6	21	53	199	0.38

GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2007)
T.H. = Total Hardness
Bold indicates an exceedance of the Guidelines for Canadian Drinking Water Quality (Health Canada, 2007)

Table 4-5 indicates that the water quality for all selected parameters is below the GCDWQ limits, with the exception of iron, which exceeded the GCDWQ aesthetic objective in the water sample collected during the installation of the well at the Oakdene Centre. The elevated iron concentration may be attributed to insufficient well development, as the sample was collected during air lift testing.

Examples of anthropogenic factors which can influence groundwater quality include road salt, domestic fuel oil spills/ leaks and sewage disposal system. Based on the findings of the water supply survey and interviews during the site visit, there are no known significant sources of groundwater contamination from anthropogenic sources in the Bear River area.

4.1.8 Hillsborough Water Society Water System

According to discussions with the system administrator, the Hillsborough Water Society was incorporated in 1905, and originally consisted of a reservoir which supplied local residents with domestic water by gravity. A well was drilled in 1990 (Well Log #901421) by W & R Robar Drilling Co. Ltd., and the system presently consists of a 155 mm diameter, 33.5 m deep drilled well, a 27,500 L (6,000 ig) open bottom rock/ concrete reservoir, and a distribution system with approximately 24 service connections. It was noted, however, that a number of the buildings serviced by the water supply are presently vacant.

The well was completed with 7.3 m of casing and an open borehole intake configuration, intercepting the underlying slate bedrock aquifer. The preliminary well yield reported by the driller was 36.3 Lpm (8 igpm), although anecdotal information from the system operator indicates that the pump ran continuously for 18 months producing approximately 50 Lpm (11 igpm) at a constant rate (excess water flowed to waste). The approximate location of the well and reservoir is indicated in Figure 4-2.

Water treatment consists of the periodic manual addition of Javex to the reservoir to maintain an adequate chlorine residual in the system. Over the past year the system operator has implemented a number of improvements to the reservoir to reduce the potential for surface water entry. The system, however, has been under a boil advisory order since it was registered with NSEL in 2000.

4.1.9 Summary of Potential Groundwater Sources

- Sustainable yields of approximately 20 – 60 Lpm can be obtained from wells installed in bedrock aquifers.
- Successful high capacity wells are most likely to be found in fracture zones associated with structures along geological contacts in the area, or in groundwater discharge zones (e.g. hillside areas).
- Based on geological mapping, geologic contacts are interpreted between the Granite, Meguma, White Rock, and Torbrook Formations in the Bear River area.
- The review did not identify any high potential bedrock groundwater sources for large capacity groundwater development in the Bear River area, although given the community’s limited water demands, the Riverview – Lansdowne Road area may present a strategic location for test drilling.
- Quaternary sand and gravel deposits in the Bear River East and Clementsvale areas may offer high potential for large capacity groundwater development.
- Yields in excess of 500 Lpm can be obtained from sand and gravel deposits, depending on the extent and saturated thickness of the deposits.

- Wells drilled immediately adjacent to Bear River are vulnerable to saltwater influence.
- Water quality data from wells in the study area indicates relatively good quality water, with average chemical concentrations below the GCDWQ limits.

4.2 Surface Water

Based on available mapping and a site visit, the following major surface water sources were identified in the Bear River area:

- Lake Mulgrave system;
- Barnes Lake; and
- Lake LeMarchant.

The location of First Pond (Lake Mulgrave system), Barnes Lake, and Lake LeMarchant are approximately 3.6 km, 5 km, and 10.5 km, respectively, from the Bear River downtown area.

As indicated in Chapter 1, all municipal water supplies using surface water are required to comply with the “Surface Water Treatment Standard”. The general requirements of the Standard establish the “theme” as follows:

- Filtration is required for all surface water treatment facilities;
- Treatment facilities are required to have a minimum of two filters to ensure that unfiltered water does not enter the water distribution system;
- Treatment facilities are required to have a minimum of two disinfection units to ensure that non-disinfected water does not enter the water distribution system; and
- A combination of filtration and disinfection has to provide specified treatment efficiencies.

Compliance with these NSEL requirements for municipal surface water development can result in significant capital and operating costs for the delivery of central water in low density rural communities relative to groundwater source development, where filtration or chemical treatment may not be required.

Due to the considerable distance to surface water sources, the relatively good quality of groundwater interpreted in the study area, and the greater economic feasibility of developing municipal groundwater systems in low density rural communities, it was determined, in consultation with the County of Annapolis, that a detailed evaluation of these potential surface water supply sources would not be required.

Chapter 5 Water Supply Options

5.1 Central Water Supply

A groundwater source from the bedrock aquifer underlying the area between Riverview and Lansdowne Road was determined to have the highest potential to supply the community of Bear River based on the following key criteria:

- Available water quality data indicates that the groundwater quality meets the requirements of the Guidelines for Canadian Drinking Water Quality for all parameters analyzed;
- The yield appears adequate given the community's low water demands;
- The source is located in close proximity to the identified priority servicing area; and
- No significant source water protection concerns were identified.

Bedrock Aquifer Source (White Rock HU) West of Riverview Road

The following assumptions were made for this system:

1. The wellfield for the Bear River area central water system is located within 100 m from any point in the distribution system.
2. A safe sustainable yield of 45.4 Lpm (10 igpm) can be obtained from a properly sited and constructed drilled well in the White Rock HU.
3. The wellfield will require three 200 mm diameter wells, drilled to a depth of approximately 60 m.
4. Redundant wells and equipment are provided as per NSEL requirements.
5. Each wellhead includes a pitless adapter, fencing and single phase power.
6. The well pumps will pump the groundwater to a storage reservoir located in the vicinity of the wells.
7. The water is disinfected using sodium hypochlorite (Javex) prior to discharge into the storage reservoir.
8. Treatment is not required for chemical or physical parameters.
9. Pumping is required from the reservoir to the distribution system.
10. Transmission/distribution length is based on existing development and proposed (2007) sewer serviced area.
11. Total transmission/distribution main length is 5500 m (4100 m in Digby County and 1400 m in Annapolis County).
12. The distribution system is sized for the supply of domestic water only.
13. Distribution system water pressure is maintained between 275 and 550 kilopascals (40 to 80 psi).
14. A 100,000 L storage volume is provided.

15. The storage tank consists of an underground concrete structure.
16. Pumping equipment and controls for the distribution system is located in a building located above the storage tank.

The average and peak hour flows for the Bear River system were determined to be 100,000 Lpd and 400,000 Lpd, respectively, based on the following;

- Average flow requirements of 500 Lpd per service connection;
- 200 service connections in total;
- 25 non-residential users with an estimated water use of 12,500 Lpd;
- Remaining users having an estimated water use of 87,500 Lpd;
- Total estimated average water use of 100,000 Lpd; and
- A factor of 4 was used to determine peak hour demands.

The proposed water servicing concept is shown in Figure 5-1. This option assumes that the water distribution system services the same area as the existing and proposed wastewater service area. The entire area is serviced by 100 mm diameter watermain. A Pressure Reducing Valve (PRV) is required to maintain the pressure within 275 and 550 kilopascals. The distribution system watermain crosses the Bear River at the Clementsvale Road bridge. Pressure boosting is not required within the water distribution system. This option allows for phasing, if required.

5.2 Individual Well/ Water Treatment Improvements

In this option, water users are individually responsible for necessary well upgrades and for installing and maintaining on-site water treatment systems to improve water quality. This option may also be considered as an interim water strategy for Bear River, until such time that financing is available for the provision of central water.

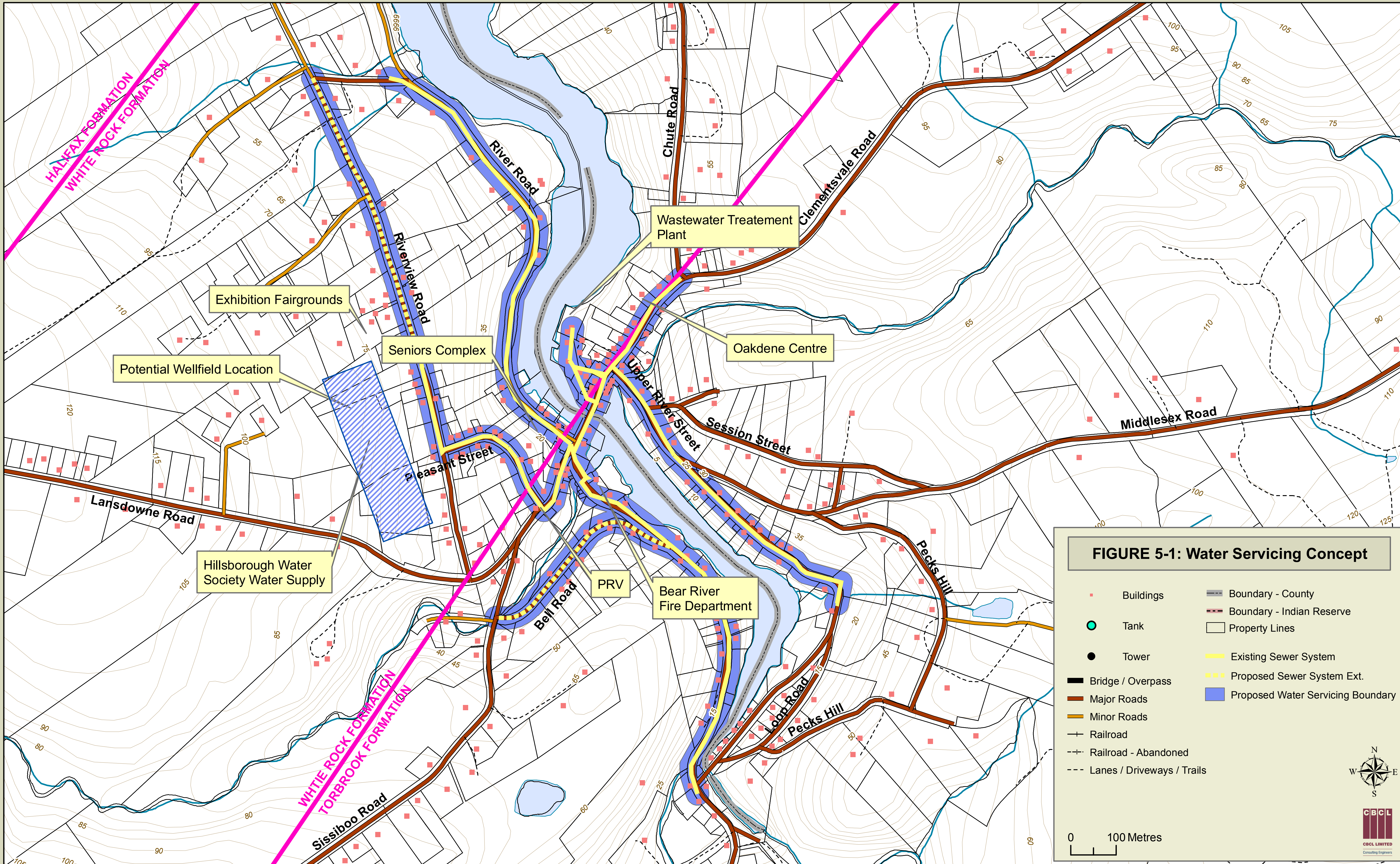
The recommended process to improve domestic water supplies includes a public education initiative, and a water supply assessment/ improvement program.

Public Education and Preliminary Water Supply Assessment

NSEL initiated an Environmental Home Assessment Program in the Fall of 2006. The program offers assessments of individual homes served by water wells and on-site septic systems. The home assessment will provide educational information about the importance of regular well water quality testing, pumping of the septic system and maintenance of the oil tank.

Homeowners who participate in the program will receive:

- A water and wastewater assessment for their property;
- A $50 rebate on septic tank pumping;
- A water quality sampling kit;



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- Water saving devices;
- Samples of environmentally friendly cleaners; and
- A home oil tank system checklist.

Although central sewer servicing is available throughout much of the community, the County of Annapolis and District of Digby should encourage residents to participate in this initiative to make residents and commercial users aware of the health risks and aesthetic issues associated with their well water supplies.

Where adequate water quality information is not available, well owners should be encouraged to collect a raw water sample from the water supply system for physical, chemical and microbiological analyses to characterize well water quality.

In the Bear River area, the NSEL Environmental Home Assessment program is being administered by the Clean Annapolis River Project. The contact number for the environmental organization is (902) 532-7533.

Well Inspection

The well inspection program would involve the following:

- Visual assessment of dug wells; and
- Visual and video inspection of drilled wells.

Both dug and drilled wells would be assessed by persons qualified under NSEL requirements to carry out such work.

Participants would be advised to search for a well record for the construction of their well by contacting their well contractor. Recommendations for well upgrades and/or water treatment would be site-specific, and therefore information would be collected for each individual well water supply system to determine appropriate improvements. The construction of wells greater than 15 years old, and any well with identified water quality concerns (e.g. suspected surface water influence), would be inspected.

A well inspection of a drilled well would involve a down-hole video inspection by a licensed pump installer, to assess and document the condition and depth of well casing, and the condition of the pitless adaptor (if applicable), driveshoe, and pump discharge line. A recommendation to continue the use of the well, to rehabilitate the existing well, or to install a new well would be made based on the results of the well inspection, appropriate cost considerations, the local hydrogeology, and the available water quality results.

A well inspection of a dug well would involve a visual inspection by a licensed pump installer, to assess and document the condition and depth of well liner and the apron, and to inspect the topography around the well. A recommendation to continue with the use of the well, improve the surface water drainage features around the well, or to install a new well would be made based on the results of the well inspection, appropriate cost considerations, the local hydrogeology, and the available water quality results.

A decision by water users to proceed with the recommended well improvements will be influenced by the scope of the improvements required, the cost of the proposed work, and by the ability of participants to fund the improvements.

Well Improvement –Drilled Wells

Drilled well rehabilitation may include one or more of the following:

- Improvement of seal between driveshoe and formation;
- Conversion to pitless adaptor system;
- Removal of well crock and the installation of annular seal around wellhead from bottom of crock (original) to grade surface and backfilling of well crock;
- Extension of well casing above grade;
- Re-grading around wellhead;
- New well cap; and
- Repairs to well casing and/or discharge line.

Well Improvement – Dug Wells

Discussions with well contractors have indicated that the rehabilitation of a dug well to comply with current NSEL requirements typically requires the removal of the well and the full construction of a new well. The rehabilitation of a dug well is therefore not generally a viable option. Improvements with respect to surface water drainage around the well crock and the grouting of upper joints, however, can be readily made.

Well improvement options for dug wells therefore include re-grading around the well crock, grouting of the upper joints, replacing the well cap, a new dug well, or a new drilled well.

New Well Installation

If rehabilitation of an existing dug or drilled well is not an option, the option of installing a new well may be considered. A new well should meet the requirements of the NSEL Well Construction Regulations. It is recommended that new drilled wells should be constructed with 12.2 m of casing and an annular grout to adequately protect the well from shallow groundwater and surface water contamination.

Following the installation of a new well, the existing well would have to be abandoned in accordance with NSEL regulations. If sufficient yield cannot be obtained from a new well, a water storage tank system may be considered.

Water Treatment

Water quality is influenced by well construction, and therefore the well water quality and required treatment (if applicable) would be evaluated following the installation of a new well or rehabilitation of the existing well. Qualified treatment equipment suppliers/installers should make recommendations for appropriate treatment based on the water quality results.

5.3 On-Site vs. Central Water

In general, a higher level of service and reliability is associated with a central system with water treatment, compared to an on-site system. Large-scale water treatment equipment with adequate controls is provided and a certified operator is responsible for the system. The operation of an individual treatment system, if not serviced by the equipment supplier, requires due diligence on the part of the well owner.

From a public health perspective, a central water system would allow the Municipalities to better manage public health risks attributed to improper construction and siting of private wells, and poor groundwater quality. Groundwater supply is heterogeneous, and there exists the potential that at some locations within the community, it will not be possible to obtain adequate yields of potable quality water without significant on-site treatment/ storage.

If water servicing is not considered a viable and attractive option, a program to improve on-site well water supplies could be implemented.

Chapter 6 Opinions of Probable Costs

One of the key elements of the feasibility assessment is the opinion of the probable construction and operational costs. Opinions of the probable costs have been generated based on the conceptual development of the water supply option presented in Chapter 5. The reader is cautioned that these costs have been developed for the purpose of determining the overall feasibility of water system servicing and should not be used for municipal budgeting purposes. In order to establish more detailed cost estimates for the development of a municipal groundwater supply system, a groundwater exploration program would be required to identify well locations, the number of supply wells, and water treatment requirements, if any.

6.1 Central Water Supply Option

At this phase of the investigation, cost components considered in the magnitude of cost assessment include the following:

- Groundwater Exploration and Aquifer Characterization Studies;
- Establishment of a Water Utility;
- Pre-Design Studies, Approvals, Plans and Permits;
- Wellfield Construction;
- Transmission Mains and Laterals;
- Water Treatment Plant;
- Storage Reservoir;
- Operating and Maintenance Costs.

We have provided a general description of each of these components for information purposes.

Groundwater Exploration and Aquifer Characterization Studies

Groundwater exploration and aquifer characterization would include a desktop hydrogeological evaluation, test well construction, and aquifer testing and interpretation, including pump tests.

The desktop hydrogeological evaluation would determine the optimum location and number of test wells to construct. Test wells would then be constructed and 72-hour pumping tests (or longer-term as required) would be performed. The number of test wells required depends on the program's success at locating groundwater resources with sufficient capacity to meet the requirements of the proposed water supply system. Groundwater exploration programs are therefore typically conducted as multi-phased work. The construction of test wells may involve road construction to provide access to sites for well drilling. If a suitable groundwater supply is located during the test drilling program, the test wells may be developed into production wells. The primary objective of the exploration program would be to characterize the aquifer, including the safe yield and water quality characteristics, and to determine the suitability of the aquifer for municipal groundwater supply development.

Establishment of a Water Utility

The creation of a Water Utility would require the creation of an administration section that would be responsible to operate and maintain the water system.

Pre-Design Studies, Approvals, Plans and Permits

The development of a groundwater supply would require a GUDI assessment, application to the NSEL for a groundwater withdrawal permit, and the development and implementation of a source water protection plan, including groundwater modelling. To facilitate the implementation of the source protection plan, new wells should be sited in relatively undeveloped areas, where possible.

A detailed engineering pre-design study would be required to evaluate the preferred option at a greater level of detail, and would establish more detailed cost estimates for budgeting purposes. A pre-design study would establish available yields, provide recommendations on the most cost-effective alternative, establish the water quality and water treatment process requirements, and evaluate potential facility sites.

Wellfield Construction

The development of the wellfield would involve the construction of an access road to the site, wellfield site development (land clearing, installation of fencing, 3 phase power, etc.), the construction of high capacity groundwater wells to municipal standards, including a minimum of 12.2 m of casing with an annular seal, and the installation of wellfield yard piping to connect the wells to the treatment plant. The wells should be spaced at appropriate intervals, and 100 m intervals was assumed.

Mains and Laterals

Cost estimates for mains include wellfield piping, transmission/ distribution mains, services, and appurtenances.

Water Treatment Plant

This component includes the costs for a water treatment plant complete with site works, controls, building superstructure, process equipment, electrical provisions and waste treatment. Water treatment would depend on the water quality characteristics of the source aquifer. Based on the recorded water quality characteristics of the White Rock HU, water treatment would likely involve disinfection only.

Storage Reservoir

Balancing requirements have been calculated based on maximum day demands. For the purposes of this report, it has been assumed that an in-ground concrete storage reservoir is best suited for this application. The optimum location for a storage reservoir is in the vicinity of the wellfield, but the actual location of the storage reservoir would be confirmed as part of a pre-design study.

Operating and Maintenance

Operating and maintenance (O&M) cost components considered include the following:

- power;
- chemicals;
- heat;
- maintenance & miscellaneous; and
- labour.

A lifecycle analysis was also performed using the net present value (NPV) approach assuming an interest rate of 7% and duration of 25 years. All capital, O&M and lifecycle costs were also expressed in terms of the cost per connection.

A qualified operator will be required to maintain both the treatment and distribution components of the system. Staffing requirements would have to be determined in consultation with County of Annapolis and District of Digby personnel, and would have to consider the certification and availability of existing personnel. In addition, issues such as back-up personnel would have to be considered.

6.1.1 Opinions on Probable Costs for the Development of a Central Water Supply

The opinion of construction and operational costs are provided in Table 6-1. Note that these figures include 25% engineering and contingency on construction, but do not include costs for HST or land acquisition.

The opinion of probable construction and operational costs have been divided into Supply, Treatment, Storage and Distribution components, with the following subdivisions:

- Structures;
- Mechanical; and
- Electrical/Instrumentation/Controls.

Based on the opinions of probable costs shown in Table 6-1, the estimated cost per service connection (assuming a total of 200 connections) for the development of a central groundwater supply would amount to

Table 6-1: Opinions of Probable Costs - Central Water Supply - Study Area

Component	Costs
SUPPLY	
Structures/ Site Development	$ 192,835
Mechanical	$ 8,625
Electrical/ Instrumentation/ Controls	$ 26,250
SUBTOTAL	$ 227,710
TREATMENT	
Structures/ Site Development	$ 53,750
Mechanical	$ 25,000
Electrical/ Instrumentation/ Controls	$ 27,500
SUBTOTAL	$ 106,250
STORAGE	
Structures/ Site Development	$ 110,000
Mechanical	$ 23,750
Electrical/ Instrumentation/ Controls	$ 12,500
SUBTOTAL	$ 146,250
DISTRIBUTION	
	$ 1,666,875
SUBTOTAL	$ 1,666,875
Present Worth on Capital	$ 2,147,085
OPERATING & MAINTENANCE	
Chemicals	$ 1,100
Heat & Power	$ 6,400
Maintenance & Miscellaneous	$ 2,500
Operations	$ 15,000
Total O&M	$ 25,000
Annual Interest Rate	7%
Amortization Period	25
O&M Net Present Worth	$ 291,340
Total Net Present Worth	*$ 2,438,425*
Net Present Worth per Connection (200)	*$ 12,192*

***Probable costs shown above are +/- 25%**

***The 'Structures/ Site Development' subdivision of the Supply component includes the cost of required hydrogeological studies, water quality analyses, and Source Water Protection**

***Probable costs shown above include 25% Engineering and Contingency**

approximately $12,200 (expressed as net present worth over 25 year period).

6.2 Individual Well/ Water Treatment Improvement Options

The costs for assessing and implementing the individual well improvements will vary with the number of participants and with the findings of the water supply assessment program. The costs provided herein are for residential wells and would increase for commercial high capacity groundwater supply assessment or development.

Participation in the water supply improvement program would be voluntary. At a minimum the water supply assessment would include a water quality analysis and the identification of a well record. Where a well inspection is warranted, persons qualified under the requirements of NSEL to carry out such work would assess both dug and drilled wells.

If the well assessment indicates that the well construction is acceptable and water treatment is not required, the cost would be limited to the well inspection and water analysis costs. For the purposes of this report, it is assumed that the assessment of a well is approximately $700, which includes a general chemistry, metals, and bacteriological water quality analysis and a well inspection. The estimated cost of a well inspection may decrease if the same well contractor performs a number of well inspections as a tender package.

In the event that the assessment indicates that the construction of a dug well is not acceptable, it is assumed that a new well will be required. As indicated previously, this is based on discussions with well contractors that indicate that the rehabilitation of a dug well to comply with current NSEL requirements typically requires the removal of the well and the construction of a new well.

In the event that a drilled well is not acceptable, options include the rehabilitation of the well or the construction of a new well.

Tables 6-2 to 6-3 provide a range of estimated costs based on the homeowner assuming financial responsibility for upgrading a drilled well and/or treatment system.

Tables 6-4 to 6-5 provide estimated costs based on the homeowner assuming financial responsibility for replacing a dug well and/or treatment system.

The 25 year life cycle costs are estimated as follows:

- Well Rehabilitation – treatment not required: $4,615
- Well Rehabilitation – treatment required: $15,158
- New Well – treatment not required: $8,065

Table 6-2: Drilled Well Rehabilitation Costs

Item	Costs
Typical Homeowner Costs (Year 1)	
Water Supply Assessment	$700
Well Improvement (worst case)	$2,050
Water Treatment	$0
Total	**$2,750**
Typical Water System Maintenance Costs (Per Year)	
Water Quality Sampling	$110
Treatment Equipment	$0
Pump	$50
Total	**$160**
Lifecycle Cost Analysis (25 Year)	
Interest Rate	7%
Period (Years)	25
Initial Capital Cost	$2,750
Treatment Equipment Replacement at Year 10 & 20	$0
Net Present Worth on Capital Items	$2,750
Annual O&M Costs	$160
Net Present Worth on O&M	$1,865
Total Net Present Worth per Home	**$4,615**

Table 6-3: Drilled Well Rehabilitation Costs (with Treatment)

Item	Costs
Typical Homeowner Costs (Year 1)	
Water Supply Assessment	$700
Well Improvement (worst case)	$2,050
Water Treatment	
Treatment Equipment	$1,660
Disinfection Equipment	$1,000
Total	**$5,410**
Typical Water System Maintenance Costs (Per Year)	
Water Quality Sampling	$110
Treatment Equipment	$220
Pump	$50
Total	**$380**
Lifecycle Cost Analysis (25 Year)	
Interest Rate	7%
Period (Years)	25
Initial Capital Cost	$5,410
Treatment Equipment Replacement at Year 10 & 20	$5,320
Net Present Worth on Capital Items	$10,730
Annual O&M Costs	$380
Net Present Worth on O&M	$4,428
Total Net Present Value per Home	**$15,158**

Table 6-4: New Well Costs

Item	Costs
Typical Homeowner Costs (Year 1)	
Water Supply Assessment	$700
New Well	$5,500
Water Treatment	$0
Total	**$6,200**
Typical Water System Maintenance Costs (Per Year)	
Water Quality Sampling	$110
Treatment Equipment	$0
Pump	$50
Total	**$160**
Lifecycle Cost Analysis (25 Year)	
Interest Rate	7%
Period (Years)	25
Initial Capital Cost	$6,200
Treatment Equipment Replacement at Year 10 & 20	$0
Net Present Worth on Capital Items	$6,200
Annual O&M Costs	$160
Net Present Worth on O&M	$1,865
Total Net Present Value per Home	**$8,065**

Table 6-5:New Well Costs (Treatment Required)

Item	Costs
Typical Homeowner Costs (Year 1)	
Water Supply Assessment	$700
New Well	$5,500
Water Treatment	
Treatment Equipment	$1,660
Disinfection Equipment	$1,000
Total	**$8,860**
Typical Water System Maintenance Costs (Per Year)	
Water Quality Sampling	$110
Treatment Equipment	$220
Pump	$50
Total	**$380**
Lifecycle Cost Analysis (25 Year)	
Interest Rate	7%
Period (Years)	25
Initial Capital Cost	$8,860
Treatment Equipment Replacement at Year 10 & 20	$5,320
Net Present Worth on Capital Items	$14,180
Annual O&M Costs	$380
Net Present Worth on O&M	$4,428
Total Net Present Value per Home	**$18,608**

- New Well – treatment required: $18,608

It should be noted that the worst case well rehabilitation estimates assume that the existing drilled well is in a well crock that will have to be removed, a pitless adaptor installed, and the casing extended above grade level.

As an alternative option, a homeowner whose well construction assessment is not favourable may decide to purchase bottled water for drinking water and/or cooking purposes, and maintain the well for other uses.

The estimated costs of bottled water for drinking and cooking, not including taxes, is as follows:

- Cooler rental: $90 per year
- Cooler purchase: $160
- Water purchase: $540 per year based on 6 bottles (18.9L) per month

Over a 25 year period, the cost of using bottled water for drinking and cooking would therefore amount to an estimated $13,500 (excluding the cost of the cooler).

It should be noted that the following factors would influence the costs of bottled water:

- Use of bottled water (drinking and/or cooking);
- Volume of bottle purchased;
- Water source; and
- Delivery or pick up service.

The costs for maintaining a well for non-potable water uses would include treatment (if required) and pump maintenance costs.

The magnitude of cost assessment for on-site water supplies in Tables 6-2 to 6-5 should not be directly compared to those provided in Table 6-1. The cost estimates for Tables 6-2 to 6-5 refer to individual costs that a homeowner could incur to improve a water supply over the next 25 years.

Based on the results of the questionnaire, many of the on-site supplies within Bear River are already considered adequate, and therefore residents/ commercial users would not have to upgrade their systems. The cost of improvements depends on the scope of the problem and water uses (i.e. commercial vs. residential). Individual owners of the water supplies would be responsible for the financing, installation and operation of the on-site water system.

Chapter 7 Summary and Recommendations

7.1 Summary

The results of the water supply questionnaire, site visits to observe building densities and commercial centres, discussions with interested stakeholders, and a review of population distribution mapping found that the majority of water users and water shortages/ problems are located in the community downtown area, which corresponds approximately to the area serviced by the wastewater collection system. The existing and future servicing extent of the wastewater collection system was therefore considered a priority area for water servicing.

An evaluation of the water use requirements for a central water system to supply the community of Bear River determined that the community flow requirements should be established at 100,000 Lpd, or 500 Lpd per unit. This figure reflects a 94 % increase over the calculated 257 Lpd per unit average wastewater flow recorded at the Bear River sewage treatment plant in 2006.

A review of potential groundwater supply sources identified fractured slate and quartzite bedrock aquifers (White Rock or Torbrook HU) in the Bear River area with low to moderate yield, and relatively good water quality.

Due to the considerable distance to local surface water sources, the relatively good quality of groundwater interpreted in the study area, and the greater economic feasibility of developing municipal groundwater systems in low density rural communities, it was determined, in consultation with the County of Annapolis, that a detailed evaluation of potential surface water supply sources would not be required.

A groundwater source from the bedrock aquifer (White Rock HU) underlying the area between Riverview Road and Lansdowne Road was determined to have the highest potential to supply the community of Bear River based on the following key criteria:

- Available water quality data indicates that the groundwater quality meets the requirements of the Guidelines for Canadian Drinking Water Quality (GCDWQ) for all parameters analyzed;
- The yield appears adequate given the community's low water demands;
- The source is located in close proximity to the identified priority servicing area; and
- No significant source water protection concerns were identified.

A concept for a water supply system was proposed that included the following components:

- A wellfield comprised of three 200 mm diameter production wells drilled to a depth of approximately 60 m;
- A 100,000 L in-ground concrete storage reservoir;
- Water treatment consisting of sodium hypochlorite disinfection; and
- Approximately 5500 m of transmission/distribution main, including appropriate appurtenances.

The option of improving individual well water supplies, as required, was also investigated.

Opinions of probable construction and operational costs were developed for both the central water supply and the individual well improvements options. Based on the opinions of probable costs, the estimated cost per service connection (assuming a total of 200 connections) for the development of a central groundwater supply in Bear River would amount to approximately $12,200 per connection (expressed as net present worth over 25 year period). Comparatively, the costs a homeowner may spend over the next 25 years to upgrade or replace their on-site well/ treatment system, including operation and maintenance costs, were estimated to range from approximately $4,500 to $18,500 (expressed as net present worth).

7.2 Recommendations

Upon completion of the Study, the Municipality should hold public meetings within the community to review the Study findings and to determine the economic feasibility of a community water system based on costs and probable subscription to the service.

If central water servicing is found to be an attractive option, the Municipalities should conduct groundwater exploration activities in the Riverview Road – Lansdowne Road area to further assess the feasibility of the proposed groundwater supply source. Negotiation with existing land owners would be required prior to the initiation of a groundwater exploration program to obtain an approval to conduct groundwater exploration activities.

7.3 Phasing

As indicated in Chapter 3, the site investigation found that the majority of water users and water shortages/ problems are located in the community downtown area. On this basis, after review of the Draft Report, the client identified the "downtown" area as Phase 1, and requested opinions of probable construction and operational costs for the Phase.

Opinions of probable construction and operational costs for Phase 1 are provided in Table D-1 in Appendix D. Based on the opinions of probable costs, the construction costs for Phase 1 is estimated cost at $1,065,000. For comparisons with other options, the cost per service connection (assuming a total of 50 connections) for Phase 1 is approximately $21,300 (expressed as net present worth over 25 year period).

Phase 1 is indicated in Figure D-1 in Appendix D, and in general, services the “downtown” area up to the Oakdene Centre, and the residential homes located along the watermain between the wellfield and the downtown area. Fifty service connections are assumed.

The infrastructure requirements, in comparison to the total serviced area, are as follows:

<u>Supply Component</u>

- Reduced number of wells from three to two; and
- Reduced length of road access.

<u>Treatment Component</u>

- Reduced instrumentation Control.

<u>Storage</u>

- Reduced number of distribution system pumps from three to two.

<u>Distribution</u>

- Approximately one km of watermain.

Chapter 8 References

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Ham, L.J., 1994. Geological Map of Digby, Nova Scotia, 1:50,000, South Mountain Batholith Project. Nova Scotia Department of Natural Resources Minerals and Energy Branch.

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Trescott, P. 1969. Groundwater Resources and Hydrogeology of the Annapolis Valley, Nova Scotia; Nova Scotia Department of Mines, Memoir 6.

Appendix A
Water Supply Questionnaire

Bear River Water System Feasibility Study

Water Supply Questionnaire

Prepared for the
County of Annapolis and the Municipality of the District of Digby
by
CBCL Limited

Background

The Municipality of the County of Annapolis and the Municipality of the District of Digby are undertaking a feasibility study to determine options for water servicing in the community of Bear River. The goal of this survey is to gather feedback from community groups and stakeholders to document existing water supply issues in the community.

The individual survey responses will be kept confidential. Upon completion, please forward a copy of your responses by email, fax or mail to the contact provided.

Gavin Kennedy, Hydrogeologist
Process Engineering Department
CBCL Limited
PO Box 606, Halifax NS, B3J 2R7
Phone: (902) 421-7241 x2321
Fax: (902) 423-3938
E-mail: gavink@cbcl.ca

Please return your survey by **February 9 2007.**

Thank you very much for your interest and time.

A. Contact Information

Your Name: ____
Affiliation (where applicable): ____
Address: ____
Phone number: ____________________ Fax number: _________________________
Email: ____

Water Supply Questionnaire

B. Current Water Supply Source

1. What is your current water supply source?
   - ❑ Dug well/reservoir
   - ❑ Drilled well
   - ❑ Other _______________

If your water supply source is from a well, indicate the well depth: _________

2. Where is the location of your pump?
   - ❑ Inside house
   - ❑ In the well

If the pump is located in the house, what is the depth of the water intake in the well/ reservoir? __________

If the pump is located in the well, what is the depth of the pump? __________

3. Is your water supply source shared with another household?
   - ❑ Yes
   - ❑ No

If yes, how many households are connected to your water supply? _________

4. How many persons in your household are served by your water supply? ___________

5. Which of the following uses apply to your water supply?
(Please check all that apply)
   - ❑ Drinking
   - ❑ Cooking
   - ❑ Cleaning
   - ❑ Flushing
   - ❑ Showering
   - ❑ Other _______________

6. If the domestic water supply is not used for drinking, indicate why not:
   - ❑ Bacterial Quality Concerns
   - ❑ Chemical/Physical Quality Concerns
   - ❑ Other_______________

7. How would you describe your water quality?
   - ❑ Good
   - ❑ Adequate
   - ❑ Poor

List any known water quality concerns (attach water quality results if available):____

CBCL LIMITED
Consulting Engineers

Water Supply Questionnaire

8. Do you treat your water supply?
   - ❑ Yes
   - ❑ No

If yes, what treatment equipment do you use?
   - ❑ UV disinfection
   - ❑ Chlorination (Javex)
   - ❑ Water softener
   - ❑ Reverse osmosis
   - ❑ Other_______________

9. Do you experience water shortages?
   - ❑ Yes
   - ❑ No

If yes, how often and when do they typically occur?

____

10. Do you purchase water from a water hauler during water shortages?
   - ❑ Yes
   - ❑ No

C. Additional Information

Please use the space below for your additional comments and concerns.

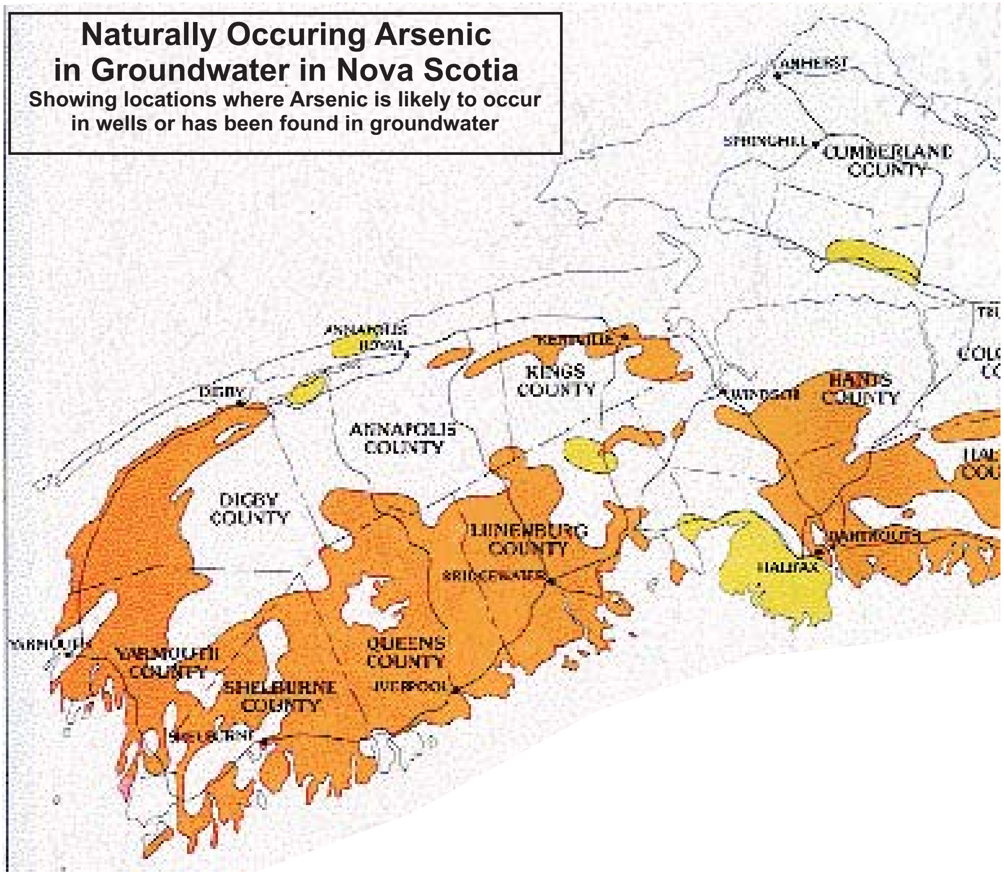
____
____
____
____
____
____
____
____
____
____
____
____
____
____

Thank you for taking the time to complete this questionnaire.
Please return your responses to Gavin Kennedy, CBCL Limited.

Appendix B
Risk Maps of Naturally Occurring Arsenic and Uranium

Naturally Occuring Arsenic in Groundwater in Nova Scotia

Showing locations where Arsenic is likely to occur in wells or has been found in groundwater

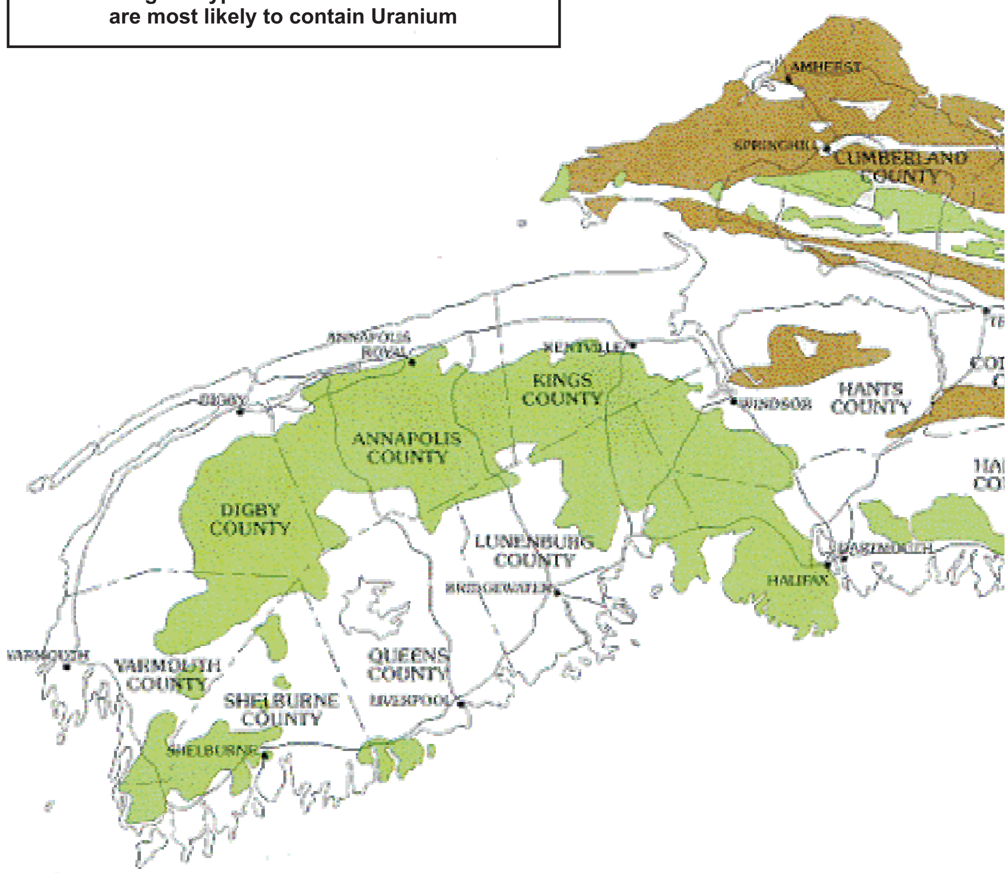


Bedrock of the Meguma Group - Halifax and Goldenville formations (slate, quartzite, greywacke, and metamorphosed equivalents: gneiss, schist). This is the type of Bedrock most likely to contain Arsenic.

It must be noted, however, that arsenic contamination of wells has also occured in areas with other types of bedrock.

Naturally Occuring Uranium in Groundwater in Nova Scotia

Showing the types of bedrock where wells are most likely to contain Uranium



Igneous Rocks - primarily granite

Carboniferous Basin - primarily sandstone, conglomerate and shales includes Pictou, Canso and Cumberland Groups

Appendix C
Laboratory Water Quality Reports

Table C.1: Raw Water Quality Results

Parameters	Units	GCDWQ	*Bear River FD* 13-Mar-07	*Oakdene* 13-Mar-07	*Hillsborough* 13-Mar-07
Escherichia coli	MPN/100mL	**ND**	-	-	ND
Total Coliforms	MPN/100mL	**ND**	-	-	**1**
Total Alkalinity (Total as CaCO3)	mg/L	**-**	66	73	69
Dissolved Chloride (Cl)	mg/L	**250***	53	97	52
Colour	TCU	**15***	<5	<5	<5
Hardness (CaCO3)	mg/L	**-**	130	110	130
Nitrate + Nitrite	mg/L	**-**	0.38	0.52	0.45
Nitrite (N)	mg/L	**-**	<0.02	<0.02	<0.02
Nitrogen (Ammonia Nitrogen)	mg/L	**-**	<0.05	<0.05	<0.05
Total Organic Carbon (C)	mg/L	**-**	<0.5	<0.5	<0.5
Orthophosphate (P)	mg/L	**-**	0.01	<0.01	<0.01
pH	pH	**6 - 8.5***	7.87	7.3	7.56
Reactive Silica (SiO2)	mg/L	**-**	12	8.5	18
Dissolved Sulphate (SO4)	mg/L	**500***	21	11	10
Turbidity	NTU	**1**	0.5	0.2	<0.1
Conductivity	uS/cm	**-**	340	480	320
Calcium	mg/L	**-**	43	39	38
Magnesium	mg/L	**-**	5.2	2.9	9
Phosphorus	mg/L	**-**	<0.1	<0.1	<0.1
Potassium	mg/L	**-**	1.7	2.3	1
Sodium	mg/L	**200***	22	58	11
Anion Sum	me/L	**-**	3.27	4.45	3.09
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	**-**	65	73	69
Calculated TDS	mg/L	**500***	199	265	182
Carb. Alkalinity (calc. as CaCO3)	mg/L	**-**	<1	<1	<1
Cation Sum	me/L	**-**	3.59	4.8	3.12
Ion Balance (% Difference)	%		4.66	3.78	0.48
Langelier Index (@ 4C)	-	**-**	-0.313	-0.903	-0.66
Saturation pH (@ 4C)	-		8.18	8.2	8.22
Nitrate (N)	mg/L	**10**	0.38	0.52	0.45
Total Aluminum (Al)	ug/L	**-**	11	<10	<10
Total Antimony (Sb)	ug/L	**6**	<2	<2	<2
Total Arsenic (As)	ug/L	**10**	4	<2	<2
Total Barium (Ba)	ug/L	**1000**	15	20	9
Total Beryllium (Be)	ug/L	**-**	<2	<2	<2
Total Bismuth (Bi)	ug/L	**-**	<2	<2	<2
Total Boron (B)	ug/L	**5000**	8	10	<5
Total Cadmium (Cd)	ug/L	**5**	<0.3	0.5	<0.3
Total Chromium (Cr)	ug/L	**50**	<2	<2	<2
Total Cobalt (Co)	ug/L	**-**	<1	<1	<1
Total Copper (Cu)	ug/L	**1000**	6	64	<2
Total Iron (Fe)	ug/L	**300***	60	<50	<50
Total Lead (Pb)	ug/L	**10**	0.7	1	<0.5
Total Manganese (Mn)	ug/L	**50***	10	5	<2
Total Molybdenum (Mo)	ug/L	**-**	5	<2	<2
Total Nickel (Ni)	ug/L	**-**	<2	<2	<2
Total Selenium (Se)	ug/L	**10**	<2	<2	<2
Total Silver (Ag)	ug/L	**-**	<0.5	<0.5	<0.5
Total Strontium (Sr)	ug/L	**-**	280	420	110
Total Thallium (Tl)	ug/L	**-**	<0.1	<0.1	<0.1
Total Tin (Sn)	ug/L	**-**	<2	<2	<2
Total Titanium (Ti)	ug/L	**-**	<2	<2	<2
Total Uranium (U)	ug/L	**20**	1.6	12	0.2
Total Vanadium (V)	ug/L	**-**	<2	<2	2
Total Zinc (Zn)	ug/L	**5000***	10	59	8

GCDWQ = Canadian Drinking Water Quality Guidelines, CCME 1999, Updated 2007
***Aesthetic Objective** — **Guideline exceeded** (highlighted)

Your Project #: 060851
Site: BEAR RIVER
Your C.O.C. #: B 21741

Attention: GAVIN KENNEDY
CBCL Limited
1489 Hollis St
PO Box 606
Halifax, NS
B3J 2R7

Report Date: 2007/03/20

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: A723407
Received: 2007/03/13, 16:52

Sample Matrix: Water
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Carbonate, Bicarbonate and Hydroxide	3	N/A	2007/03/14		
Alkalinity	3	N/A	2007/03/14	ATL SOP 00013	Based on EPA310.2
Chloride	3	N/A	2007/03/14	ATL SOP 00014 R2	Based on SM4500-Cl-
Colour	3	N/A	2007/03/14	ATL SOP 00020	Based on EPA110.2
Conductance - water	3	N/A	2007/03/15	ATL SOP 00004/00006	Based on SM2510B
Hardness (calculated as CaCO3)	3	N/A	2007/03/14	Based on SM2340B	ATL SOP 00048
Total metals in water OES	3	N/A	2007/03/15	ATL SOP 00025	Based on EPA200.7
Elements by ICPMS - Total (FIAS)	3	N/A	2007/03/16	ATL SOP 00024	Based on EPA6020A
Ion Balance (% Difference)	3	N/A	2007/03/14		
Anion and Cation Sum	3	N/A	2007/03/14		
Nitrogen Ammonia - water	3	N/A	2007/03/16	ATL SOP 00015	Based on USEPA 350.1
Nitrogen - Nitrate + Nitrite	3	N/A	2007/03/14	ATL SOP 00016 R2	Based on USGS - Enz.
Nitrogen - Nitrite	3	N/A	2007/03/14	ATL SOP 00017	Based on USEPA 354.1
Nitrogen - Nitrate (as N)	3	N/A	2007/03/14	ATL SOP 00018	Based on ASTMD3867
pH	3	N/A	2007/03/15	ATL SOP 00003/00005	Based on EPA150.1
Phosphorus - ortho	3	N/A	2007/03/14	ATL SOP 00021	Based on USEPA 365.1
Sat. pH and Langelier Index (@ 20C)	3	N/A	2007/03/14		
Sat. pH and Langelier Index (@ 4C)	3	N/A	2007/03/14		
Reactive Silica	3	N/A	2007/03/14	ATL SOP 00022	Based on EPA 366.0
Sulphate	3	N/A	2007/03/14	ATL SOP 00023	Based on EPA 375.4
Total Dissolved Solids (TDS calc)	3	N/A	2007/03/14		
Organic carbon - Total (TOC) (1)	3	N/A	2007/03/15	ATL SOP 00037	Based on SM5310C
Turbidity (1)	3	N/A	2007/03/15	ATL SOP 00011	based on EPA 180.1

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) SCC/CAEAL

../2

200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel:902-420-0203 Toll-free:800-565-7227 Fax:902-420-8612 www.maxxamanalytics.com

Your Project #: 060851
Site: BEAR RIVER
Your C.O.C. #: B 21741

Attention: GAVIN KENNEDY
CBCL Limited
1489 Hollis St
PO Box 606
Halifax, NS
B3J 2R7

Report Date: 2007/03/20

CERTIFICATE OF ANALYSIS

-2-

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

JANE BARTEAUX, Project Manager
Email: jane.barteaux.reports@maxxamanalytics.com
Phone# (902) 420-0203

==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. SCC and CAEAL have approved this reporting process and electronic report format.

Total cover pages: 2

Maxxam Job #: A723407
Report Date: 2007/03/20

CBCL Limited
Client Project #: 060851
Project name: BEAR RIVER
Sampler Initials:

ATLANTIC RCAP-MS TOTAL METALS IN WATER (WATER)

Maxxam ID		R32454		R32455		
Sampling Date		2007/03/13 14:00		2007/03/13 14:00		
COC Number		B 21741		B 21741		
	Units	**BEAR RIVER FD**	**QC Batch**	**OAKDENE**	**RDL**	**QC Batch**
INORGANICS						
Total Alkalinity (Total as CaCO3)	mg/L	66	1183785	73	5	1183785
Dissolved Chloride (Cl)	mg/L	53	1183786	97	1	1183786
Colour	TCU	<5	1183789	<5	5	1183789
Hardness (CaCO3)	mg/L	130	1182840	110	1	1182854
Nitrate + Nitrite	mg/L	0.38	1183791	0.52	0.05	1183791
Nitrite (N)	mg/L	<0.02	1183792	<0.02	0.02	1183792
Nitrogen (Ammonia Nitrogen)	mg/L	<0.05	1185751	<0.05	0.05	1185751
Total Organic Carbon (C)	mg/L	<0.5	1184285	<0.5	0.5	1184285
Orthophosphate (P)	mg/L	0.01	1183790	<0.01	0.01	1183790
pH	pH	7.87	1184190	7.30	N/A	1184190
Reactive Silica (SiO2)	mg/L	12	1183788	8.5	0.5	1183788
Dissolved Sulphate (SO4)	mg/L	21	1183787	11	2	1183787
Turbidity	NTU	0.5	1184455	0.2	0.1	1184455
Conductivity	uS/cm	340	1184180	480	1	1184180
RCAP CALCULATIONS						
Anion Sum	me/L	3.27	1182856	4.45	N/A	1182856
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	65	1182839	73	1	1182853
Calculated TDS	mg/L	199	1182861	265	1	1182861
Carb. Alkalinity (calc. as CaCO3)	mg/L	<1	1182839	<1	1	1182853
Cation Sum	me/L	3.59	1182856	4.80	N/A	1182856
Ion Balance (% Difference)	%	4.66	1182855	3.78	N/A	1182855
Langelier Index (@ 20C)	N/A	-0.0640	1182859	-0.654	N/A	1182859
Langelier Index (@ 4C)	N/A	-0.313	1182860	-0.903	N/A	1182860
Saturation pH (@ 20C)	N/A	7.93	1182859	7.95	N/A	1182859
Saturation pH (@ 4C)	N/A	8.18	1182860	8.20	N/A	1182860
Elements (ICP-MS)						
Total Aluminum (Al)	ug/L	11	1185705	<10	10	1185705
Total Antimony (Sb)	ug/L	<2	1185705	<2	2	1185705
Total Arsenic (As)	ug/L	4	1185705	<2	2	1185705
Total Barium (Ba)	ug/L	15	1185705	20	5	1185705
Total Beryllium (Be)	ug/L	<2	1185705	<2	2	1185705
Total Bismuth (Bi)	ug/L	<2	1185705	<2	2	1185705

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel:902-420-0203 Toll-free:800-565-7227 Fax:902-420-8612 www.maxxamanalytics.com

Maxxam Job #: A723407
Report Date: 2007/03/20

CBCL Limited
Client Project #: 060851
Project name: BEAR RIVER
Sampler Initials:

ATLANTIC RCAP-MS TOTAL METALS IN WATER (WATER)

Maxxam ID		R32454		R32455		
Sampling Date		2007/03/13 14:00		2007/03/13 14:00		
COC Number		B 21741		B 21741		
	Units	**BEAR RIVER FD**	**QC Batch**	**OAKDENE**	**RDL**	**QC Batch**
Total Boron (B)	ug/L	8	1185705	10	5	1185705
Total Cadmium (Cd)	ug/L	<0.3	1185705	0.5	0.3	1185705
Total Chromium (Cr)	ug/L	<2	1185705	<2	2	1185705
Total Cobalt (Co)	ug/L	<1	1185705	<1	1	1185705
Total Copper (Cu)	ug/L	6	1185705	64	2	1185705
Total Iron (Fe)	ug/L	60	1185705	<50	50	1185705
Total Lead (Pb)	ug/L	0.7	1185705	1.0	0.5	1185705
Total Manganese (Mn)	ug/L	10	1185705	5	2	1185705
Total Molybdenum (Mo)	ug/L	5	1185705	<2	2	1185705
Total Nickel (Ni)	ug/L	<2	1185705	<2	2	1185705
Total Selenium (Se)	ug/L	<2	1185705	<2	2	1185705
Total Silver (Ag)	ug/L	<0.5	1185705	<0.5	0.5	1185705
Total Strontium (Sr)	ug/L	280	1185705	420	5	1185705
Total Thallium (Tl)	ug/L	<0.1	1185705	<0.1	0.1	1185705
Total Tin (Sn)	ug/L	<2	1185705	<2	2	1185705
Total Titanium (Ti)	ug/L	<2	1185705	<2	2	1185705
Total Uranium (U)	ug/L	1.6	1185705	12	0.1	1185705
Total Vanadium (V)	ug/L	<2	1185705	<2	2	1185705
Total Zinc (Zn)	ug/L	10	1185705	59	5	1185705
Elements (ICP-OES)						
Total Calcium (Ca)	mg/L	43	1184298	39	0.1	1184298
Total Magnesium (Mg)	mg/L	5.2	1184298	2.9	0.1	1184298
Total Phosphorus (P)	mg/L	<0.1	1184298	<0.1	0.1	1184298
Total Potassium (K)	mg/L	1.7	1184298	2.3	0.1	1184298
Total Sodium (Na)	mg/L	22	1184298	58	0.1	1184298
RCAP CALCULATIONS						
Nitrate (N)	mg/L	0.38	1182858	0.52	0.05	1182858

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Job #: A723407
Report Date: 2007/03/20

CBCL Limited
Client Project #: 060851
Project name: BEAR RIVER
Sampler Initials:

ATLANTIC RCAP-MS TOTAL METALS IN WATER (WATER)

Maxxam ID		R32457		
Sampling Date		2007/03/13 14:00		
COC Number		B 21741		
	Units	**HILLSBOROUGH**	**RDL**	**QC Batch**
INORGANICS				
Total Alkalinity (Total as CaCO3)	mg/L	69	5	1183785
Dissolved Chloride (Cl)	mg/L	52	1	1183786
Colour	TCU	<5	5	1183789
Hardness (CaCO3)	mg/L	130	1	1182854
Nitrate + Nitrite	mg/L	0.45	0.05	1183791
Nitrite (N)	mg/L	<0.02	0.02	1183792
Nitrogen (Ammonia Nitrogen)	mg/L	<0.05	0.05	1185751
Total Organic Carbon (C)	mg/L	<0.5	0.5	1184285
Orthophosphate (P)	mg/L	<0.01	0.01	1183790
pH	pH	7.56	N/A	1184190
Reactive Silica (SiO2)	mg/L	18	0.5	1183788
Dissolved Sulphate (SO4)	mg/L	10	2	1183787
Turbidity	NTU	<0.1	0.1	1184455
Conductivity	uS/cm	320	1	1184180
RCAP CALCULATIONS				
Anion Sum	me/L	3.09	N/A	1182856
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	69	1	1182853
Calculated TDS	mg/L	182	1	1182861
Carb. Alkalinity (calc. as CaCO3)	mg/L	<1	1	1182853
Cation Sum	me/L	3.12	N/A	1182856
Ion Balance (% Difference)	%	0.480	N/A	1182855
Langelier Index (@ 20C)	N/A	-0.409	N/A	1182859
Langelier Index (@ 4C)	N/A	-0.660	N/A	1182860
Saturation pH (@ 20C)	N/A	7.97	N/A	1182859
Saturation pH (@ 4C)	N/A	8.22	N/A	1182860
Elements (ICP-MS)				
Total Aluminum (Al)	ug/L	<10	10	1185705
Total Antimony (Sb)	ug/L	<2	2	1185705
Total Arsenic (As)	ug/L	<2	2	1185705
Total Barium (Ba)	ug/L	9	5	1185705
Total Beryllium (Be)	ug/L	<2	2	1185705
Total Bismuth (Bi)	ug/L	<2	2	1185705

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Job #: A723407
Report Date: 2007/03/20

CBCL Limited
Client Project #: 060851
Project name: BEAR RIVER
Sampler Initials:

ATLANTIC RCAP-MS TOTAL METALS IN WATER (WATER)

Maxxam ID		R32457		
Sampling Date		2007/03/13 14:00		
COC Number		B 21741		
	Units	**HILLSBOROUGH**	**RDL**	**QC Batch**
Total Boron (B)	ug/L	<5	5	1185705
Total Cadmium (Cd)	ug/L	<0.3	0.3	1185705
Total Chromium (Cr)	ug/L	<2	2	1185705
Total Cobalt (Co)	ug/L	<1	1	1185705
Total Copper (Cu)	ug/L	<2	2	1185705
Total Iron (Fe)	ug/L	<50	50	1185705
Total Lead (Pb)	ug/L	<0.5	0.5	1185705
Total Manganese (Mn)	ug/L	<2	2	1185705
Total Molybdenum (Mo)	ug/L	<2	2	1185705
Total Nickel (Ni)	ug/L	<2	2	1185705
Total Selenium (Se)	ug/L	<2	2	1185705
Total Silver (Ag)	ug/L	<0.5	0.5	1185705
Total Strontium (Sr)	ug/L	110	5	1185705
Total Thallium (Tl)	ug/L	<0.1	0.1	1185705
Total Tin (Sn)	ug/L	<2	2	1185705
Total Titanium (Ti)	ug/L	<2	2	1185705
Total Uranium (U)	ug/L	0.2	0.1	1185705
Total Vanadium (V)	ug/L	2	2	1185705
Total Zinc (Zn)	ug/L	8	5	1185705
Elements (ICP-OES)				
Total Calcium (Ca)	mg/L	38	0.1	1184298
Total Magnesium (Mg)	mg/L	9.0	0.1	1184298
Total Phosphorus (P)	mg/L	<0.1	0.1	1184298
Total Potassium (K)	mg/L	1.0	0.1	1184298
Total Sodium (Na)	mg/L	11	0.1	1184298
RCAP CALCULATIONS				
Nitrate (N)	mg/L	0.45	0.05	1182858

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Report Date: 2007/03/20

CBCL Limited
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GENERAL COMMENTS

Elevated Nitrite RDL due to method blank performance.

NOx: matrix spike recovery for QC batch 1183791 applies only to sample R22096.

Results relate only to the items tested.

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Client Project #: 060851
P.O. #:
Project name: BEAR RIVER

Quality Assurance Report

Maxxam Job Number: DA723407

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1183785 LMA	MATRIX SPIKE	Total Alkalinity (Total as CaCO3)	2007/03/14		85	%	N/A
	QC STANDARD	Total Alkalinity (Total as CaCO3)	2007/03/14		100	%	80 - 120
	Spiked Blank	Total Alkalinity (Total as CaCO3)	2007/03/14		100	%	80 - 120
	Method Blank	Total Alkalinity (Total as CaCO3)	2007/03/14	<5		mg/L	
	RPD	Total Alkalinity (Total as CaCO3)	2007/03/14	NC		%	25
1183786 LMA	MATRIX SPIKE	Dissolved Chloride (Cl)	2007/03/14		89	%	80 - 120
	QC STANDARD	Dissolved Chloride (Cl)	2007/03/14		106	%	80 - 120
	Spiked Blank	Dissolved Chloride (Cl)	2007/03/14		104	%	80 - 120
	Method Blank	Dissolved Chloride (Cl)	2007/03/14	<1		mg/L	
	RPD	Dissolved Chloride (Cl)	2007/03/14	2.2		%	25
1183787 LMA	MATRIX SPIKE	Dissolved Sulphate (SO4)	2007/03/14		NC	%	80 - 120
	QC STANDARD	Dissolved Sulphate (SO4)	2007/03/14		108	%	80 - 120
	Spiked Blank	Dissolved Sulphate (SO4)	2007/03/14		108	%	80 - 120
	Method Blank	Dissolved Sulphate (SO4)	2007/03/14	<2		mg/L	
	RPD	Dissolved Sulphate (SO4)	2007/03/14	2.1		%	25
1183788 LMA	MATRIX SPIKE	Reactive Silica (SiO2)	2007/03/14		106	%	80 - 120
	QC STANDARD	Reactive Silica (SiO2)	2007/03/14		117	%	75 - 125
	Spiked Blank	Reactive Silica (SiO2)	2007/03/14		108	%	80 - 120
	Method Blank	Reactive Silica (SiO2)	2007/03/14	<0.5		mg/L	
	RPD	Reactive Silica (SiO2)	2007/03/14	0.4		%	25
1183789 LMA	QC STANDARD	Colour	2007/03/14		100	%	80 - 120
	Method Blank	Colour	2007/03/14	<5		TCU	
	RPD	Colour	2007/03/14	NC		%	25
1183790 LMA	MATRIX SPIKE	Orthophosphate (P)	2007/03/14		103	%	80 - 120
	QC STANDARD	Orthophosphate (P)	2007/03/14		94	%	80 - 120
	Spiked Blank	Orthophosphate (P)	2007/03/14		91	%	80 - 120
	Method Blank	Orthophosphate (P)	2007/03/14	<0.01		mg/L	
	RPD	Orthophosphate (P)	2007/03/14	NC		%	25
1183791 LMA	MATRIX SPIKE	Nitrate + Nitrite	2007/03/14		75 (1)	%	80 - 120
	QC STANDARD	Nitrate + Nitrite	2007/03/14		102	%	80 - 120
	Spiked Blank	Nitrate + Nitrite	2007/03/14		86	%	80 - 120
	Method Blank	Nitrate + Nitrite	2007/03/14	<0.05		mg/L	
	RPD	Nitrate + Nitrite	2007/03/14	1.4		%	25
1183792 LMA	MATRIX SPIKE	Nitrite (N)	2007/03/14		95	%	80 - 120
	QC STANDARD	Nitrite (N)	2007/03/14		117	%	80 - 120
	Spiked Blank	Nitrite (N)	2007/03/14		106	%	80 - 120
	Method Blank	Nitrite (N)	2007/03/14	<0.02		mg/L	
	RPD	Nitrite (N)	2007/03/14	NC		%	25
1184180 SMT	QC STANDARD	Conductivity	2007/03/15		101	%	80 - 120
	Method Blank	Conductivity	2007/03/15	1.3		uS/cm	
	RPD	Conductivity	2007/03/15	1.2		%	25
1184190 SMT	QC STANDARD	pH	2007/03/15		101	%	80 - 120
	Method Blank	pH	2007/03/15	5.44		pH	
	RPD	pH	2007/03/15	0.2		%	25
1184285 CRA	MATRIX SPIKE	Total Organic Carbon (C)	2007/03/15		97	%	N/A
	QC STANDARD	Total Organic Carbon (C)	2007/03/15		93	%	80 - 120
	Spiked Blank	Total Organic Carbon (C)	2007/03/15		102	%	75 - 125
	Method Blank	Total Organic Carbon (C)	2007/03/15	<0.5		mg/L	
	RPD	Total Organic Carbon (C)	2007/03/15	NC		%	25
1184298 MLB	MATRIX SPIKE						
	[R32457-01]	Total Calcium (Ca)	2007/03/15		99	%	80 - 120
		Total Magnesium (Mg)	2007/03/15		99	%	80 - 120
		Total Phosphorus (P)	2007/03/15		99	%	80 - 120
		Total Potassium (K)	2007/03/15		101	%	80 - 120
		Total Sodium (Na)	2007/03/15		100	%	80 - 120

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Client Project #: 060851
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Project name: BEAR RIVER

Quality Assurance Report (Continued)

Maxxam Job Number: DA723407

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1184298 MLB	QC STANDARD	Total Calcium (Ca)	2007/03/15		111	%	80 - 120
		Total Magnesium (Mg)	2007/03/15		111	%	80 - 120
		Total Phosphorus (P)	2007/03/15		99	%	80 - 120
		Total Potassium (K)	2007/03/15		100	%	80 - 120
		Total Sodium (Na)	2007/03/15		113	%	80 - 120
	Spiked Blank	Total Calcium (Ca)	2007/03/15		101	%	80 - 120
		Total Magnesium (Mg)	2007/03/15		101	%	80 - 120
		Total Phosphorus (P)	2007/03/15		100	%	80 - 120
		Total Potassium (K)	2007/03/15		98	%	80 - 120
		Total Sodium (Na)	2007/03/15		104	%	80 - 120
	Method Blank	Total Calcium (Ca)	2007/03/15	<0.1		mg/L	
		Total Magnesium (Mg)	2007/03/15	<0.1		mg/L	
		Total Phosphorus (P)	2007/03/15	<0.1		mg/L	
		Total Potassium (K)	2007/03/15	<0.1		mg/L	
		Total Sodium (Na)	2007/03/15	<0.1		mg/L	
	RPD [R32457-01]	Total Calcium (Ca)	2007/03/15	1.2		%	25
		Total Magnesium (Mg)	2007/03/15	2.4		%	25
		Total Phosphorus (P)	2007/03/15	NC		%	25
		Total Potassium (K)	2007/03/15	0.7		%	25
		Total Sodium (Na)	2007/03/15	4.9		%	25
1184455 SMT	QC STANDARD	Turbidity	2007/03/15		108	%	80 - 120
	Method Blank	Turbidity	2007/03/15	0		NTU	
	RPD	Turbidity	2007/03/15	3.5 (2)		%	25
1185705 DLB	MATRIX SPIKE	Total Aluminum (Al)	2007/03/16		113	%	80 - 120
		Total Antimony (Sb)	2007/03/16		101	%	80 - 120
		Total Arsenic (As)	2007/03/16		97	%	80 - 120
		Total Barium (Ba)	2007/03/16		95	%	80 - 120
		Total Beryllium (Be)	2007/03/16		101	%	80 - 120
		Total Bismuth (Bi)	2007/03/16		98	%	80 - 120
		Total Boron (B)	2007/03/16		91	%	80 - 120
		Total Cadmium (Cd)	2007/03/16		99	%	80 - 120
		Total Chromium (Cr)	2007/03/16		98	%	80 - 120
		Total Cobalt (Co)	2007/03/16		101	%	80 - 120
		Total Copper (Cu)	2007/03/16		100	%	80 - 120
		Total Lead (Pb)	2007/03/16		100	%	80 - 120
		Total Manganese (Mn)	2007/03/16		111	%	80 - 120
		Total Molybdenum (Mo)	2007/03/16		99	%	80 - 120
		Total Nickel (Ni)	2007/03/16		97	%	80 - 120
		Total Selenium (Se)	2007/03/16		100	%	80 - 120
		Total Silver (Ag)	2007/03/16		98	%	80 - 120
		Total Strontium (Sr)	2007/03/16		100	%	80 - 120
		Total Thallium (Tl)	2007/03/16		97	%	80 - 120
		Total Tin (Sn)	2007/03/16		100	%	80 - 120
		Total Titanium (Ti)	2007/03/16		99	%	80 - 120
		Total Uranium (U)	2007/03/16		97	%	80 - 120
		Total Vanadium (V)	2007/03/16		100	%	80 - 120
		Total Zinc (Zn)	2007/03/16		103	%	80 - 120
	QC STANDARD	Total Aluminum (Al)	2007/03/16		114	%	80 - 120
		Total Antimony (Sb)	2007/03/16		108	%	80 - 120
		Total Arsenic (As)	2007/03/16		104	%	80 - 120
		Total Barium (Ba)	2007/03/16		92	%	80 - 120
		Total Beryllium (Be)	2007/03/16		98	%	80 - 120
		Total Boron (B)	2007/03/16		91	%	80 - 120
		Total Cadmium (Cd)	2007/03/16		102	%	80 - 120
		Total Chromium (Cr)	2007/03/16		101	%	80 - 120

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Quality Assurance Report (Continued)

Maxxam Job Number: DA723407

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1185705 DLB	QC STANDARD	Total Cobalt (Co)	2007/03/16		104	%	80 - 120
		Total Copper (Cu)	2007/03/16		98	%	80 - 120
		Total Iron (Fe)	2007/03/16		111	%	80 - 120
		Total Lead (Pb)	2007/03/16		108	%	80 - 120
		Total Manganese (Mn)	2007/03/16		107	%	80 - 120
		Total Molybdenum (Mo)	2007/03/16		101	%	80 - 120
		Total Nickel (Ni)	2007/03/16		99	%	80 - 120
		Total Selenium (Se)	2007/03/16		100	%	80 - 120
		Total Strontium (Sr)	2007/03/16		98	%	80 - 120
		Total Thallium (Tl)	2007/03/16		97	%	80 - 120
		Total Uranium (U)	2007/03/16		105	%	80 - 120
		Total Vanadium (V)	2007/03/16		97	%	80 - 120
		Total Zinc (Zn)	2007/03/16		102	%	80 - 120
	Spiked Blank	Total Aluminum (Al)	2007/03/16		151 (3)	%	80 - 120
		Total Antimony (Sb)	2007/03/16		100	%	80 - 120
		Total Arsenic (As)	2007/03/16		96	%	80 - 120
		Total Barium (Ba)	2007/03/16		99	%	80 - 120
		Total Beryllium (Be)	2007/03/16		95	%	80 - 120
		Total Bismuth (Bi)	2007/03/16		106	%	80 - 120
		Total Boron (B)	2007/03/16		88	%	80 - 120
		Total Cadmium (Cd)	2007/03/16		97	%	80 - 120
		Total Chromium (Cr)	2007/03/16		98	%	80 - 120
		Total Cobalt (Co)	2007/03/16		99	%	80 - 120
		Total Copper (Cu)	2007/03/16		99	%	80 - 120
		Total Lead (Pb)	2007/03/16		100	%	80 - 120
		Total Manganese (Mn)	2007/03/16		110	%	80 - 120
		Total Molybdenum (Mo)	2007/03/16		100	%	80 - 120
		Total Nickel (Ni)	2007/03/16		98	%	80 - 120
		Total Selenium (Se)	2007/03/16		95	%	80 - 120
		Total Silver (Ag)	2007/03/16		100	%	80 - 120
		Total Strontium (Sr)	2007/03/16		99	%	80 - 120
		Total Thallium (Tl)	2007/03/16		99	%	80 - 120
		Total Tin (Sn)	2007/03/16		101	%	80 - 120
		Total Titanium (Ti)	2007/03/16		99	%	80 - 120
		Total Uranium (U)	2007/03/16		99	%	80 - 120
		Total Vanadium (V)	2007/03/16		98	%	80 - 120
		Total Zinc (Zn)	2007/03/16		118 (4)	%	80 - 120
	Method Blank	Total Aluminum (Al)	2007/03/16	<10		ug/L	
		Total Antimony (Sb)	2007/03/16	<2		ug/L	
		Total Arsenic (As)	2007/03/16	<2		ug/L	
		Total Barium (Ba)	2007/03/16	<5		ug/L	
		Total Beryllium (Be)	2007/03/16	<2		ug/L	
		Total Bismuth (Bi)	2007/03/16	<2		ug/L	
		Total Boron (B)	2007/03/16	<5		ug/L	
		Total Cadmium (Cd)	2007/03/16	<0.3		ug/L	
		Total Chromium (Cr)	2007/03/16	<2		ug/L	
		Total Cobalt (Co)	2007/03/16	<1		ug/L	
		Total Copper (Cu)	2007/03/16	<2		ug/L	
		Total Iron (Fe)	2007/03/16	<50		ug/L	
		Total Lead (Pb)	2007/03/16	<0.5		ug/L	
		Total Manganese (Mn)	2007/03/16	<2		ug/L	
		Total Molybdenum (Mo)	2007/03/16	<2		ug/L	
		Total Nickel (Ni)	2007/03/16	<2		ug/L	
		Total Selenium (Se)	2007/03/16	<2		ug/L	
		Total Silver (Ag)	2007/03/16	<0.5		ug/L	

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Quality Assurance Report (Continued)

Maxxam Job Number: DA723407

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1185705 DLB	Method Blank	Total Strontium (Sr)	2007/03/16	<5		ug/L	
		Total Thallium (Tl)	2007/03/16	<0.1		ug/L	
		Total Tin (Sn)	2007/03/16	<2		ug/L	
		Total Titanium (Ti)	2007/03/16	<2		ug/L	
		Total Uranium (U)	2007/03/16	<0.1		ug/L	
		Total Vanadium (V)	2007/03/16	<2		ug/L	
		Total Zinc (Zn)	2007/03/16	7, RDL=5 (3)		ug/L	
	RPD [R32457-01]	Total Aluminum (Al)	2007/03/16	NC		%	25
		Total Antimony (Sb)	2007/03/16	NC		%	25
		Total Arsenic (As)	2007/03/16	NC		%	25
		Total Barium (Ba)	2007/03/16	NC		%	25
		Total Beryllium (Be)	2007/03/16	NC		%	25
		Total Bismuth (Bi)	2007/03/16	NC		%	25
		Total Boron (B)	2007/03/16	NC		%	25
		Total Cadmium (Cd)	2007/03/16	NC		%	25
		Total Chromium (Cr)	2007/03/16	NC		%	25
		Total Cobalt (Co)	2007/03/16	NC		%	25
		Total Copper (Cu)	2007/03/16	NC		%	25
		Total Iron (Fe)	2007/03/16	NC		%	25
		Total Lead (Pb)	2007/03/16	NC		%	25
		Total Manganese (Mn)	2007/03/16	NC		%	25
		Total Molybdenum (Mo)	2007/03/16	NC		%	25
		Total Nickel (Ni)	2007/03/16	NC		%	25
		Total Selenium (Se)	2007/03/16	NC		%	25
		Total Silver (Ag)	2007/03/16	NC		%	25
		Total Strontium (Sr)	2007/03/16	0.7		%	25
		Total Thallium (Tl)	2007/03/16	NC		%	25
		Total Tin (Sn)	2007/03/16	NC		%	25
		Total Titanium (Ti)	2007/03/16	NC		%	25
		Total Uranium (U)	2007/03/16	NC		%	25
		Total Vanadium (V)	2007/03/16	NC		%	25
		Total Zinc (Zn)	2007/03/16	NC		%	25
1185751 LMA	MATRIX SPIKE	Nitrogen (Ammonia Nitrogen)	2007/03/16		99	%	80 - 120
	QC STANDARD	Nitrogen (Ammonia Nitrogen)	2007/03/16		107	%	80 - 120
	Spiked Blank	Nitrogen (Ammonia Nitrogen)	2007/03/16		99	%	80 - 120
	Method Blank	Nitrogen (Ammonia Nitrogen)	2007/03/16	<0.05		mg/L	
	RPD	Nitrogen (Ammonia Nitrogen)	2007/03/16	NC		%	25

N/A = Not Applicable
NC = Non-calculable
RPD = Relative Percent Difference
QC Standard = Quality Control Standard
SPIKE = Fortified sample
(1) Poor spike recovery due to sample matrix.
(2) POTENTIAL EXCEEDENCE FOR PARAMETER
(3) Low level lab contamination. Minimal impact on data quality.
(4) Recovery is within acceptance criteria.

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Appendix D
Opinions of Probable Costs
Phase 1

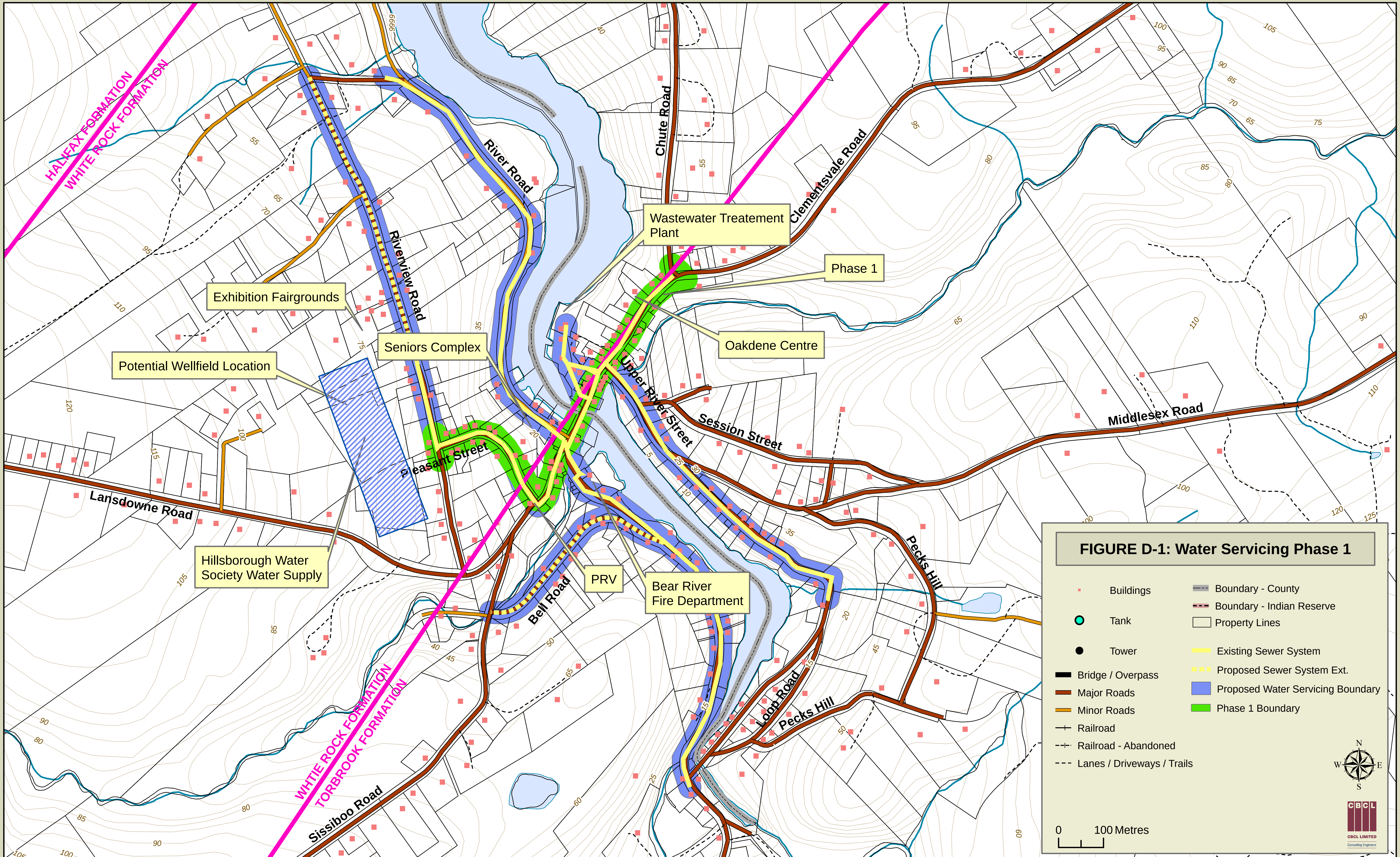
Table D-1: Opinions of Probable Costs, Central Water Supply - Phase 1

Component	Costs	
SUPPLY		
Structures/ Site Development	$	147,365
Mechanical	$	5,750
Electrical/ Instrumentation/ Controls	$	25,000
SUBTOTAL	$	178,115
TREATMENT		
Structures/ Site Development	$	53,750
Mechanical	$	25,000
Electrical/ Instrumentation/ Controls	$	25,000
SUBTOTAL	$	103,750
STORAGE		
Structures/ Site Development	$	110,000
Mechanical	$	18,750
Electrical/ Instrumentation/ Controls	$	12,500
SUBTOTAL	$	141,250
DISTRIBUTION		
	$	369,513
SUBTOTAL	$	369,513
Present Worth on Capital	$	792,628
OPERATING & MAINTENANCE		
Chemicals	$	400
Heat & Power	$	6,000
Maintenance & Miscellaneous	$	2,000
Operations	$	15,000
Total O&M	$	23,400
Annual Interest Rate		7%
Amortization Period		25
O&M Net Present Worth	$	272,694
Total Net Present Worth	*$*	*1,065,321*
Net Present Worth per Connection (50)	*$*	*21,306*

***Probable costs shown above are +/- 25%**

***The 'Structures/ Site Development' subdivision of the Supply component includes the cost of required hydrogeological studies, water quality analyses, and Source Water Protection**

***Probable costs shown above include 25% Engineering and Contingency**



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Data Source: 1: 10000 Digital Data; Service Nova Scotia & Municipal Relations; Projection: UTM NAD 83 Zone 20