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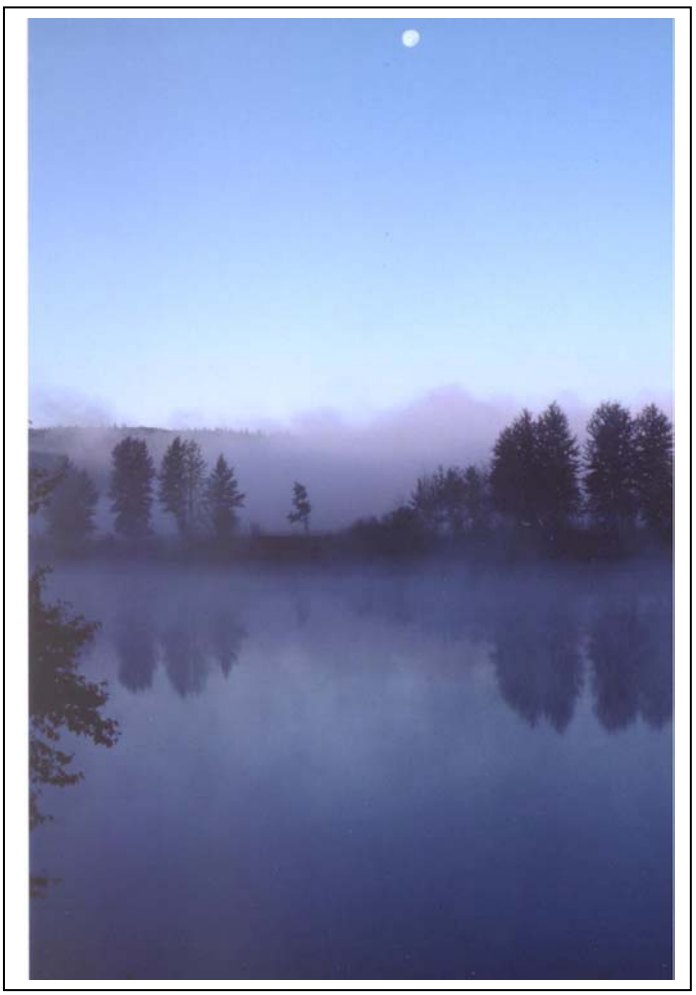

APPLICATION FOR ENVIRONMENTAL ASSESSMENT CERTIFICATE AND DRAFT COMPREHENSIVE STUDY REPORT

CITY OF PRINCE GEORGE HART WATER SUPPLY IMPROVEMENTS FISHTRAP ISLAND COLLECTOR WELL PROJECT, PRINCE GEORGE, BC

Submitted to:

British Columbia Environmental Assessment Office
2nd Floor, 836 Yates Street
Victoria, BC

August 22, 2003

Golder Associates

CITY OF PRINCE GEORGE

CITY OF PRINCE GEORGE

B.C.'s Northern Capital
1100 Patricia Boulevard, Prince George, B.C., Canada V2L 3V9
Telephone (250) 561-7600 / Email ServiceCentre@city.pg.bc.ca

August 22, 2003 File: 2150-03-04-01

B.C. Environmental Assessment Office
P.O. Box 9426 Station Provincial Government
2nd Floor -836 Yates Street
Victoria BC V8W 9V1

Attention: Ms. Kim Cholette
Project Assessment Manager

RE: APPLICATION FOR ENVIRONMENTAL ASSESSMENT CERTIFICATE AND DRAFT COMPREHENSIVE STUDY REPORT CITY OF PRINCE GEORGE HART WATER SUPPLY IMPROVEMENTS, FISHTRAP ISLAND COLLECTOR WELL PROJECT PRINCE GEORGE, BC

Dear Ms. Cholette:

Thank you for your letter of August 13th, 2003 confirming that the *Application for Environmental Assessment Certificate/ draft Comprehensive Study Report* complies with the screening requirements identified in Schedule A 2(ii) of the Section 11 Order under the *British Columbia Environmental Assessment Act* for the *City of Prince George Hart Water Supply Improvement, Fishtrap Island Collector Well Project*. Please note that the City of Prince George has addressed the editorial and preliminary review comments that arose during this screening process.

Accordingly, the City of Prince George is pleased to submit the requisite number of hard copies of the *Application for Environmental Assessment Certificate/ draft Comprehensive Study Report* to each member of the Technical Working Group. In addition, we are also supplying complete electronic versions of this environmental assessment report to the Environmental Assessment Office (EAO) so that it can be posted on the Agency's Project Information Centre, and to Western Economic Diversification Canada as the lead Responsible Authority (RA) under the *Canadian Environmental Assessment Act* (CEAA).

Finally, we will provide to you under separate cover, a detailed Consultation Plan that outlines how the City of Prince George proposes to make copies of the Application/ draft Comprehensive Study Report available to the public, including our proposed consultation efforts with First Nations and the general public during the regulatory and public review period.

Please feel free to contact the undersigned, or alternatively, Mr. Don Gamble of Golder Associates Ltd. at (604) 850-8786 should you have any questions regarding the enclosed Application for Environmental Assessment Certificate/ draft Comprehensive Study Report.

Once again, and on behalf of the City of Prince George, we would like to take this opportunity to thank you and other members of the Technical Working Group for your constructive input and comments during the preparation and finalization of the environmental assessment for the proposed Hart Water Supply Improvement Fishtrap Island Collector Well Project.

Yours truly,

CITY OF PRINCE GEORGE

Dave Dyer, P.Eng.
Manager, Infrastructure Planning

Attachment Prince George Fishtrap Island Well Project, Technical Working Group List, July 30, 2003

cc: Don Gamble, MCIP, R.P.Bio., Associate/ Environmental Planner, Golder Associates Ltd.

Nick Sargent, M.Sc., P.Geo., Associate/ Senior Hydrogeologist, Golder Associates Ltd.

John Boyle, P.Eng., Principal/ Project Manager, Dayton and Knight Consulting Engineers

PRINCE GEORGE FISHTRAP ISLAND COLLECTOR WELL PROJECT
Technical Working Group List
Updated July 30, 2003

NAME	ORGANIZATION	PHONE/ FAX	COURIER ADDRESS	NUMBER OF COPIES
Kim Cholette	Environmental Assessment Office	T (250) 387-1624 F (250) 357-2208	2 - 836 Yates St. Victoria BC V8W 9V1	3 copies plus electronic copy
Peter Bailey	Ministry of Community, Aboriginal Women Services	T (250) 356-7255 F (250) 356-1873	4 - 800 Johnson St. Victoria BC V8W 9N7	1 copy
Bruce Gaunt	Northern Health Authority, Environmental Health	T (250) 565-2150 F (250) 565-2144	4 - 1600 3rd Ave. Prince George BC V2L 3G6	1 copy
Vicki Carmichael	Ministry of Water, Land and Air Protection	T (250) 387-9465 F (250) 356-7197	3 - 2975 Jutland Rd. Victoria BC V8W 9M1	1 copy
Bill Arthur	Ministry of Water, Land and Air Protection	T (250) 614-9902 F	#4051 - 18th Ave Prince George BC V2N 1B3	1 copy
Dave Sutherland	Ministry of Water, Land and Air Protection	T (250) 565-6465 F (250) 565-6629	3 - 1011 Fourth Ave. Prince George BC V2L 3H9	1 copy
Jim Spafford	Archaeology, Planning & Assessment Branch, Ministry of Sustainable Resource Management	T (250) 952-4067 F (250) 952-4188	3RD Floor, 3400 Davidson Ave Victoria BC V8Z 3P8	1 copy
Rick Brand	Corporate Policy & Planning Branch, Ministry of Forests	T (250) 356-6675 F (250) 356-7903	3rd Floor – 595 Pandora Ave Victoria V8W 9C2	1 copy
Tom Muirhead	Land and Water BC	T (250) 565-6440 F (250) 565-6941	455 – 1011 Fourth Ave Prince George V2L 3H9	1 copy
Rick Krehbiel	Lheidli-T'enneh c/o Krehbiel Consulting	T (250) 962-5843 F (250) 962-5842	6932 View Place Prince George, BC V2K 4C6	1 copy
Wendy Bertrand-Bolton	Western Economic Diversification Canada	T (604) 666-7394 F (604) 666-7433	700 – 601 West Hastings St. Vancouver BC V6B 5G9	2 copies plus 2 electronic copies
Derek Nishimura	Fisheries and Oceans	T (604) 666-2365 F (604) 666-6971	200 – 401 Burrard St. Vancouver BC V6C 3S4	1 copy
Jennifer Tennant	Environment Canada	T (604) 666-3567 F (604) 666-7463	201 – 401 Burrard St. Vancouver BC V6C 3S5	1 copy

NAME	ORGANIZATION	PHONE/ FAX	COURIER ADDRESS	NUMBER OF COPIES
Iain Baird	Health Canada	T (250) 561-5378 F (250) 564-3272	220 – 177 Victoria St. Prince George BC V2L 5R8	1 copy
Carl Alleyne	Health Canada	T (604) 666-4693 F(604)666-3149	3155 Willingdon Green Burnaby, B.C. V5G 4P2	1 copy
Keith Grady	Infrastructure Canada	T (613) 954-1372 F (613) 946-9888	7 - 400 Cooper St. Ottawa ON K1A 0R5	1 copy
Linda Sullivan	CEAA	T (604) 666-8784 F (604) 666-6990	320 – 757 West Hastings St. Vancouver BC V6C 1A1	1 copy
Debra Myles	CEAA	T (819) 994-5225 F (819) 997-4931	200 Sacre-Couer Hull PQ K1A 0H3	1 copy
Dave Dyer	City of Prince George	T (250) 561-7633 F (250) 561-7721	1100 Patricia Boulevard Prince George BC V2L 3V9	4 copies
John Boyle	Dayton & Knight Ltd.	T (250) 922-3255 F (250) 922-3253	612 Clyde Avenue West Vancouver BC V7T 1C9	2 copies
Don Gamble	Golder Associates Ltd.	T (604) 850-8786 F (604) 850-8756	#202-2790 Gladwin Road Abbotsford BC V2T 4S8	1 copy
Nick Sargent	Golder Associates Ltd.	T (250) 828-6116 F (604) 828-1215	100-388 First Avenue Kamloops BC V2C 6W3	1 copy

Golder Associates Ltd.

100 – 388 First Avenue
Kamloops, B. C., Canada V2C 6W3
Telephone (250) 828-6116
Fax (250) 828-1215

REPORT ON

APPLICATION FOR ENVIRONMENTAL ASSESSMENT CERTIFICATE AND DRAFT COMPREHENSIVE STUDY REPORT

CITY OF PRINCE GEORGE HART WATER SUPPLY IMPROVEMENTS FISHTRAP ISLAND COLLECTOR WELL PROJECT PRINCE GEORGE, BC

Submitted to:

British Columbia Environmental Assessment Office
2nd Floor 836 Yates Street
Victoria, BC
V8W 1L8

DISTRIBUTION:

3	Copies	-	British Columbia Environmental Assessment Office
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August 22, 2003 022-3050

EXECUTIVE SUMMARY

The City of Prince George (the City) is proposing to upgrade and augment its municipal water supply and distribution system to the Hart Area. The upgrade will require the construction and operation of a new groundwater collector well, and ancillary facilities that include two water transmission mains and access roads. The construction of the proposed collector well, with the associated infrastructure upgrades, is referred to as the *Hart Water Supply Improvement Project*.

Regulatory Context

The proposed Fishtrap Island Collector Well will be capable of extracting up to 93 200 m^3/day (1079 L/s, or 34 million m^3/year) of groundwater from the Lower Nechako River Aquifer. This water will be available principally for distribution to the City's Hart Water Supply Area. Under provincial regulations Part 5, Table 9, Column 1, Item 4 of the *Environmental Assessment Act Reviewable Projects Regulation* (BC Regs. 370/2002), pursuant to the *British Columbia Environmental Assessment Act* (BCEAA), projects involving extraction of groundwater in excess of 75 L/s are deemed reviewable.

The City has applied for funding for the Hart Water Supply Improvement Project from the federal and provincial governments under the *Canada – British Columbia Infrastructure Program*. Due to the contribution of federal funding to the project, construction and operation of the City of Prince George's Hart Water Supply Improvement Project triggers a review under the federal *Canadian Environmental Assessment Act* (CEAA).

Accordingly, this environmental assessment has been prepared as an Application for an Environmental Assessment Certificate (EAC) under the requirements of the *British Columbia Environmental Assessment Act* (BCEAA), and concurrently, as a draft Comprehensive Study Report under the requirements of the *Canadian Environmental Assessment Act* (CEAA). This draft Comprehensive Study Report will ultimately form the basis for the final Comprehensive Study Report following receipt of public and regulatory agency comments. It will then be submitted, along with the City of Prince George's responses to these comments, to the federal Minister of Environment by Western Economic Diversification Canada, the designated Responsible Authority (RA) under CEAA.

Project Description and Rationale

Water supply to the Hart Area, north of the Nechako River, is currently provided by conventional vertical wells, including PW607. The well PW607, located on the north

side of the Nechako River, is down gradient of the City of Prince George landfill and potentially vulnerable to contamination from landfill leachate. The demand for the Hart Area is also nearing the capacity of PW607. Consequently, the Hart Area is subjected to tighter lawn sprinkling restrictions than the Bowl and College Heights areas of Prince George. Though it may be possible to expand the well source at PW607, when other factors such as its vulnerability to landfill leachate contamination and the superior water quality and considerably higher capacity of the Fishtrap Island source are considered, investing in the Fishtrap Island source is more attractive. The proposed Fishtrap Island Collector Well will replace the function of PW607 and will also serve as a back-up water supply source to collector well number PW605 that supplies water to Upper College Heights, Lafreniere, and the University of Northern British Columbia (UNBC) and is located east of the proposed Fishtrap Island Collector Well on the south bank of the Nechako River.

Fishtrap Island is located on the south side of the Nechako River at the Foothills Boulevard Bridge, just north of the CN railway tracks and Otway Road. The south abutment of the Foothills Bridge, crossing the Nechako River, is constructed at the west end of the island. A predominantly dry back channel between the island and a steep slope rising up to the CN railway tracks, is the feature that distinguishes the area as an island. Fishtrap Island is owned by the City of Prince George. The property's legal description is District Lot 2851, Cariboo District, Except Plan 30383. It is zoned Green Belt (GB) and P-4A (Public Utility) which allows for the presence of the existing BC Hydro power lines on the property. Though the Zoning Bylaw would allow for the public utility use to accommodate local distribution, collection or appurtenant facilities within a Green Belt zoning district, it would be appropriate to rezone the well compound lands and watermain rights-of-way on Fishtrap Island to P4-A.

The proposed collector well on Fishtrap Island will be setback approximately 50 m from the south bank of the Nechako River, approximately 7 km upstream from its confluence with the Fraser River. The setback will avoid undertaking works within the municipally designated Environmental Development Permit Area (EDPA) that includes land that is within 50 m of riverbanks. The proposed setback will also meet Fisheries and Oceans Canada's (DFO) riparian requirements and will allow construction of a fenced compound around the perimeter of, and access to, the collector well outside of the 50 m buffer along the top of the Nechako River bank.

The proposed Fishtrap Island Collector Well will connect to the following:

- the Hart area via a 750 mm diameter water transmission line to the north, terminated at the pumping station adjacent PW607; and

- PW605 via a 750 mm diameter water transmission line to the southeast.

With the exception of approximately 100 m of water transmission main leading to PW607 (that would be installed within the Road allowance approaches to the Foothills Boulevard Bridge), these project components will be outside the Environmental Development Area (EDPA) adjacent to the Nechako River. Depending on the final alignment of the water transmission main determined at the detailed design stage of the project, the installation of the 100 m of water transmission main leading to PW607 may trigger an EDPA permit.

Based on an evaluation of three alternative methods of installing the 750 mm diameter water transmission main across the Nechako River to the Hart Water Supply Area, the option of installing the pipeline within the existing Foothills Bridge structure has been selected. This option is considered to be the least environmentally intrusive resulting in no impacts to aquatic, terrestrial, or cultural resources. It is also the most economic method.

The described project would consist of the following components:

- development of the Fishtrap Island collector well and pump station (the collector well will consist of an approximately 30 m deep caisson, approximately 6 m in diameter, with 24 to 36 lateral well screens projected outwards into the aquifer, from the base of the collector well, up to 46 m from the caisson perimeter);

- installation of a 1.9-km long, 750 mm diameter water transmission main north across the Nechako River along Foothills Boulevard to the existing production well PW607 (Hart Pressure Zone);

- installation of a 0.7-km long, 750 mm diameter water transmission main to Pressure Zone 2 near PW605 south and east of Fishtrap Island;

- installation of a disinfection and fluoridation system;

- installation of an electrical power supply line leading from the existing BC Hydro powerline to the collector well;

- installation of sentinel wells to serve as monitoring points for potential sources of groundwater contamination; and

- development of access roads required for construction and operation of the facility.

Although outside of the scope of the currently proposed project, the City of Prince George may eventually expand the Hart Water Supply Improvements Project to include a future reservoir and booster station north of PW607 and south of the existing Vellencher Reservoir.

Summary of Assessment of Project Effects

Hydrogeology

The proposed Fishtrap Island Collector Well will be completed in the Lower Nechako River Aquifer. Groundwater withdrawal for the proposed Fishtrap Island Collector Well will induce recharge from the Nechako River into the Lower Nechako River Aquifer. This induced recharge will account for all of the water withdrawn from the proposed Fishtrap Island Collector Well. The hydrogeological impacts of withdrawal of groundwater from the proposed Fishtrap Island Collector Well, in conjunction with other wells completed in the Lower Nechako River Aquifer, have been assessed using a verified and calibrated three-dimensional finite difference groundwater flow model. The calibration and implementation of the model is described in Golder's report titled "*Capture Zone Analysis, Contaminant Inventory and Preliminary Groundwater Monitoring Plan, City of Prince George"*, dated March 27, 2003 (Golder 2003).

Even at high flow rates, the capture zone of the proposed Fishtrap Island Collector Well, as assessed in the groundwater flow model, is limited to a discrete area that extends north to the Nechako River and only approximately 250 m south of the well. Its east-to-west width is approximately 1200 m. Given the withdrawal rates from the proposed Fishtrap Island Collector Well, this capture zone is very limited. Furthermore, it is apparent from the modelling that recharge from the Nechako River is rapid; hence, no long-term drawdown of the aquifer will result from operation of the proposed Fishtrap Island Collector Well. In addition, it is apparent that the portion of the Lower Nechako River Aquifer on the north side of the Nechako River will be unaffected by operation of the well.

Hydrology

As determined in the groundwater flow model, virtually all of the water withdrawn from the Fishtrap Island Well will originate from the Nechako River, hence its design flow of 93 200 m^3/day (1079 L/s) can be compared with the flows in the Nechako River.

The Nechako River's highest mean monthly flow of 605 m^3/s occurs in July and the lowest mean monthly flow of 141 m^3/s in March. Hence, the total withdrawal from the proposed Fishtrap Island Collector Well is approximately 0.76% of the lowest mean monthly flow and only 0.18% of the highest mean monthly flow. The effect on water levels in the Nechako River is expected to be undetectable, as 1% of river flow is well below the margin of error of the river flow measurements.

Fisheries and Other Aquatic Resources

It is not anticipated that construction of the collector well itself will result in the harmful alteration, disruption, or destruction of aquatic habitat because the footprint for the well and pump house will be approximately 50 m from top of bank of the Nechako River. The only instream works will be within the remnant back channel of Fishtrap Island. These works will be associated with upgrading the existing access road and installing the 750 mm diameter water transmission main, leading towards PW605, across the back channel. Activities undertaken adjacent to sensitive areas, such as the back channel along the south side of Fishtrap Island that drain into Nechako River, will be performed in isolation from any flowing water. During low water conditions, there is typically no flow through the existing culvert beneath the access road, and the section of the back channel immediately downstream of the access road is often dry.

Wildlife Resources

Areas of disturbance for the proposed collector well, water transmission mains, and access roads do not support unique wildlife habitats, such as raptor nests or heron rookeries, nor do they constitute integral components of wildlife corridors. Furthermore, the overall footprint of disturbance resulting from clearing activities required for the project components is relatively small, occurs in an area that has already been partially cleared as a result of other activities, and is unlikely to have a substantial impact on wildlife populations.

Vegetation Resources

The continuous operation of the Fishtrap Island Collector Well will lower groundwater levels on the island, particularly in close proximity to the well. The change in water table is expected to have little or no effect on shallow rooted plants. Vegetation close to the riverbank is unlikely to be substantially affected due to high transmissivity and local recharge characteristics of the Lower Nechako River Aquifer. It is possible that more deeply rooted tree and shrub species will be somewhat more affected due to the lowering of the groundwater table.

Cultural Resources

According to Statement of Intent (SOI) maps available from the Ministry of Sustainable Resource Management, Fishtrap Island lies within the asserted traditional territory of the Lheidli T'enneh First Nation, and is very near the north boundary of the Nazko Indian Band's traditional territory. The Lheidli T'enneh First Nation's interest in the area was confirmed by telephone as part of the archaeological component of the assessment. The Band was invited to participate in the archaeological field assessment, but due to scheduling conflicts, their representative was unable to attend. Several unsuccessful attempts were made to contact the Nazko Indian Band to determine whether the Project is within their asserted territory.

An archaeological impact assessment (AIA) was conducted as part of the environmental assessment, under Heritage Inspection Permit 2002-349. The AIA consisted of a visual inspection and subsurface testing. No identifiable landform features, indicative of archaeological site potential, were observed during the surface inspection, and no cultural depressions, modified trees, or other visible archaeological materials or features were observed within the vicinity of the well and surrounding area. Subsurface testing did not identify any buried archaeological resources in the sampled locations. Similarly, no archaeological resources were found along the alignment of the water transmission mains leading to PW607 north of the Nechako River, or to PW605 to the east end of the island. The archaeological assessment concludes that there is a low probability that the Project would impact archaeological resources, and an archaeological impact assessment or monitoring of the project are considered unwarranted.

Wells and Other Licensed Water Users

The assessed hydrogeological impact of the proposed Fishtrap Island Collector Well is limited. Under maximum well capacity pumping conditions, only two private wells were identified within the zone of influence, only one of which appears to be extracting groundwater from Lower Nechako River Aquifer. The potential for interference between this well and the proposed Fishtrap Island Collector Well is considered to be minor, since the estimated drawdown related to the proposed Fishtrap Island Collector Well in the area of the private well is only 0.2 m to 0.3 m. The second well is screened in bedrock, and therefore should not be influenced by the pumping from surficial sediments associated with the proposed Fishtrap Island Collector Well. As determined in the hydrogeological model, users of the Lower Nechako River Aquifer upstream, downstream, and across the Nechako River will not discern any effect from the proposed Fishtrap Island Collector Well. This lack of impact arises from virtually all of the flow from the proposed Fishtrap Island Collector Well being replenished by recharge from the Nechako River.

With regards to other water licence holders downstream of Fishtrap Island, the potential withdrawal rate will not have an impact on their withdrawals. The total volume of flow to be withdrawn will be on the order of 1.079 m^3/s, whereas the licensed net withdrawals on the reach from Isle Pierre downstream to the confluence with the Fraser are 14.47 m^3/s. It is expected that the potential to reduce water supply to downstream users is minimal, as the total incremental withdrawal for the collector well constitutes less than 10% of the existing water licences on this reach of the river and less than 1% of the actual river flow over 90% of the time.

Mitigation Measures

Overall, potential impacts to biophysical and cultural resources are considered to be low and manageable based on the adoption of the mitigation measures recommended below. These measures reflect standard regulatory requirements and best management practices.

The recommended environmental mitigation measures to be implemented during and following construction of this project include the following:

- **Wellhead and Aquifer Protection Plan** to ensure the continued safety and integrity of water quality within the Lower Nechako River Aquifer. (Much of the background information required to develop such a plan was collected during Golder's 2003 study).

- **Well Closure Plan** consistent with the provisions of *Draft Code of Practice for Construction, Testing, Maintenance, Alteration and Closure of Wells, Province of B.C.* (Interim Water Well Drilling Advisory Committee, March 25th, 1994). Among other things, the Well Closure Plan will identify the details of eventual abandonment of the collector well showing placement and amounts of sealants and fill materials.

- **Fish and Aquatic Habitat Protection Plan**, that will include provisions for delineating environmentally sensitive areas to minimize potential for unauthorized encroachment into the Development Permit Area (within 50 m of top of bank of the Nechako River), during construction or when undertaking instream work associated with installing the water transmission main leading to PW605. The latter work will be completed during an approved fisheries window and in isolation from flowing water.

- **Sediment and Erosion Control Plan** to minimize the potential for water quality impacts associated with sediment releases and erosion of exposed soils

during construction, such as during excavation for the collector well caisson and during trenching for the water transmission mains.

- **Wildlife and Terrestrial Habitat Protection Plan** for protecting wildlife resources and enhancing wildlife habitats upon project completion.

- **Landscaping and Revegetation Plan** to be implemented immediately following construction activities, reflective of planting with native riparian shrubs and trees consistent with the *Recommended Native Tree and Shrub Planting* Criteria *for the Enhancement and Restoration of Riparian Habitat* (MELP 1998), and in accordance with applicable requirements of the *City of Prince George's Tree Protection Bylaw No. 6343.*

- **Emergency Response and Spill Prevention Plan** will include a detailed assessment of a risk of spill, spill/release notification and alerting procedures, containment, recovery, and clean-up procedures, and names and telephone numbers of persons and organizations that may be contacted in the event of a potential environmental incident.

- **Environmental Construction Monitoring and Management Program** to inspect, evaluate, and report on the performance of construction activities, and efficiency of environmental control strategies and mitigation measures with respect to regulatory permits, approvals, and authorizations, environmental legislation, and best management practices. Environmental monitoring by qualified personnel will also reduce the likelihood of activities, whether accidental or intentional that contravenes environmental legislation and regulations.

- **Post-Construction Monitoring Program**, if necessary, following completion of the construction phase of the project to evaluate the long-term success of any replanted or revegetated areas.

Providing the above-referenced environmental mitigation and compensation measures are implemented, it is anticipated that there will be no residual impacts due to construction of the City of Prince George Hart Water Supply Improvement, Fishtrap Island Collector Well Project.

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1.0 INTRODUCTION

The City of Prince George (the City) is developed around the confluence of the Nechako and Fraser rivers in the central interior of British Columbia (Figure 1.1). The City is proposing to upgrade and augment its municipal water supply and distribution system to the Hart Area. The upgrade will require the construction and operation of a new groundwater collector well. The construction of the proposed collector well, with the associated infrastructure upgrades, is referred to as the *Hart Water Supply Improvement Project*.

The proposed collector well, referred to in this report as the Fishtrap Island Collector Well, will be located on Fishtrap Island, near the south bank of the Nechako River, approximately 7 km upstream from its confluence with the Fraser River. The channel that originally separated the south bank of the Nechako River from Fishtrap Island has been nearly completely in-filled by river sediments and vegetation. Thus, most of the southern portion of the island now forms a continuous landmass with the area to the south of the Nechako River (Figure 1.2).

The principal infrastructure upgrades associated with the construction of the Fishtrap Island Collector Well are indicated in Figure 1.3. The upgrades will include the construction and operation of two 750 mm diameter water transmission mains, as described below.

- A water transmission main to service the Hart Water Supply Area would extend northward across the Nechako River for a distance of approximately 1.9 km to an existing pump station. The pump station is located adjacent to the conventional vertical well PW607, near the intersection of Foothills Boulevard and North Nechako Road. It is proposed that PW607, following installation of the water transmission main from the Fishtrap Island Collector Well, will be maintained for use only during emergencies.

- The second water transmission main would allow the Fishtrap Island Collector Well to serve as a back-up supply for the southern part of the City. It will lead southwest to tie-in section near an existing collector well PW605, approximately 900 m southeast of the Fishtrap Island Collector Well site.

As indicated below, this environmental assessment has been prepared as an Application for an Environmental Assessment Certificate (EAC) under the requirements of the *British Columbia Environmental Assessment Act* (BCEAA), and concurrently, as a draft Comprehensive Study Report under the requirements of the *Canadian Environmental*

Assessment Act (CEAA). This draft Comprehensive Study Report will ultimately form the basis for the final Comprehensive Study Report following receipt of public and regulatory agency comments. It will then be submitted, along with the City of Prince George's responses to these comments, to the federal Minister of Environment by Western Economic Diversification Canada, the designated Responsible Authority (RA) under CEAA.

The Terms of Reference that this Application/Comprehensive Study Report is based on, including organization, structure, and scope of technical environmental assessments, are provided in Appendix I. Based on the technical assessments conducted for this Application/Comprehensive Study Report, environmental planning and mitigation measures are provided to minimize, and where possible avoid, potentially adverse environmental and social effects associated with the construction and operation of the City of Prince George's Hart Water Supply Improvement Project.

1.1 The Applicant

The name, address, and title of the Applicant for whom this Application/Comprehensive Study Report has been prepared is:

City of Prince George
1100 Patricia Boulevard
Prince George, B.C.
V2L 3V9

The responsible individual representing the Applicant is:

Dave Dyer, P.Eng.
Manager, Infrastructure Planning
City of Prince George
Telephone: (250) 561-7663
Facsimile: (250) 561-7721
Email: ddyer@city.pg.bc.ca

The Applicant's Agents who have prepared and submitted this Application/Comprehensive Study Report are:

Golder Associates Ltd.
Suite 100 – 388 First Avenue
Kamloops, B.C. V2C 6W3

Dayton & Knight Ltd. Consulting Engineers
612 Clyde Avenue
West Vancouver, B.C.
V7V 3N9

The responsible individuals representing the Agents who can respond to questions regarding this Application/Comprehensive Study Report are:

Nick Sargent, M.Sc., P.Geo.
Associate/Project Hydrogeologist
Golder Associates Ltd.
Telephone: (250) 828-6116
Facsimile: (250) 828-1215
Email: nsargent@golder.com

Don Gamble, MCIP, R.P.Bio
Associate/Environmental Planner
Golder Associates Ltd.
Telephone: (604) 850-8786
Facsimile: (604) 850-8756
Email: dgamble@golder.com

John Boyle, P.Eng.
Principal/Project Manager
Dayton & Knight Ltd.
Telephone: (604) 922-3255
Facsimile: (604) 922-3253
Email: jboyle@dayton-knight.com

2.0 PURPOSE OF THE PROJECT

2.1 Background

The City of Prince George's municipal water supply is wholly serviced by groundwater wells, most of which are completed in the eastern portion of the generally unconfined Lower Nechako River Aquifer[1]-Provincial Aquifer 92 (Figure 2.1). The Lower Nechako River Aquifer in Prince George is a flat triangular area bounded by Cranbrook Hill to the west, the Hart Highlands that define the north side of the Nechako River valley to the

[1] As defined by BCMWLAP http://wlapwww.gov.bc.ca/wat/aquifers/aqmaps/aqdescription.html

north, and the Fraser River to the east (Figure 2.2). A continuation of the Lower Nechako River Aquifer, outside of the area defined as Provincial Aquifer 92, occurs on the east side of the Fraser in the southeast corner of the Lower Nechako River Aquifer.

The bulk of the City's municipal water supply is presently derived from two groundwater collector wells: high capacity wells consisting of a concrete caisson from which multiple well screens are projected radially into the aquifer. The wells are PW605 (also referred to as Collector Well #1) and PW601 (also referred to as Collector Well #3), both of which are located within the Lower Nechako River Aquifer on the south bank of the Nechako River. These two wells supply potable water to areas in Prince George, south of the Nechako River, including the Bowl Area, Upper College Heights, the University of Northern British Columbia (UNBC), and Blackburn (Figures 2.3 and 2.4).

Another collector well (Collector Well #2) was constructed between 1980 and 1981 by the City of Prince George, but abandoned because the water was high in iron and manganese. The abandoned well is the most easterly of the collector wells constructed by the City of Prince George. This well was constructed at a location known to be somewhat less favourable for collector well construction. Its abandonment does not reflect on the general viability of the collector wells in Prince George. The locations of the two existing collector wells, the proposed Fishtrap Island Well, and the City's other (conventional vertical) water supply wells that are relevant to assessing the total withdrawal of water from the Lower Nechako River Aquifer are shown on Figure 2.5. The conventional vertical wells are identified as PW606, PW607, PW608/9 (one well), PW621/624 (one well), PW625, PW627, and PW632.

Water supply to the Hart Area north of the Nechako River is currently provided by conventional vertical wells, including PW607. Conventional wells are constructed of vertical steel casings with stainless steel well screens. Well PW607 is located on the north side of the Nechako River, near the intersection of Foothills Boulevard and North Nechako Road. Well PW607 is down gradient of the municipal solid waste landfill operated by the Regional District of Fraser Fort George at Foothills Boulevard and Austin Road West. The well is potentially vulnerable to contamination from landfill leachate, as determined by a monitoring program conducted by the Regional District of Fraser Fort-George (D. Dyer, Manager, Infrastructure Planning, City of Prince George, Prince George, B.C., pers. comm.). Well PW607 is also reaching its capacity to supply the demand for the Hart Area. Consequently, the Hart Area is subjected to tighter lawn sprinkling restrictions than the Bowl and College Heights areas of Prince George. Though it may be possible to expand the well source at PW607, when other factors such as its vulnerability to landfill leachate contamination and the superior water quality and

substantially higher capacity of the Fishtrap Island source are considered, investing in the Fishtrap Island source is more attractive.

The proposed Fishtrap Island Collector Well is required to meet current and projected water demands within the City's Hart area, located to the north of the Nechako River. The proposed Fishtrap Island Collector Well will replace the conventional vertical well PW607, which will be maintained solely for back up. In the future, the Collector Well will replace wells PW608 and PW610. The proposed Fishtrap Island Collector Well will also serve as a back-up water supply source to collector well number PW605, which supplies water to the West Bowl Area, Upper College Heights, Lafreniere, and the University of Northern British Columbia (UNBC).

The estimated withdrawal rates for all of the City's wells for the present day average pumping rate and 20-year projected average demand are shown in Table 2.1. In addition, the maximum design flow rates for the three collector wells are shown. The design flow rates are calculated by the wells' designer based on the installed open-screen area and a maximum screen entrance velocity of 0.0076 m/s (0.025 ft/s). As they represent the design flows of the collector wells, these flow rates are used in this Application for an Environmental Assessment Certificate/Comprehensive Study Report. It should be noted, however, that the well design flow rates exceed the 20-year projected average demands by a factor approaching three.

In addition to the City of Prince George's wells, three other high capacity (i.e., yields greater than 500 Igpm) private commercial wells operate in the Lower Nechako River Aquifer. These include Canadian Forest Products Ltd.'s (Canfor) collector well, and individual conventional vertical wells for Pacific Western Brewery and a fish hatchery. These commercial well locations are also shown on Figure 2.5, they are all on the north bank of the Nechako River and hence hydraulically separated from the City's collector wells.

Collector wells are ideally suited to areas located adjacent to rivers which serve as a source of recharge to the local aquifer. Given the relative lengths and multiple number of well screens associated with collector wells, when compared with conventional wells, collector wells are capable of substantially higher yields with significantly less drawdown.

Table 2.1
Summary of Municipal Pumping Rates
(based on 4 different pumping scenarios)
for Capture Zone Analysis

Well	Current Average Pumping Rate		Projected Average Day Demand		Projected Maximum Day Demand		Maximum Well Capacity	
	m3/day	L/s	m3/day	L/s	m3/day	L/s	m3/day	L/s
PW601	12,257	142	17,194	199	43,100	499	93,200	1,079
PW605	24,640	285	31,277	362	74,800	866	93,200	1,079
PW606	1,637	19	2,126	25	0	0	0	0
PW607	4332	50	9,219	106.7	0	0	0	0
PW608	1018	12	3,871	44.8	0	0	0	0
PW621/624	2597	30	12,753	147.6	0	0	0	0
PW625	95	1	198	2	0	0	0	0
PW627	1637	19	3,888	45	0	0	0	0
PW632	975	11	2,108	24.4	0	0	0	0
Fishtrap Island Collector	8,977	103.9	13,090	151.5	37,900	439	93,200	1,079

Current pumping rate provided by the City of Prince George based on pumping records from 1995 through 2001
Projected average demand based on recent estimates by Dayton and Knight, with some modifications by the City of Prince George
Projected maximum daily demand provided by the City of Prince George
Maximum well capacity provided by the City of Prince George

2.2 Regulatory Context

2.2.1 Provincial Jurisdiction

The proposed Fishtrap Island Collector Well is projected to be capable of extracting up to 93 200 m^3/day (1079 L/s, or 34 million m^3/year) of groundwater from the Lower Nechako River Aquifer for subsequent distribution to the City's Hart Water Supply Area. Under provincial regulations Part 5, Table 9, Column 1, Item 4 of the *Environmental Assessment Act Reviewable Projects Regulation* (BC Reg. 370/2002), pursuant to the *British Columbia Environmental Assessment Act* (BCEAA), projects involving extraction of groundwater in excess of 75 L/s are deemed reviewable. Specifically, Part 5, Table 9, Column 1, Item 4 of the *Environmental Assessment Act Reviewable Projects Regulation* states:

> "*The construction of a new facility constitutes a reviewable project if the facility is designed to be operated, or when the construction phase is substantially completed will be designed to be operated, so that groundwater is extracted at a rate of 75 litres or more per second.*"

2.2.2 Federal Jurisdiction

The City of Prince George has applied for funding for the Hart Water Supply Improvement Project from the federal and provincial governments under the *Canada – British Columbia Infrastructure Program*. In June 2002, the City of Prince George received notice that $5.5 million was approved for the development of the Fishtrap Island Collector Well and construction of the well pump station, subject to completion of an environmental assessment and review. The approved project cost will be split equally between federal and provincial agencies and the City of Prince George. (Note that the segment of the water transmission main that will connect the new well to the Hart Water System north of PW607 has not, to date, received funding under this part of the program.)

Because of the contribution of federal funding to the project, construction and operation of the City of Prince George's Hart Water Supply Improvement Project triggers a review under the federal *Canadian Environmental Assessment Act* (CEAA). Section 5(1)(b) of CEAA requires an environmental assessment where a federal authority:

> "*makes or authorizes payments or provides a guarantee for a loan or any other form of financial assistance to the proponent for the purpose of enabling the project to be carried out in whole or in part, except where the financial assistance is in the form of any reduction, avoidance, deferral, removal, refund,*

remission or other form of relief from the payment of any tax, duty or impost imposed under any Act of Parliament, unless that financial assistance is provided for the purpose of enabling an individual project specifically named in the Act, regulation or order that provides the relief to be carried out."

The federal agency administering the *Canada – British Columbia Infrastructure Program* for this project is Western Economic Diversification Canada (WEDC). Therefore, WEDC is a Responsible Authority (RA) as defined in Section 2(1) of CEAA and has a mandate to *"ensure that the environmental assessment is conducted as early as is practicable in the planning stages of the project and before irrevocable decisions are made"* (Section 11[1] of CEAA).

The project is reviewable as a Comprehensive Study Report because the proposed rate of groundwater extraction exceeds the 200 000 m^3/year threshold indicated in Part III, Section 10 of the *Comprehensive Study List Regulations.*

2.2.3 Harmonized Jurisdiction

As this environmental assessment for the City of Prince George's Hart Water Supply Improvement Project falls under federal and provincial jurisdiction, it has been prepared and is organized to facilitate a harmonized review of the project. The report is intended to provide an *Application for an Environmental Assessment Certificate* (referred to in this report as the "Application") under BCEAA, and concurrently, as a draft *Comprehensive Study Report* under CEAA. As indicated above, this draft Comprehensive Study Report will ultimately form the basis for the final Comprehensive Study Report following receipt of public and regulatory agency comments. It will then be submitted, along with the City of Prince George's responses to these comments, to the federal Minister of Environment by Western Economic Diversification Canada, the designated Responsible Authority (RA) under CEAA.

Table 2.2 provides a cross-reference identifying where each of the CEAA Section 16(1) and 16(2) factors are addressed in this Application/Comprehensive Study.

Table 2.2 Correlation of CEAA Section 16(1) and 16(2) Factors with BCEAA Terms of Reference

CEAA Section 16(1) Factors to be Considered	Cross-Reference Sections in this Terms of Reference
(*a*) the environmental effects of the project, including the environmental effects of malfunctions or accidents that may occur in connection with the project and any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out.	• Section 9.0 Existing Site Characteristics and Conditions • Section 10.0 Potential Environmental Effects • Section 11.0 Effects of the Environment on the Project • Section 12.0 Accidents, Malfunctions and Adverse Conditions • Section 13.0 Cumulative Environmental Effects
(*b*) the significance of the effects referred to in paragraph (*a*).	• Section 15.0 Significance of Residual Environmental Effects
(*c*) comments from the public that are received in accordance with this Act and the regulations.	• Section 16.0 Public Information Distribution and Consultation • Section 17.0 First Nations Consultation, Issues and Responses • Section 18.0 Discussions with Government
(d) measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project.	• Section 14.0 Mitigation Measures: Environmental Management Plan
(*e*) any other matter relevant to the screening, comprehensive study, mediation or assessment by a review panel, such as the need for the project and alternatives to the project, that the responsible authority or, except in the case of a screening, the Minister after consulting with the responsible authority, may require to be considered.	• Section 4.0 Project Justification • Section 5.0 Review of Alternatives
CEAA Section 16(2) Additional Factors to be Considered	
(*a*) the purpose of the project.	• Section 2.0 Purpose of the Project

CEAA Section 16(1) Factors to be Considered	Cross-Reference Sections in this Terms of Reference
(b) alternative means of carrying out the project that are technically and economically feasible and the environmental effects of any such alternative means.	• Section 5.0 Review of Alternatives
(c) the need for, and the requirements of, any follow-up program in respect of the project.	• Section 14.7 Environmental Construction Monitoring and Management Plan • Section 14.8 Post-construction Monitoring
(d) the capacity of renewable resources that are likely to be affected by the project to meet the needs of the present and those of the future.	• Section 10.5.4 Renewable Resources

3.0 ENVIRONMENTAL ASSESSMENT OBJECTIVES, GENERAL APPROACH, AND METHODOLOGY

3.1 Objectives and General Approach

The objectives of this Application/Comprehensive Study Report are to provide the following:

- a clear description and justification for the project;
- the proposed construction methodology and schedule;
- a discussion of alternative means of undertaking the project, including design, configuration, and location of project components;
- a summary of public involvement and notification initiatives conducted to date, including liaison with First Nations, regulatory agencies, and non-government organizations;
- characterization of the existing environmental setting of the project area including physical, biological, and cultural resources;
- an evaluation of potential environmental effects that might occur as a result of the construction and operation of the collector well and ancillary facilities;

- an evaluation of the effects of the environment on the project;
- an evaluation of the cumulative effects to environmental resources in consideration of other projects and activities;
- recommended mitigation measures to be implemented by the City of Prince George to undertake the project in an environmentally responsible manner;
- recommended environmental monitoring and surveillance programs during construction of the project to oversee the implementation of the mitigation measures; and
- recommended follow-up monitoring programs to evaluate the integrity and performance of any design mitigation and compensation features, if applicable.

In order to accomplish these objectives, relevant information has been collected from available published sources and through interviews with key regulatory and non-government stakeholders, supplemented by field investigations to describe physical, biological, and cultural site characteristics.

3.2 Methodology

In order to accomplish these objectives, relevant information has been collected from available published sources and through interviews with key regulatory and non-government stakeholders, supplemented by reconnaissance-level field investigations to describe physical, biological, and cultural site characteristics. Visual surveys of the project area were conducted on Fishtrap Island from the entrance to Wilson Park to Foothills Boulevard Bridge across the Nechako River. Observations of relevant biophysical features were noted along Foothills Boulevard within the vicinity of the proposed water transmission main corridor. In addition, observations were made within the immediate vicinity of the proposed collector well and test well locations on Fishtrap Island.

The following summarizes details of the site reconnaissance and field investigation programs for each of the environmental components.

3.2.1 Hydrogeology

Hydrogeological investigations conducted in 1998 by International Water Consultants Ltd. (IWC) provided evidence to support the proposed general location of the Fishtrap Island Collector Well (IWC 1998). This work was followed by interpretation of location-specific groundwater pumping tests conducted from a 300 mm diameter test well and observed using three 50 mm diameter piezometers in 2002 (IWC 2003). These tests have confirmed groundwater recharge and water quality characteristics. In addition, groundwater movement patterns within the Lower Nechako River Aquifer have been assessed using a calibrated numerical model in Golder's report titled *"Capture Zone Analysis, Contaminant Inventory and Preliminary Groundwater Monitoring Plan, City of Prince George"*, dated March 27, 2003 (Golder 2003) developed to support groundwater protection planning by the City of Prince George.

3.2.2 Fisheries and Aquatic Resources

The following information sources were reviewed to evaluate aquatic habitat characteristics and potential fisheries resources within the Nechako River and the vicinity of Fishtrap Island:

- Fisheries Information Summary System (FISS) records for the Nechako River;
- consultants' reports describing fish and fish habitat along the Nechako River;
- interviews with the Ministry of Water Land and Air Protection (MWLAP) regional habitat biologists to request available information regarding site-specific aquatic habitat characteristics, timing restrictions, target species, and management objectives; and
- interviews and onsite meetings with Fisheries and Oceans Canada (DFO) regional habitat biologists.

Site reconnaissance-level field investigations were conducted in September and October 2002 by registered professional biologists. Representative site photographs depicting various biophysical features throughout the project area are provided in Appendix III. Efforts were made to evaluate, and where possible estimate, areas of potential disturbance to aquatic habitat and other environmentally sensitive features such as wetlands and surface drainage courses. These included areas of potential riparian disturbance associated with the siting of the collector well, transmission pipelines, and access roads.

3.2.3 Vegetation Resources

Characterization of vegetation resources within the project area was based on a review of the following information:

- B.C. Conservation Data Centre (CDC) and Committee on the Status of Endangered Wildlife in Canada (COSEWIC) databases to determine if there are any recorded rare, endangered, or unique plant species or vegetation communities within the vicinity of the project;
- Ecoregion classification for British Columbia; and,
- Tree Protection Bylaw administered by the City of Prince George to confirm what replanting criteria, if any, may be required to replace trees or other plant cover that may need to be removed to accommodate construction of the collector well and ancillary facilities.

During the site reconnaissance in September and October 2002, areas requiring tree clearing and vegetation removal to facilitate construction access were identified based on species type and ecological value.

3.2.4 Wildlife Resources

Several sources of information to characterize potential wildlife use and terrestrial habitats within the vicinity of the proposed collector well and ancillary facilities were reviewed. These included the following:

- B.C. Conservation Data Centre (CDC) of "Rare Element Occurrences" to determine if there are any records of animal species considered to be endangered or threatened (red-listed), or vulnerable and at risk (blue-listed) within the project area;
- input from regional wildlife habitat biologists within the Ministry of Water Land and Air Protection (MWLAP); and
- input from environmental stakeholder groups and specialized wildlife biologists within Prince George region.

These data sources and reports, together with anecdotal information obtained from the above-referenced stakeholders, served to identify potentially sensitive species and

habitats that may be impacted by the construction and operation of the collector well and ancillary facilities.

During the site reconnaissance in September and October 2002, the project area was visually inspected to identify the location and characteristics of key wildlife habitats, including presence/absence of potential wildlife trees and nest sites. The purpose of the site reconnaissance was to confirm the presence or absence of any raptor nests or heron rookeries which could be affected by site mobilization and construction activities for the proposed collector well and ancillary facilities. It also served to evaluate the potential for rare or endangered (red-listed or blue-listed) mammal, amphibian, and reptile species to occur within the vicinity of the project.

3.2.5 Cultural Resources

The Cultural Resources component of the Application/Comprehensive Study Report consisted of an Archaeological Impact Assessment (AIA) in October and November 2002 to determine whether any archaeological sites are present within the proposed project area and to assess the likelihood that unrecorded archaeological sites may be present and potentially impacted by the proposed development. The archaeological overview included the following tasks:

- review of existing archaeological site records on file with the Archaeology and Recreation Inventory Section, Resource Information Department (Ministry of Sustainable Resource Management);
- interviews with the Lheidli T'enneh First Nation, Carrier-Sekani Tribal Council, and Nazko Band Government to solicit knowledge of unrecorded archaeological resources and traditional land uses in the project area;
- review of available site plans and aerial photographs of the project site and components;
- site reconnaissance of the project area by a Registered Professional Consulting Archaeologist to evaluate the potential for archaeological sites and cultural features; and
- subsurface testing within the footprint of the Hart Water Supply Improvement Project in accordance with a Heritage Inspection Permit 2002-349 by a Registered Professional Consulting Archaeologist.

3.2.6 Socioeconomic and Land Use

The following information sources were reviewed to characterize general socioeconomic and land use characteristics within the vicinity of the proposed location of the collector well and ancillary facilities:

- land use designation and zoning information from the City of Prince George;
- City of Prince George Official Community Plan (OCP 2001);
- City of Prince George municipal bylaws and zoning maps; and
- Environmental Development Permit Area (EDPA) maps within the OCP administered by the City of Prince George.

During the field reconnaissance conducted as part of this assessment, locations of nearby public utilities, gravel mining operations along Foothills Boulevard, and passive recreation activities on Fishtrap Island were noted. These observations were used to identify existing land uses and public safety issues that could be affected by the project.

3.3 Evaluation Criteria and Determination of Significant Adverse Environmental Effects

As a basis for determining "significance" of potential adverse environmental effects associated with the proposed development of the Hart Water Supply Improvement Project, impact parameters and evaluation criteria are presented here and are applied to potential environmental effects, both before and after mitigation.

Residual impacts are defined as environmental changes that result from the project after mitigation measures have been incorporated. As much as possible, the "significance" of residual impacts is qualified with an assessment of the level of impact according to the parameters and evaluation criteria described below. It is intended that application of these criteria will enable a systematic and objective determination of "significance", which is both defensible and transparent, and which reduces or eliminates biases in deciding the importance of adverse impacts to environmental resources following mitigation.

The following impact parameters are used as a basis for determining significance of residual impacts:

- *Magnitude* describes the amount of change in a measurable parameter or variable relative to the baseline condition (for example, percentage of water withdrawal from the Lower Nechako River Aquifer relative to available flows in the Nechako River);
- *Duration* refers to the length of time over which an environmental impact occurs;
- *Frequency* describes how often the effect occurs within a given time period;
- *Geographical extent* is the spatial area that is affected by the project. In general, the geographic extent of an impact is defined as being local, municipal, or regional; and
- *Reversibility* is an indicator of the potential for recovery of the ecological endpoint from the impact (for example, if a vegetation or wildlife species is red-listed or blue-listed and could be impacted as a result of the project, significance of impact would be considered higher than to a non-listed species).

Table 3.1 provides evaluation criteria for each of the above impact parameters, and which are applied to the environmental effects assessment before mitigation (Section 10.0), and as a basis for determining significance of residual environmental effects after mitigation (Section 15.0) in this Application/Comprehensive Study Report.

Table 3.1 Parameters and Evaluation Criteria Used to Determine Significance

Impact Parameter	Descriptors	Evaluation Criteria
Magnitude	Negligible	• < than 2% change over baseline
	Low	• 2 to 5% change over baseline
	Moderate	• 5 to 10% change over baseline
	High	• > 10% change over baseline
Duration	Short Term	• 1 to 30 days
	Medium Term	• 30 to 60 days
	Long Term	• > than 60 days
Frequency	Low	• 0 to 5 times or events per year
	Moderate	• 5 to 10 times or events per year
	High	• > than 10 times or events per year

Impact Parameter	Descriptors	Evaluation Criteria
Geographical Extent	Localized	• within a 2 km radius of collector well site, and transmission line corridors
	Municipal	• within 2 to 5 km radius of collector well site, and transmission line corridors
	Regional	• greater than 5 km radius of collector well site, and transmission line corridors
Reversibility	Yes	• returns to baseline immediately following construction of collector well and/or water transmission pipelines
	No	• does not return to baseline following construction and collector well and/or water transmission pipelines

A rating scheme has been developed to provide a measurement that consolidates these parameters. The purpose of assigning a numeric rating which integrates these parameters is to provide a systematic basis for making a determination whether a residual impact after mitigation is "significant" or not. Table 3.2 outlines the scoring system used in Section 15.0 to determine whether a residual impact is significant or not based on the above parameters and evaluation criteria. The scoring system uses a numerical score for each of the parameters considered in evaluating an impact. The total is then used as a guide for determining "significance" of residual impacts, as follows:

- Negligible: 0 to 5
- Low: 6 to 10
- Moderate: 11 to 15
- High: greater than 15

Table 3.2 Evaluation Criteria for Determining Significance

Magnitude (Severity)	Geographic Extent	Duration	Frequency	Reversibility
negligible 0	local 0	short-term 0	low 0	yes -3
low +5	municipal +1	medium-term +1	moderate +1	no +3
moderate +10	regional +2	long-term +2	high +2	
high +15				

For the purposes of this assessment, a residual impact with an aggregate total rating of 15 or higher would be considered "significant". For example, if a residual impact was considered to have a moderate magnitude (i.e., 5 to 10% change over baseline conditions), with a regional geographic extent (i.e., affecting an area within a 2 to 5 km radius of the project site), having a long-term duration (i.e., greater than 60 days), and a high frequency of occurrence (i.e., greater than 10 times per year), then it would be assigned a score of 16, and therefore, considered "significant".

Impact magnitude is weighted more heavily than the other parameters, with a maximum value of 15 provided for a high magnitude impact, compared with maximum values of 2 for geographic extent, 2 for duration, 2 for frequency, and 3 for reversibility. In some cases the level of scientific uncertainty is sufficiently high that an estimate of environmental consequence cannot be made with a sufficient degree of confidence. Undetermined ratings are accompanied by recommendations for research or monitoring to provide more data in the future.

Note, that not all of the above-referenced evaluation criteria will necessarily be applicable to residual impacts for each environmental component; however, it is anticipated that in most instances magnitude, duration, and geographical extent will be relevant. In addition, it should be noted that the above-referenced evaluation criteria used to derive "significance" of adverse residual impacts are specific to this project.

Since the EA predicts future conditions of characteristics that are, by their very nature, continuously changing and dynamic, there is frequently a level of scientific uncertainty related to the prediction. In some cases, the level of uncertainty associated with an impact prediction has required that a subjective assessment be provided about an impact, and the requirement for ongoing monitoring has been identified.

These evaluation criteria are applied to the residual potential environmental effects, both before and after mitigation, in Section 15.0 of this Application/Comprehensive Study Report and are summarized in a matrix format to determine significance of the residual effects of the project, following implementation of the mitigation measures.

4.0 PROJECT JUSTIFICATION

The City of Prince George's proposed Fishtrap Island Collector Well will fulfill current and projected water demands within the Hart area of Prince George to the north of the Nechako River. Once the Fishtrap Island Collector Well is in production, the City's production well PW607, presently supplying the Hart area, will be maintained for use only during emergencies. This is a benefit as PW607 is down gradient of the City's landfill site, located 3.5 km north of the well, and is potentially vulnerable to contamination from leachate generated from the landfill. The potential for landfill leachate to contaminate PW607 was inferred from monitoring of the landfill conducted by the Regional District of Fraser-Fort George. Furthermore, design flows from PW607 are inadequate for projected water demands of the Hart area.

In addition to providing adequate supply for the Hart area, the proposed Fishtrap Island Collector Well will provide a backup water supply source to areas of the City south of the Nechako River. A water transmission main proposed to connect the Fishtrap Island Collector Well to the existing pump station at collector well PW605, located approximately 900 m southeast of the proposed Fishtrap Island Collector Well, will allow this function.

5.0 REVIEW OF ALTERNATIVES

5.1 Alternatives to the Project

Potential alternatives to the proposed project would be to either upgrade the existing collector wells, or to develop a surface water intake as a supply source.

5.1.1 Upgrade of Existing Collector Wells

Upgrading of the City's existing collector wells would require removing the existing wells from operation during the upgrade period of approximately six to 12 months. As a result, there would be no means to meet the City's current water demand during the period of construction. Therefore, this alternative was deemed infeasible and did not warrant further consideration.

5.1.2 Surface Water Intake

Because of the high water quality required for municipal drinking water that can be provided by a collector well, a surface water intake on the Nechako River as an alternative to a collector well is not considered feasible. Extracting water directly from a surface source such as the Nechako River would require the installation of a water treatment and filtration plant to maintain a reliable water quality for human consumption. Such a plant would be more costly to construct and considerably more costly to operate than the proposed collector well. The City's municipal water supply is wholly serviced by groundwater wells, due in part, to water quality concerns in the Nechako River. Water quality in the Nechako River is affected by several factors including recreational activity (watercraft), parasites resulting from agricultural runoff, and naturally high levels of turbidity, especially during spring freshet. Furthermore, a direct water intake into the Nechako River would have a detrimental impact on fish habitat at the intake location.

Research conducted in the United States has demonstrated that there is an association between daily fluctuations in drinking water turbidity and subsequent hospital admissions for gastrointestinal illnesses (Schwartz *et. al.* 2000). Drinking water turbidity is commonly used as a proxy measure for the risk of microbial contamination and the effectiveness of the treatment of public drinking water (United States Environmental Protection Agency 1984).

Other research has shown that rainfall events cause increased concentrations of *Giardia* cysts and *Cryptosporidium* oocysts through its influence on turbidity and possibly other unidentified factors (Atherholt *et. al* 1998). Because both coliform bacteria and *Giardia* and *Cryptosporidium* are derived from fecal material from a wide variety of animals, levels of these parasites in surface water are affected by rainfall-induced increases in particulate matter in a similar fashion as coliform bacteria and other fecally-derived micro-organisms.

Due to requirement to treat surface water used for potable supply and the associated relatively high costs, the option of developing a surface water intake from the Nechako River was not considered a feasible or practical alternative for the Hart Water Supply Improvement Project.

5.2 Alternative Means of Performing the Proposed Project

As required by the Canadian Environmental Assessment Agency's *Operational Policy Statement OPS-EPO/2 – 1998* (October 1998), the following section summarizes potential environmental effects associated with technically and economically feasible

alternative means of performing the proposed project. Analysis of alternative means of performing the project provides the basis for selecting the preferred project concept with respect to the following:

- the collector well site location;
- the water transmission main construction methodology and alignment across to the north side of the Nechako River; and
- the construction and maintenance access to the collector well location.

5.2.1 Collector Well Location Alternatives

During 1998, a series of eight (8) test wells were installed on the western portion of Fishtrap Island, west of the BC Hydro powerline right-of-way and east of Foothills Boulevard (Figure 5.1). These test wells are identified as TW 1/98 to TW 8/98, and were used to evaluate potential groundwater drawdown, capture zones, groundwater recharge characteristics, and groundwater quality conditions at the site (IWC 1998, Appendix II). Test wells TW 1/98 to TW 7/98 were completed as small-diameter, nested, observation wells arranged concentrically around TW 8/98, which was completed as a 300 mm test production well; TW8/98 was used for groundwater withdrawal during testing. Based on analytical interpretations from the 1998 test wells, it was determined that Fishtrap Island is ideally suited for development of a collector well. The central large-diameter well, TW 8/98, was located approximately 30 m south of the top of the bank of the Nechako River. In the event that a collector well was developed following this round of testing, the well would have been centered on TW 8/98, bringing the edge of its caisson within approximately 27 m of the top of the Nechako River bank.

During development of this report, in conjunction with more detailed engineering design, the City of Prince George concluded that development of a collector well centered on TW 8/98 was inappropriate. This conclusion was reached based on (1) Golder's hydrogeological analysis that suggested the well capture zone would extend across the river beyond the north bank, (2) setback guidelines of 30 m from Department of Fisheries and Oceans, (3) the proximity of TW 8/98 to the top of the Nechako River bank, and (4) the 50 m setback required by the City's EDPA. On this basis, three collector well location options (Figure 5.2) were evaluated that would place the proposed Fishtrap Island Collector Well in the vicinity of TW 8/98, but at a greater distance from the top of the south bank of the Nechako River. The following options were considered for the location of the Collector Well.

Option 1: 50 m Setback from Top of Bank on Fishtrap Island

Since the test well program in 1998, the City is committed to maintain a minimum 50 m setback from the top of the Nechako River bank for all works associated with the proposed well. This commitment is consistent with the City of Prince George, Official Community Plan, Bylaw No. 7281, 2001 (adopted September 17, 2001) which designates all lands within 50 m of the Nechako River as Environmental Development Permit Areas (EDPA). The purpose of this initiative is to protect and maintain the integrity of the riverbanks and adjacent areas. Option 1, therefore, places the centre of the proposed Fishtrap Island Collector Well 75 m from top of bank, thus keeping the well and any required compound, outside of the required 50 m setback. This setback will avoid undertaking works within the municipally designated EDPA, which includes land that is within 50 m of riverbanks. The proposed setback will also meet DFO's riparian requirements and will allow construction of an access road and fenced compound around the perimeter of the collector well outside of the 50 m buffer along the top of the Nechako River bank.

Option 2: 130 m Setback from Top of Bank on Fishtrap Island

Option 2 locates the collector well considerably further south, approximately 130 m from the top of bank on Fishtrap Island. Option 2 has the following three potential disadvantages:

- its distance from the Nechako River has the potential to reduce flow from the proposed well;
- the distance from the Nechako River increases the potential of encountering groundwater that is lower in oxygen and hence higher in iron and manganese; and
- Option 2 is closer to the Canadian National Railway (CNR) line and in the event of a derailment would afford the City very little reaction time in which to implement protective measures for the well.

Option 3: North Side of Nechako River

The third option considered was to site the collector well on the north side of the Nechako River, north of Fishtrap Island. This option was eliminated from further consideration since there is a risk of groundwater contamination from landfill leachate and from nearby gravel mining operations along Foothills Boulevard. As indicated

above, one of the reasons for developing the proposed collector well on Fishtrap Island was to enable the existing production well at PW607 to be removed from active production because it is potentially vulnerable to contamination from the City's landfill.

Selection of Preferred Option for the Collector Well Location

Based on the above evaluation of alternative locations for the collector well, the site on Fishtrap Island, described as **Option 1**, was selected as the preferred location based on the following factors:

- ensures the proposed well and its associated compound is outside of DFO's riparian requirement on Fishtrap Island;
- maintains a 50 m vegetated buffer between the Nechako River and the north side of the collector well compound and is therefore outside of the EDPA;
- minimizes disturbance to trees and other vegetation, as it is located in a small clearing and can be accessed from the already cleared BC Hydro powerline right-of-way; and
- provides the greatest degree of protection from potential sources of contamination from the south (CN railway) and from the north (gravel mining operations and landfill), within the constraints of the EDPA to the north and the railway to the south.

Additional testing of Preferred Option 1

To confirm Option 1 as being an appropriate location, an additional test well program was conducted on Fishtrap Island during the fall of 2002. This test well program verified satisfactory groundwater quality and recharge characteristics approximately 75 m from the top of bank, and south of the original TW 8/98 test well (IWC 2003, Appendix II). The site of the proposed collector well is shown as Option 1 on Figure 5.2.

5.2.2 Water Transmission Main Routing Alternatives

The following three alternatives were considered for crossing the Nechako River with the proposed northward 750 mm diameter water transmission line.

Option 1: Suspending the Pipeline from the Existing Foothills Boulevard Bridge

A structural evaluation of the Foothills Boulevard Bridge was undertaken by Earth Tech Inc. (Earth Tech) to assess its ability to safely support an operating 750 mm diameter water main.

In reviewing the original design of the bridge, Earth Tech noted that provisions for a large-diameter pipeline utility had been made in the bridge design, including 800 mm diameter block-outs in the abutment ballast walls and pier diaphragms with threaded inserts in the underside of the deck. Based on comprehensive structural analysis, Earth Tech has confirmed that the existing bridge can adequately withstand the additional loads and stresses from the proposed operating 750 mm diameter, steel, water transmission main routed through the existing block-outs.

As part of their analysis, Earth Tech has confirmed that the water transmission main will not be an impediment to navigation because it will be installed within the existing bridge structure and will not hang below the profile of the existing bridge.

Option 2: Horizontal Directional Drilling (HDD) Installation of the Pipeline Beneath the Nechako River

A geotechnical assessment of the subsurface conditions beneath the bed of the river was undertaken by Amec Earth & Environmental Ltd. (AMEC) to evaluate the technical feasibility and risks associated with utilizing horizontal directional drilling (HDD) for installing the water transmission pipeline beneath the Nechako River.

Based on AMEC's geotechnical assessment, the following technical concerns were identified with respect to HDD beneath this reach of the Nechako River:

- Directional drill holes are typically drilled using mud-rotary techniques. Highly permeable soils, as are found under the Nechako River, are prone to circulation losses of the drilling fluid. This can result in an inability to clean cuttings from the borehole and/or loss of support of the borehole walls, leading to borehole collapse. In addition, large quantities of water flowing into the borehole, from the permeable soils, can thin the drilling mud, impairing their ability to build a mud cake on the borehole walls and/or transport cuttings out of the borehole. These potential problems result in a relatively high potential for drilling fluid blowout/ leakage from the HDD into the Nechako River, regardless of the depth of the drill path below the river bottom. Furthermore, these potential problems also decrease the chance of successfully crossing the Nechako using HDD.

- Relatively large containment areas would be required to handle drilling fluids, potentially affecting park use on Fishtrap Island within the riparian area of the Nechako River.

- Boulders and cobbles have been identified in the area where HDD would be conducted. If encountered, they could prevent reaming of the borehole by jamming the reamers and may prevent further drilling by falling into the borehole path.

- Loose sediments in the area may collapse due to poor stability.

- Relatively large excavations would be needed at both the pipeline drill entry and exit points, resulting in greater environmental disturbance and expense.

- The nearby BC Hydro powerlines, parallel to the direction of the drill path, have the potential to interfere with the directional drill control instruments.

- Estimated costs to install the water transmission pipeline via HDD under the Nechako River could range from $1 million to $1.8 million.

In summary, HDD is costly and carries with it relatively high environmental risks. Furthermore, there is a higher than average risk of project failure.

Option 3: Open Trench Excavation of the Pipeline Across the Nechako River

Golder considered the regulatory requirements and risks and principal placement issues associated with installing the proposed 750 mm diameter water transmission main via open trench. Of the three options considered for this pipeline, this alternative was deemed to be the least favorable based upon the following considerations:

- Excavation of an open trench within the Nechako River would result in a harmful alteration, disruption, destruction of fish habitat (HADD), through direct loss of rearing habitat, temporary obstruction of flows, and water quality degradation.

- Harmful alteration, disruption, or destruction of aquatic habitat would require preparation of a detailed habitat compensation plan, which would be subject to review and authorization by DFO under Section 35(2) of the federal *Fisheries Act*.

- Any habitat compensation plan would need to satisfy DFO's no-net-loss principle, contained within the *Policy for the Management of Fish Habitat* (DFO 1986), which may be technically difficult to achieve.

- Design and construction of any compensatory habitat would be subject to, among other things, post-construction monitoring, surveillance, and reporting to evaluate the success of compensatory habitats. This would entail long-term additional costs, especially if the success of the compensatory habitat was deemed to be inadequate, and needed to be reconstructed.

- Open trench excavation would be subject to restrictions imposed for managing flows and water quality during construction, as well as restrictions on periods of the year when instream works could be undertaken to minimize direct impacts on anadromous and resident fish populations, including red-listed sturgeon.

- Open trench excavation would need to minimize, or avoid, potential impacts to navigation and boat traffic, and would likely be subject to an Approval under Section 5 of the *Navigable* Waters *Protection Act* by the Canadian Coast Guard.

- Installing the water transmission main would need to address hydrological issues to ensure that the pipeline has sufficient protection from river scour and erosion. This would require detailed river engineering modelling and analysis, again at additional costs.

- A trenched pipeline could not be placed very deep below the riverbed. Hence, to ensure that it did not become exposed, long-term maintenance and monitoring would be required to protect the integrity and safety of the pipeline from hydrological changes.

- Costs associated with an open trench excavation and associated water management, monitoring, and mitigation measures would likely exceed those associated with installing the pipeline within the bridge structure, although they would probably be less than those associated with the HDD option.

On the basis of the above considerations, the option of installing the water transmission pipeline via open trench has been eliminated from further consideration, recognizing that there are other technically and economically feasible options.

Selection of Preferred Nechako Water Transmission Main Crossing Alternative

Based on the above evaluation of alternative means of installing the water transmission main across the Nechako River, the option deemed to be the most technically and economically feasible is installation of the water transmission main within the Foothills Boulevard Bridge structure.

With the exception of approximately 100 m of water transmission main leading to PW607 that would be installed within the Road allowance approaches to the Foothills Boulevard Bridge, the preferred proposed water transmission pipeline will entirely be outside of the 50 m setback from the Nechako River. The installation within the setback may trigger an Environmental Development Permit in accordance with the City's Official Community Plan depending on the final alignment of the water transmission main determined at the detailed design stage of the project. The construction of the water transmission line will follow an existing gravel road to the Foothills Boulevard Bridge. The selected option is considered to be the least environmentally intrusive and should minimize potential impacts to aquatic, terrestrial, or cultural resources.

5.2.3 Access Road Alternatives

The following two alternatives have been considered for accessing the Fishtrap Island Collector Well during both construction and operation phases of the project (Figure 5.3):

- upgrading and utilizing the existing access road parallel to the south side of Fishtrap Island leading from Ospika Boulevard; and/or

- developing a new off-ramp from Foothills Boulevard that would connect with the existing gravel road that parallels the south side of the island.

For both scenarios, access to the collector well site would be along the existing cleared BC Hydro powerline right-of-way, and then westward to the well location. Tree clearing required to access the collector well site would generally be limited to a 20 m wide corridor from the BC Hydro powerline right-of-way (Figure 5.3). This access corridor is more than 50 m from the top of bank of the Nechako River, and therefore, outside of the DFO's riparian requirement and the City's EDPA.

Option 1: Access to Collector Well from Ospika Boulevard

Use of the existing 1 km long gravel road that parallels the south side of Fishtrap Island for construction access would require upgrade of the road to allow passage of heavy

construction equipment. Typically, the access road would be upgraded using clean granular pit run to a width of 6 m. Although the design of the access road is not yet complete, it would typically have 2:1 side slopes and ditching for drainage control. During construction, silt fencing would be installed along the toe of the road next to the surface drainage ditch to minimize the release of suspended sediments into the roadside drainage ditch.

It is also anticipated that the existing culvert that conveys flow from the back channel beneath the access road during periods of high water may need to be replaced with larger diameter culverts, especially if the road needs to be widened at this location.

Potential environmental and safety issues associated with using the existing road on Fishtrap Island as the primary construction and permanent access to the collector well are as follows:

- the need to improve and/or upgrade the existing culvert where the back channel crosses beneath the road, necessitating limited instream works (albeit during dry periods);

- the route brings construction traffic through residential areas along Otway Road and Ospika Boulevard, resulting in potential safety, noise, and dust issues;

- construction traffic would need to use the existing, level crossing over the Canadian National Railway (CNR), resulting in potential safety conflicts with trains;

- operations and maintenance personnel crossing the existing CNR crossing once the project is constructed, also resulting in potential safety conflicts with trains; and

- operations and maintenance personnel would be unable to access the facility in a timely manner during an emergency at the collector well for instance when a long train is passing through the crossing or in the event of a derailment at the crossing.

Option 2: Access to Collector Well from Foothills Boulevard

The other access option would be construction of a new off-ramp from Foothills Boulevard to tie into the existing gravel road that parallels the south side of the island.

The gravel road would then lead to the BC Hydro powerline right-of-way. Access to the off ramp could be from a deceleration and turn lane leading onto Fishtrap Island from Foothills Boulevard, or alternatively, from a controlled intersection with a 90 degree turn from Foothills Boulevard.

The benefits of establishing a new access ramp onto Fishtrap Island from Foothills Boulevard for construction and maintenance of the collector well are as follows:

- it would provide approximately 500 m shorter travel distance to the collector well site than the Option 1 route;

- it would greatly reduce the requirement for construction traffic to travel through residential areas and eliminate the need to cross over the CN railway line; therefore, afford greater safety benefits, while reducing the impact on residents in the area; and

- development of this access corridor from the west would provide an alternate egress/access route to the collector well site in the event of an emergency, especially if there was a train blocking access to Fishtrap Island.

Other issues related to Accessing the proposed Collector Well

Regardless of the access option selected, it will be necessary to maintain an unobstructed construction access route to the collector well during installation of the proposed 750 mm diameter water transmission pipeline leading to the existing PW605 production well. It is proposed that this water transmission pipeline will be constructed within the alignment of the existing access road.

Construction access to and from Fishtrap Island could potentially pose safety risks. Therefore, it will be necessary to consider strategies for minimizing the potential for accidents associated with construction traffic entering and leaving Foothills Boulevard. These may include, but are not necessarily limited to, the following:

- traffic control; and

- placing restrictions to right-hand turns only for accessing and/or departing Foothills Boulevard from Fishtrap Island.

Selection of Preferred Access Alternative

Based on the above discussion of alternative means of accessing the Fishtrap Island Collector Well site, it is likely that access from both the east (i.e., from Ospika Boulevard Road) and from the west (i.e., from Foothills Boulevard) will be required (Figure 5.3). Therefore, the project includes both the following:

- upgrading of the existing access road leading from Ospika Boulevard, parallel to the south side of Fishtrap Island, to the collector well site; and

- construction of a new access road/ramp leading from Foothills Boulevard.

Figure 5.4 shows all of the project components together.

6.0 PROJECT COMPONENTS

6.1 Preliminary Engineering Concept

The operating concept for the proposed Fishtrap Island Collector Well project is to provide a water supply and transmission system that will supply the water supply requirements of the Hart-Nechako area and also provide a backup and supplementary water supply source for Pressure Zone 2.

The Fishtrap Island collector well pump station will pump to the Hart-Nechako pressure zone through a 750 mm diameter water transmission main installed across the Foothills Boulevard Bridge, north along Foothills Boulevard to the existing booster station PW607 located at Foothills Boulevard and North Nechako Road.

Pressure Zone 2 will be supplied from the proposed Fishtrap Island collector well through a proposed 750 mm diameter water transmission main installed south and east across Fishtrap Island to the existing water transmission main that ties into the Zone 2 well and booster station, PW605.

The described project would consist of the following components:

- development of the Fishtrap Island collector well and pump station (the collector well will consist of an approximately 33.5 m deep caisson, approximately 6 m in diameter, with 24 to 36 lateral well screens projected outwards into the aquifer, from the base of the collector well, up to 46 m from the caisson perimeter) (Figure 6.1);

- installation of the 1.9-km long, 750 mm diameter water transmission main north across the Nechako River along Foothills Boulevard to the existing production well PW607 (Pressure Zone 1);

- installation of a 0.7-km long, 750 mm diameter water transmission main to Pressure Zone 2 at PW605 south and east of Fishtrap Island;

- installation of a disinfection and fluoridation system;

- installation of an electrical power supply line leading from the existing BC Hydro powerline to the collector well;

- installation of a diesel generator for back-up power supply;

- installation of sentinel wells to serve as monitoring points for potential sources of groundwater contamination; and

- development of access roads required for construction and operation of the facility.

Although outside of the scope of the currently proposed project, the City of Prince George may eventually expand the Hart Water Supply Improvements Project to include a future reservoir and booster station north of PW607 and south of the existing Vellencher Reservoir (Figure 6.2).

6.1.1 Sentinel Wells

Sentinel wells will be located around the proposed Fishtrap Island Collector Well with the intent of providing a means of early detection of groundwater contaminants approaching the well from the periphery of the capture zones created at different well flow rates. The City is presently commissioning a study to determine the preferred locations of these wells, optimum sampling suites and monitoring frequency. At the present time it is assumed that the wells would be constructed of nominal 2 inch well tubing of appropriate materials with 1.5 m well screens set at a depth equal to that of the proposed Fishtrap Island Collector well (approximately 30 to 35 m) and approximately halfway between the collector well depth and the water table. The surface section of the monitoring wells (to a depth of between 3 and 6 m) would be grouted to obviate the potential for contaminants to short circuit down the well to the water table and the above ground portion of the nested installations would be protected by robust lockable steel casing protectors firmly cemented, or driven, into place.

A contaminant inventory has been conducted for businesses or historical locations that have the potential to place contaminants in the groundwater (Golder 2003); to provide preferential pathways for contaminants to reach the subsurface and in particular the groundwater; and to identify transportation corridors that represent a significant threat to the proposed Fishtrap Island Collector Well. A review of this inventory, as it pertains to the proposed Fishtrap Island Collector Well is provided in Section 9.1.1 of this report. In addition to this contaminant inventory, numerical groundwater flow modelling presented in Golder (2003) provides an indication of flow paths to the proposed Fishtrap Island Collector Well both in the horizontal plane and in any required vertical sections. The combination of these two pieces of information provide an indication where sampling points (the screened intervals of the sentinel wells) should be placed to maximize the probability of intercepting contaminants. In addition, analysis of travel time zones (generally 60 days and one year) provides an indication of the distance that sentinel wells should be placed from the proposed Fishtrap Island Collector Well to maximize the available reaction time between a contaminant being detected and reaching the collector well. It is intended that the reaction time would be sufficient for the City to take remedial measures to protect the proposed Fishtrap Island Collector Well.

In general, under any well operating conditions, up to the maximum well capacity, of 93 200 m^3/day, potential static sources of contamination are not within its capture zone. Potential contaminant pathways are, however, provided by the test wells installed for the collector well. Furthermore, at the maximum design flow rates a gravel pit to the east of the proposed Fishtrap Island Collector Well is within its capture zone, as are transportation corridors such as the CN Rail line and Foothills Boulevard. The CN Rail line being within the 60-day travel time zone and the Foothills Boulevard being within the one year travel time zone.

Final Sentinel Well network design will, therefore, consider the following:

- the design of individual sentinel wells;
- the likely groundwater flow-lines along which contaminants would travel and hence the paths along which the sentinel wells should be set;
- the distance along those path lines that the sentinel wells should be placed from the proposed Fishtrap Island Collector Well;
- contaminants that should be tested for (or surrogates or indicators of those contaminants); and

- the frequency of monitoring.

At this time it is envisaged that there would be between 3 and 6 nested (well screens at two elevations in the water table) monitoring wells associated with the Fishtrap Island Collector Well and that the monitoring frequency would be between every two months and quarterly for selected surrogates of the potential contaminants of concern for sentinel wells protecting the 60 day travel time zone and ½ yearly for sentinel wells protecting the 1 year travel time zone. The final sentinel network design will refine these preliminary estimates.

6.2 Production Capacity and Size

Based on recent and ongoing pumping tests by IWC, it is estimated that the proposed groundwater collector well will be capable of flow rates of up to approximately 93 200 m^3/day (1079 L/s, or 34 million m^3/year). All of the groundwater withdrawal requirements are met by immediate recharge from the Nechako River; hence, the proposed withdrawals will not result in extensive or long-term declines in the water table in the Lower Nechako River Aquifer. The details of testing are provided in Appendix II. Description of the hydrogeological setting and aquifer modelling are provided in Section 9.0.

6.3 Proposed Works to be Undertaken

This section describes the following:

- construction procedure for the collector well;
- clearing, excavation, backfilling activities for ancillary facilities; and
- procedures and precautions to be taken during initial testing and commissioning of the newly installed collector well and water transmission mains to ensure that chlorinated water is not discharged into the Nechako River.

6.3.1 Construction Phase

The method used to construct the collector well obviates any requirement for dewatering until the caisson is essentially complete; thus the issue of a continuous flow of water from dewatering operations, during the relatively lengthy construction of the caisson, is avoided. The deepest part of the caisson is cast on surface first, immediately above the

proposed caisson center. Ports for projecting lateral casings and well screens, and a steel drive shoe, are included in the initial casting. The subsoils are then excavated from inside and under the caisson using a clam bucket. The caisson is then successively cast (slip-formed) and sunk into position to a depth of approximately 30 m below grade. Excess excavation spoil will be trucked away for offsite disposal. These materials may be temporarily stockpiled on the ground surface, with limited potential for the release of elevated levels of sediment-laden runoff to the Nechako River. Once the caisson has been sunk, a bottom plug is cast in the wet and allowed to set. The caisson is then dewatered.

Prior to dewatering the caisson for the first time, the pH of the water in the caisson will be tested and adjusted if necessary. The caisson water will be discharged to the ground and allowed to infiltrate.

Once the caisson has been constructed, lateral casings are projected into the formation through the ports installed in the base of the caisson. During casing projection, sand and gravel is mucked out from the bottom of the caisson. Well screens are then sized to the material encountered during casing projection and are pushed out the full length of the casings. Once the well screens are in place the projection casing is withdrawn and re-used, exposing the well screens to the formation. The well screens are then developed, by allowing formation water to flow into the well.

Once the well is completed, it will be tested for approximately two to three weeks. Testing typically consists of one to two days of step draw down testing (i.e., pumping the well at ever increasing flow rates up to its design flow rate). This is followed by testing the well at a constant flow rate that is typically at, or close to, its design capacity. During the pumping tests, the response of the aquifer is measured in surrounding observation wells. Water discharged during the pumping test is typically released to the river. In a properly constructed well, this water will be clear and essentially free of turbidity, and at this location, the water quality will be close to that of the river.

To minimize the potential for the discharge of elevated levels of suspended solids from the site into the Nechako River, the City of Prince George will install sediment control measures around the perimeter of the work area. The details of the sediment control measures will be developed during the detailed design phase of the project; however, the measures will likely include construction of settling ponds and placement of either silt fences keyed-into the subsurface with clean drain rock or construction of a protective berm around the worksite. The temporary protective berm may be constructed of hay-bales, concrete lock blocks, or excavation material covered in a geotextile or filter fabric.

The temporary berm will be removed upon completion of the construction of the collector well.

Measures will be taken during the pumping tests to ensure that the groundwater discharged to the Nechako River does not erode the riverbank or the river bottom. These measures might include discharging the water far enough away from the bank that it drops into deeper water or temporary erosion control measures on the bank such as plywood sheeting or geotextile-lined watercourses.

Construction and operation of the Fishtrap Island Collector Well project is not anticipated to generate substantial quantities of solid, liquid, or gaseous wastes. Construction-related wastes will be limited to residual quantities of waste concrete associated with the caisson construction; sand and gravel excavated from the caisson; and sand and gravel recovered in the caisson during projection of lateral casings and development of lateral well screens. Residual concrete will be retained in the concrete mixer trucks and returned to the batch plant, so that no waste concrete will be disposed of or discharged onsite.

As indicated above, principal infrastructure upgrades associated with construction of the Fishtrap Island Collector Well are the construction and operation of the following two 750 mm diameter water transmission mains.

- A water transmission main to service the Hart Water Supply Area leads northward across the Nechako River for a distance of approximately 1.9 km to an existing pump station. The pump station is located adjacent to the conventional vertical well PW607, near the intersection of Foothills Boulevard and North Nechako Road. It is proposed that PW607, following installation and commissioning of the water transmission main from the Fishtrap Island Collector Well, will be maintained for use only during emergencies.

- The second water transmission main would allow the Fishtrap Island Collector Well to serve as a back-up supply for the southern part of the City. It will lead southwest towards an existing pump station adjacent to an existing collector well PW605 and tie-in to an existing water transmission main that leads from PW605 (rather than connecting within the pump house area), approximately 900 m southeast of the Fishtrap Island Collector Well site. The actual site of the tie-in point has not been determined.

The following summarizes the sequence of activities associated with the trench excavation required for the proposed 750 mm diameter water transmission mains leading from the Fishtrap Island Collector well to each of PW605 and PW607.

- Post signs to notify the public of impending work at both ends of construction zone and secure the area to ensure that there is no risk to public safety within the work zone.

- Establish work edge boundary with flagging tape, high visibility snow fence, or other suitable means where required. As indicated below, several mitigation measures are proposed for working near environmentally sensitive areas, which include installation of high visibility snow fencing where the existing gravel access road crosses the back channel.

- Establish sediment and erosion control measures and spill prevention strategies as required.

- Strip and stockpile topsoil and vegetation along the corridors for each water transmission main.

- Isolate flows and/or standing water, particularly where the existing gravel access road on Fishtrap Island leading to PW605 crosses a constricted portion of the back channel, utilizing either a flume supported with sandbags, or some other alternative means such as a pump and sandbags to divert flows and maintain downstream water quality and unrestricted flows.

- Excavate a trench for each water transmission main to the required depth.

- Place excavated soils parallel to each trench, and cover the soils with polyethylene sheeting or tarpaulins to minimize the potential for release of sediments in the event of precipitation.

- Visually inspect excavated soils for potential signs of contamination, and separate and remove any visibly contaminated soils offsite.

- Assemble the pipe sections alongside each of the two trenches.

- Install the assembled water transmission mains into the excavated trench in sections using side-boom dozers, or excavators with slings, in accordance with the contractor’s construction plan.

- Inspect weld joints via radiographic techniques, and repair and coat as required.

- Remove polyethylene sheeting or tarpaulins, and replace excavated materials in the trench around the 750 mm diameter water transmission mains.

- Backfill pipeline trenches to grade and compact to the specifications required by the City of Prince George.

- Repair all disturbed or damaged road surfaces along Foothills Boulevard, as required.

- Restore or replace all impacted services to their original condition, as required; and landscape all disturbed areas as required to original conditions.

- Remove temporary facilities (such as pumps, sandbags, flumes, etc.) used to isolate and/or convey flows where the back channel crosses beneath the road leading to PW605.

The City of Prince George is committed to completing the above pipeline assembly, trenching, and backfilling operations along the rights-of-way for each of the two water transmission mains such that the trenches are not left open overnight to create potential environmental or public safety hazards.

6.3.2 Operation Phase

During operation of the groundwater supply system it will be necessary to disinfect the produced water with chlorine to provide a chlorine residual, and to fluoridate the water. The Fishtrap Island collector well will, therefore, have associated disinfection and fluoridation systems. Options for disinfection agents involving onsite hazardous chemical storage include chlorine gas (delivered in cylinders) and hypochlorite (liquid chlorine–like bleach). Typically, chemicals are stored in a limited access vaults within buildings accessible only by authorized, trained personnel. In treatment systems involving chlorine gas, there is an automatic alarm system that provides immediate notification of a chlorine gas leak. City personnel are trained to deal with chlorine leaks up to and including a blown safety plug on a pressurized tank. The latter is considered to be a worst-case scenario. The fire department also has personnel trained to respond to such occurrences. They carry the necessary equipment for addressing such problems on designated fire trucks. In the event of a chlorine leak, response would be by trained personnel following predetermined procedures.

Fluoride is added to the water through a metered drip system. The fluoride is contained in a storage tank with a secondary containment, in case of leak, and transferred from the storage tank to a day tank. In the event of a malfunction, the metered drip system stops the fluoride feed. The system is operated by trained personnel, using pre-determined safety procedures.

6.4 Workforce Requirements

6.4.1 Collector Well

Typically, the contractor's full-time work force varies from four to six people for the caisson construction. The inspection and contract administration work force would vary from two to four people and would consist of hydrogeologists, engineers of various disciplines, and environmental monitors.

The construction time period for a Collector Well is about 16 consecutive months from the start of ground clearing to the completion and testing of the collector well. It is anticipated that the work force would be made up of a specialist collector well contractor, supplemented by local contractors and labourers from the Prince George region.

6.4.2 Water Transmission Line

The anticipated construction work force required for the installation of the water transmission main would typically consist of a construction superintendent, a foreman, at least two pipe layers, and at least one labourer. In addition, heavy equipment operators would likely include two excavator operators and dump truck drivers as required.

The inspection and contract administration workforce would typically consist of a full-time resident engineer and part-time geotechnical and environmental inspectors.

The construction duration for the installation of the water transmission mains is approximately 6 months from the start of construction to the final commissioning and tie-in to the existing water system. It is anticipated that the work force could be comprised entirely of local forces from the Prince George region.

6.5 Maps of Project Location

Maps of the project location provided in this report include the following:

- key plan of project area (Figure 1.1);

- site plan showing test collector well and surrounding locations (Figure 2.3);
- project as proposed (Figures1.3 and 5.4);
- configuration and boundaries of Lower Nechako River Aquifer (Figure 2.1); and
- typical collector well schematic (Figure 6.1).

6.6 Layout of Project Components

Figures 1.3, 5.3, 5.4, and 6.2 depict the configuration of project components relative to other nearby geographical features.

7.0 CONSTRUCTION PLAN AND TIMETABLE

Table 7.1 provides a preliminary schedule of the construction activities associated with the project. In addition, the proposed schedule and duration of major construction activities is illustrated in Figure 7.1.

Table 7.1 Preliminary schedule of the construction activities

2003	Complete Application for Environmental Assessment Certificate (EAC) for BCEAA review, and Comprehensive Study Report for CEAA review
2004	Complete Detailed Design of Collector Well, Pump Station, and Water Transmission Main
2004	Construction and testing of Collector Well and Pump Station
2005	Construction of Water Transmission Mains leading from Fishtrap Island to existing production wells PW607 and PW605

8.0 PUBLIC WORKS OR UNDERTAKINGS

8.1 Collector Well

Three collector well location options were evaluated, which would place the proposed Fishtrap Island Collector well in the vicinity of TW 8/98, but at a greater distance from the top of the south bank of the Nechako River. The preferred option was to construct the collector well 75 m from top of bank of the Nechako River on Fishtrap Island. Since the

collector well work in 1998, the City has decided that they wish to maintain a minimum 50 m setback from the top of the Nechako River Bank for all works associated with the proposed well. The proposed setback will avoid undertaking works within the municipally designated EDPA that includes land that is within 50 m of riverbanks. The proposed setback will also meet DFO's riparian requirements and will allow construction of an access road and fenced compound around the perimeter of the collector well outside of the 50 m buffer along the top of the Nechako River bank.

To confirm this option was feasible, an additional test well program was conducted on Fishtrap Island during the fall of 2002. This test well program verified satisfactory groundwater quality and recharge characteristics approximately 75 m from the top of bank, and south of the original TW 8/98 test well (IWC 2003).

8.2 Electrical Power

Electrical power is required to operate the well pumps and ancillary systems. An electrical power supply line leading from the existing BC Hydro powerline to the collector well will be installed.

8.3 Water Transmission Lines

Three alternatives were considered for crossing the Nechako River with the proposed northward 750 mm diameter water transmission line. The preferred option was suspending the pipeline from the existing Foothills Boulevard Bridge. In reviewing the original design of the bridge, it was noted that provisions for a large diameter pipeline utility had been made in the bridge design, including 800 mm diameter block-outs in the abutment ballast walls and pier diaphragms and threaded inserts in the underside of the deck. Based on comprehensive structural analysis, Earth Tech has confirmed that the existing bridge can adequately withstand the additional loads and stresses from the proposed operating 750 mm diameter steel water transmission main when routed through the existing block-outs.

As part of their analysis Earth Tech has confirmed that the water main installed within the existing bridge structure, will not hang below the profile of the existing bridge and will not be an impediment to navigation. Installing the water transmission main across the Nechako River within the Foothills Bridge structure was the option deemed to be the most technically and economically feasible. This option is also considered to be the least environmentally intrusive, and it should not result in any substantial impacts to aquatic, terrestrial, or cultural resources.

8.4 Access Roads

Two alternatives have been considered for accessing the Fishtrap Island Collector Well during both construction and operation phases of the project: upgrading and utilizing the existing access road parallel to the south side of Fishtrap Island leading from Otway Road; and/or, developing a new off-ramp from Foothills Boulevard that would connect with the existing gravel road that parallels the south side of the island. It is likely that access from both the east (i.e., from Ospika Boulevard) and from the west (i.e., from Foothills Boulevard) will be required. Therefore, the project includes both of the following:

- upgrading of the existing access road leading from Ospika Boulevard, parallel to the south side of Fishtrap Island, to the collector well site; and

- construction of a new access road/ramp leading from Foothills Boulevard.

Regardless of the access option selected, it will be necessary to maintain an unobstructed construction access route to the collector well during installation of the proposed 750 mm diameter water transmission main leading to the existing PW605 production well. It is proposed that this water transmission main will be constructed within the alignment of the existing access road.

9.0 EXISTING SITE CHARACTERISTICS AND CONDITIONS

This section provides a description and characterization of the project setting in terms of relevant physical, biological, cultural, and economic and social disciplines. Based on this description of existing site conditions, Section 10.0 provides an evaluation of potential environmental effects associated with the construction and operation of the Hart Water Supply Improvement Project. Section 14.0 describes recommended mitigation measures to be taken during construction and operation of the project to minimize, and where possible avoid, potential adverse effects.

9.1 Physical Characteristics and Conditions

The following section provides an overview of the physical characteristics and conditions of the project area. Much of the information presented below on the hydrogeological setting was derived from the report prepared by Golder (2003). In other instances, the relevant reports are simply referenced.

The following physical characteristics of the project area that are discussed here include the following:

- hydrogeological characteristics of the Lower Nechako River Aquifer;
- hydrological characteristics of the Nechako River;
- active wells and water licences; and
- climatic characteristics.

9.1.1 Hydrogeological Characteristics of the Lower Nechako River Aquifer

All of the wells relevant to the analysis of the impact of the proposed Fishtrap Island Collector Well are completed in the alluvial deposit of the Nechako River Fan, which is the eastern extent of the Lower Nechako River Aquifer. The Nechako River Fan is triangular in outline (Figure 2.2) and has been deposited in a bowl eroded into the formations of the Interior Plateau at the confluence of the Nechako and Fraser rivers. The elevation of the fan is approximately 580 m ASL. Its apex lies to the northwest of the City of Prince George, where the Nechako River Fan starts to form as the Nechako River discharges into the Fraser River. The sides of the triangular fan are bounded approximately by the generally west to east flowing Nechako River to the north (8 km long), the southwest flowing Fraser River to the east (6 km long) and the northwest to southeast orientated base of Cranbrook Hill to the southwest (14 km long).

Bedrock Geology

Apart from providing a framework in which the Nechako River Fan and Lower Nechako River Aquifer lie, the bedrock geology of the study area has little effect on the local groundwater flow regime; therefore the bedrock geology is described only briefly.

Two main bedrock units underlie the Prince George region: fine clastic sedimentary rocks and a suite of volcanic rocks, both of the Triassic-age Takla Group (BC Geological Survey website and Wheeler and McFeely 1991). The younger (upper Triassic) volcanics lie in a broad northwest to southeast striking band, generally south of the Nechako River and extending westerly from the east side of the Fraser fault system which parallels the Fraser River, several kilometres to its east. Upper to middle Triassic age sedimentary facies consisting of mudstone, siltstone, and shale, lie to the northeast of the volcanics. An inlier of young alluvial deposits (Cenozoic age Fraser River sediment), consisting of poorly consolidated conglomerate, sandstone and mudstone, with local

lignite, tuff, breccia, and diatomite is present along the Fraser River Valley, extending both north and south from its confluence with the Nechako River.

Surficial Geology

The surficial geological formations contain the significant water-bearing unit relevant to this study: the Lower Nechako River Aquifer (Figure 9.1 through Figure 9.4). The sections provided in Figures 9.1 to 9.4 were based principally on McCallum (1969). These figures show the plan view of the surficial geology and sections through the Nechako (Figure 9.2, A-A, and Figure 9.3, B-B) and the Fraser rivers at the south end of the fan (Figure 9.4, C-C). Details of the surficial geology associated with the Nechako and Fraser rivers that occur substantially above the water table were not considered in the development of the groundwater model. As can be seen in the figures and as described above, the outwash fan of the Nechako River (Nechako River Fan) is deposited principally over, and against, bedrock and a veneer of glacial tills. The fan deposits appear to be generally in excess of 100 m thick, which substantially exceeds the depth of most of the water supply wells in the study area. The Lower Nechako River Aquifer is composed almost entirely of material from sand and gravel size up to cobbles and boulders. In general, grain size decreases away from the proximal part of the fan (northwest apex) to the distal fan. This grain size variation reflects the diminishing energy of the depositional environment away from the proximal part of the fan.

The most important contact in terms of surficial geology is the one along the flank of Cranbrook Hill to the southwest of the Nechako Fan. Along this contact, the permeable fan deposits are underlain by low hydraulic conductivity units. The fan deposits are either in direct contact with the Pre-Tertiary bedrock or with till and tertiary sediments that overly the bedrock.

Hydrostratigraphic Units

For the purposes of understanding the hydrogeology pertinent to this application, the formations of the study area can be divided into the following two primary units:

- deposits of the Nechako Fan composed of sand, gravel, and boulders, which diminish in hydraulic conductivity (as a result of the variation in grain size) down the fan axis from the proximal to the distal end; and

- bedrock and till deposits having a hydraulic conductivity low enough to form an effective barrier boundary at the base of the Lower Nechako River Aquifer.

Hydraulic Parameters

IWC evaluated the transmissivity and storage coefficients of the Lower Nechako River Aquifer using pumping tests conducted in the aquifer since approximately 1971. Table 9.1 provides a synopsis of IWC's pumping test interpretations and includes the hydraulic conductivity (*K*) of the aquifer. Contours were constructed from *K* values, calculated at each well site, by dividing the transmissivity by the aquifer thickness (where a saturated aquifer thickness of 46 m is assumed). Figure 9.5 depicts variations in *K* across the aquifer. The hydraulic conductivity decreases from the proximal part of the aquifer to the east downstream along the Nechako River.

Transmissivity values in the vicinity of the proposed Fishtrap Island Collector well were estimated by IWC from a five-day pumping test of test well TW8/98 in 1998 and a 24-hour pumping test of test well TW4/02 in 2002. The results of the pumping test of TW4/02 are presented in IWC's January 21, 2003 report titled *"City of Prince George Environmental Assessment and Preliminary Design Hart/Nechako Water Supply Improvements Investigation to Confirm Collector Well Location"*, and provided in Appendix II for reference purposes. The transmissivity in the vicinity of the proposed Fishtrap Island Collector Well was estimated to range from 19 370 m^2/day to 32 700 m^2/day based on the 1998 pumping test. The results of the 2002 pumping test indicate that locally, within 30 m to 50 m of the test well, aquifer transmissivities were estimated to range from 5700 m^2/day to 7400 m^2/day. However, at distances beyond 30 m to 50 m of the test well, a higher regional aquifer transmissivity of about 19 000 m^2/day was indicated.

As shown on Table 9.1, transmissivity declines from a range of 32 700 to 19 370 m^2/day at the Fishtrap Island Collector Site to about 4000 m^2/day at the Canfor Site, a decline approaching an order of magnitude across the aquifer. In terms of hydraulic conductivity, this is a decline from a range of 710 to 421 m/day to about 83 m/day. Regardless of these declines, all of the hydraulic conductivities encountered in the Lower Nechako River Aquifer would generally be considered to be high and, in conjunction with the nearby recharge boundaries of the river, capable of supplying productive wells.

Table 9.1
Summary of Aquifer Hydraulic Characteristics derived from Aquifer Tests

Site	UTM		Elevation	Q test	Duration	Static Water Level	Pumping Level	Drawdown	Transmissivity	Thickness	Hydraulic Conductivity	Storativity	Aquifer Type
	Eastings	*Northings*	*(m)*	*(m^3 /day)*	*(days)*	*(m)*	*(m)*	*(m)*	*(m^2 /day)*	*(m)*	*(m/day)*		
PW 605	513050	5976600	576.1	69450	3	4.9	7	2.1	11200 - 22300	46	243 - 484	0.12	W.T.
Collector 2	515300	5975100	573.07	87270	3	5.67	11.95	6.3	4100 - 6500	46	89 - 132	0.1	W.T.
PW 601	513750	5975800	571.81	95660	3	1.76	4.06	2.3	14900 - 23000	46	324 - 500		W.T.
TW 8/98 *	512350	5977125	575.3	6550	5	4.85	11.35	6.5	19370 - 32700	46	421 - 710		W.T.
TW4/02 *			574.9	6220	1	5.34		4.5	5700-7400; 19,000	46	124-413		W.T.
Canfor Collector	517100	5975350	570.85	84000	3	6.04	24.54	18.5	3700 - 4000	46	80 - 87		W.T
PW 607	512550	5978800	617	11720	0.06	37.57	38.1	0.53	14900 (approximate)	41	363	0.1	W.T.
TW 1/78	516200	5975150	570.2	6550	3				2175 - 3690	46	47 - 80	0.02 - 0.04	W.T.
PW 624	516250	5968350	568.6	9830	3	8	12.69	4.69	2150 - 2980	15	143 - 198	0.06	W.T.
PW621	516300	5968150	568.4	6550	2	10.09	13.65	3.35	2458	17	144	0.02	W.T.
College heights * well 3 & 4	516300	5968150							2205				W.T.
PW606	517050	5969700		2063	3				600	11	54	0.01	W.T.
B.C. Rail * well 2A/75	516600	5968700		650	0.25	1.1	5.7	4.6	220	13	17	0.01	W.T.
PW 627	517200	5966700	586.5	6910	3	19.51	26.87	7.36	2200 (local)	12	183	4.00E-05	C.A.
Blackburn * well 1/76	522500	5975500	573.7	1362	3	9.52	19.35	9.83	460 (with boundaries) 527	23	23	0.001	C.A.
Chilako TW 1/78	507750	5963250	719.5	2160?		76	84	8	245	38	6.4		W.T.
Autumn Estates	523400	6969550		1749	9	5.2	21.9	16.7	300 - 600 (local) 30 (with boundaries)	19.5	15.4 - 30	0.0001	C.A.
Harmony Well	519100	5967250	670	1911		27.13	27.92	0.78	3665	12.2	300	0.008	C.A. - W.T.

Note: UTM's based on 1:50000 scale mapping and approximate locations
W.T. = water table
C.A. = confined artesian
* Analysis by IWC - remaining sites from other sources

Natural Hydraulic Gradient

The Nechako and Fraser rivers control the natural hydraulic gradient in the Lower Nechako River Aquifer. Under these natural conditions, groundwater is generally recharged along the Nechako riverbank and generally discharges along the Fraser River. Hence, groundwater in the central part of the Lower Nechako River Aquifer is likely to flow from the northwest to the southeast.

It is estimated from river elevation data available from the City's GIS records that the gradient of the Nechako River ranges from 0.4 m/km to 1.7 m/km within the City limits. As noted in the IWC reports, the gradient varies along the Nechako River, with some areas of the river being steeper and riffled and other areas relatively flat. These variations in river gradient are reflected in variations in hydraulic gradient. Measurements of groundwater hydraulic gradients made by IWC were 1 m/km to the southwest for PW605 and 0.6 m/km to the east southwest for the proposed Fishtrap Collector Well site. Data on seasonal variations in groundwater hydraulic gradient are not available. Figure 9.6 presents water table contours predicted by the calibrated model (Golder 2003) under non-pumping conditions. As shown in the figure, groundwater flows nearly parallel to the Nechako River in the vicinity of the proposed Fishtrap Island Collector Well and Wells PW601 and PW605.

Recharge Characteristics

Recharge to the Lower Nechako River Aquifer occurs through infiltration of river water along the base and banks of the Nechako River, infiltration of precipitation falling directly on the ground surface, and infiltration of run-off from the surrounding hills. Withdrawal from the Lower Nechako River Aquifer is rapidly replenished by the Nechako River under the present withdrawal rates of the wells. In extreme cases (not reached in any of the scenarios considered in Golder (2003)), further recharge would be induced from the Fraser River. A quantitative evaluation of aquifer recharge is presented in Golder (2003).

Capture Zone Analysis

An understanding of the well capture zone and the time of travel zones is required to efficiently manage and protect a groundwater supply. Once the capture zone and time of travel zones are estimated, protective measures can be implemented within the zones to ensure the safety of the water supply.

A hydrogeologic model was used to analyze capture zones and zones of travel for the proposed Fishtrap Island Collector well and existing City water supply wells. The results of this analysis are presented in Golder (2003). The analysis involved the development of a conceptual model of groundwater flow based on available geologic and hydrologic information. The conceptual model, including the values for hydrogeological parameters, presented in detail in Golder (2003), is shown in Figure 9.7. The conceptual model was then used to construct a numerical MODFLOW (McDonald and Harbaugh 1988) model for the City. The numerical model represented an area of approximately 150 km^2, covering the entire alluvial fan of the Nechako River and its adjacent boundaries. The model was calibrated to groundwater levels measured during several pumping tests conducted in City Wells.

The capture zones and the zones of travel for the City Wells were delineated using the calibrated groundwater model in conjunction with the MODPATH particle tracking code. MODPATH uses groundwater flow fields computed by the groundwater model as input. It then tracks the pathway or advective transport of imaginary particles through these groundwater flow fields. To estimate the capture zones, imaginary particles were placed around the City Wells and tracked backwards to the well. Capture zones and time of travel zones were calculated for 60-days, 1-year, 5-years and 20-years under four pumping conditions: current pumping rates, projected average pumping rates, projected maximum pumping rates and maximum well capacity. The pumping rates used for these scenarios are summarized in Table 2.1.

Under Condition 1, it was assumed that all existing City wells and the proposed Fishtrap Island Collector Well would operate simultaneously at their present-day average pumping rates. The resultant capture zone for the proposed Fishtrap Island Collector Well is approximately 250 m long and 250 m wide and extends north from the well (Figure 9.8). Most groundwater within this capture zone is predicted to enter the well within approximately 60 days. Under Condition 2, it was assumed that all existing City wells and the proposed Fishtrap Island Collector Well would operate simultaneously at their projected (20-year) average pumping rates. Because of the higher pumping rate assigned to the well, the extent of the capture zone for the Proposed Fishtrap Island Collector Well increased slightly when compared to the extent of the capture zone predicted under Condition 1 (Figure 9.8). Under Condition 3, only wells PW601, PW605 and the proposed Fishtrap Island Collector Well were assumed to be pumping, while the remaining City wells were shutdown. The three operating wells were assigned pumping rates corresponding to the projected (20-year) maximum day demand. Under this simulation, the capture zone for the proposed Fishtrap Island Collector Well is approximately 400 m long and 600 m wide and extends north from the well (Figure 9.8). Most groundwater within this capture zone is predicted to enter the well in less than one

year. Condition 4 is similar to Condition 3, but the three operating wells were assigned pumping rates equivalent to the maximum capacity of each well. Because the estimated well capacity for the proposed Fishtrap Island Collector Well is approximately 100% higher than the 20-year maximum day demand, the extent of its capture zone increased when compared with the predictions for Condition 3 (Figure 9.8).

Intrinsic Vulnerability of the Lower Nechako River Aquifer to Contamination

The assessment of the vulnerability of an aquifer can be made using the MWLAP's *"Aquifer Classification System for Groundwater Management in B.C."* Kreye et al. (undated DRAFT). MWLAP's classification system categorizes aquifers according to level of development and vulnerability sub-classes as follows:

Table 9.2 Level of Development and Vulnerability Sub-classes

Development Sub-class	**I**	**II**	**III**
	Heavy Demand is high relative to productivity	**Moderate** Demand is moderate relative to productivity	**Light** Demand is low relative to productivity
Vulnerability Sub-class	**A**	**B**	**C**
	High Highly vulnerable to contamination from surface sources	**Moderate** Moderately vulnerable to contamination from surface sources	**Low** Not very vulnerable to contamination from surface sources

The sub-classes are then combined to give a Classification Class as follows:

Table 9.3 Classification Class

Aquifer Class	**I**	**II**	**III**
	IA Heavily developed, high vulnerability aquifer	**IIA** Moderately developed, high vulnerability aquifer	**IIIA** Lightly developed, high vulnerability aquifer
	IB Heavily developed, moderate vulnerability aquifer	**IIB** Moderately developed, moderate vulnerability aquifer	**IIIB** Lightly developed, moderate vulnerability aquifer
	IC Heavily developed, low vulnerability aquifer	**IIIC** Moderately developed, low vulnerability aquifer	**IIIC** Lightly developed, low vulnerability aquifer

In addition, the aquifer's priority is ranked using the aquifer ranking components indicated in Table 9.4 below:

Table 9.4 Ranking Components

	Point Value			Rationale
Criteria	**1**	**2**	**3**	
Productivity	Low	Moderate	***High***	Abundance of the resource
Vulnerability	Low	Moderate	***High***	Potential for water quality degradation
Size	< 5 km^2	5 - 25 km^2	***> 25 km^2***	Regionality of the resource
Demand	Low	Moderate	***High***	Level of reliance on the resource for supply
Type of Use	Non-drinking water	Drinking Water	***Multiple Drinking Water***	Variability/diversity of the resource for supply
Quality Concerns	Isolated	***Local***	Regional	Actual concerns
Quantity Concerns	Isolated	***Local***	Regional	Actual concerns

The point values assigned to each of the ranking components for the Lower Nechako River Aquifer in Prince George are indicated on the table of ranking components.

Using the Provincial Aquifer Classification System (Kreye et. al. DRAFT), MWLAP has classified the Lower Nechako River Aquifer as IA (15^2), indicating that it is a heavily developed (I) and has a high vulnerability to contamination from surface sources (A) (resulting principally from the general absence of a confining, low-permeability unit above the coarse alluvial sands and gravels that comprise the Lower Nechako River Aquifer). The aquifer has an overall ranking value of 15 out of a possible score from 5 to 21.

Based on the Classification system outlined above, the Lower Nechako River Aquifer *in the vicinity of Fishtrap Island* is classified as a IIA (moderately developed high vulnerability aquifer) with a score of 19 (as indicated in the "Ranking Components". We have classified the aquifer as subclass II because, despite the high productivity of the wells in Prince George, the aquifer is probably capable of producing significantly more water than it does at the present time. Aquifer scores in BC range from a high of 21 to a low of 6 (Kreye et al. undated DRAFT) and the score of 20 for the Lower Nechako River Aquifer places it amongst the most vulnerable in BC, alongside the Hopington (Ranking

[2] Not the example shown in Ranking Components

Value 21) and Abbotsford (Ranking Value 20) Aquifers in the Lower Mainland, and makes the area somewhat more vulnerable than the overall aquifer classification of 1A (15) estimated by MWLAP would indicate. Based on the information from the test wells placed around the proposed Fishtrap Island Collector Well it is our opinion that the location is likely to be as vulnerable as any other areas in the Lower Nechako River Aquifer in Prince George.

A search of the provincial water well database, maintained on-line by MWLAP, was conducted to identify water wells located in the area of the capture zone for the proposed Fishtrap Island Collector well. The search identified six wells located within the capture zone for the proposed Fishtrap Island Collector well, as defined under the maximum well capacity (Condition 4) (Figure 9.8). A review of the records associated with these wells (Appendix IV) indicates that all of the wells are owned by the City of Prince George and appear to be associated with the 1971 and 1998 testing programs. A review of the logs for the six wells, together with logs from additional test holes presented in the IWC (2003) report indicates that, in accordance with the provincial classification system, the area of the Lower Nechako River Aquifer within the capture zone of the proposed Fishtrap Island Collector Well is characterized by unconfined sands and gravels.

Potential Sources of Groundwater Contamination

A summary and evaluation of potential sources of contamination that may serve as a threat to groundwater quality was conducted as part of study conducted by Golder (Golder 2003). The assessment consisted of a regional contaminant inventory to broadly identify existing and potential sources of contamination across the City, together with detailed contaminant inventories and chemical storage inventories of the capture zones. An overview of the results of the contaminant inventory for the proposed Fishtrap Island Collector Well, within the capture zones delineated under the four different pumping conditions (Table 2.1), is presented below.

Current Capture Zone

Surface water degradation or contamination of the Nechako River may pose a risk to the groundwater quality at the proposed Fishtrap Island Collector Well because the well is ultimately recharged by the river. Ambient surface water quality can be affected by many sources, including upstream effluent discharges from industries, urban runoff and stormwater outfall locations. Specific contamination events can also occur from transportation accidents or pipeline leaks, presumably with a higher risk at designated

transportation crossings. Limited information on the quality of water within the Nechako River is available.

Improperly abandoned wells can provide direct conduits for the migration of surface contaminants to underlying aquifers. In other jurisdictions abandoned wells have been used for the disposal of wastes such as motor oil. Because improperly abandoned wells provide direct pathways to underlying aquifers, their presence may represent a threat to groundwater. Figure 9.9 shows the locations of municipal and private wells within the City, identified using the Ministry of Sustainable Resource Management database. As discussed previously, a number of former test holes, all owned by the City of Prince George, are located within the capture zone for the proposed Fishtrap Island Collector Well. At least one of these wells (a 305 mm diameter well) lies within the capture zone defined under current pumping conditions. If these wells have not been properly decommissioned, they may serve as potential contaminant sources. No private wells were identified within the capture zone of the proposed Fishtrap Island Collector Well.

Projected Average Capture Zone

No additional businesses or areas of concern were identified within the projected average capture zone.

Projected Maximum Capture Zone

Under projected maximum pumping conditions, the CN rail line falls within the 60-day time of travel zone for the Fishtrap Island Collector Well. Potential contaminants associated with the railway include diesel, herbicides, creosote, or sudden release of materials transported by rail due to a spill. Approximately one dozen spills have been reported to the MWLAP by CN Rail, indicating the potential for release. In 2000 and 2001, Methyl Tertiary Butyl Ether (MTBE) represented the largest volume of material transported (over 900 million litres) by CN Rail. In discussion with CN Rail representatives, CN Rail indicated that it intends to discontinue the transport of MTBE over the next few years (Golder 2003).

The City of Prince George's Utilities Division is planning to meet with CN railway's environmental personnel to discuss environmental issues and best management practices with respect to the application of herbicides for weed control, creosote for track maintenance, as well as train speed within or near the capture zones of PW601, PW605, and the proposed Fishtrap Island Collector Well (D. Dyer, Manager, Infrastructure Planning, City of Prince George, B.C. pers. comm.). The City will be requesting that CN commit to avoiding herbicide spraying with the capture zones of the existing wells and

Fishtrap Island Collector Well and the use of creosote be explored further (D. Dyer, Manager, Infrastructure Planning, City of Prince George, B.C. pers. comm.).

Foothills Boulevard lies within the one-year time of travel zone for the proposed Fishtrap Island Collector Well. This transportation corridor is categorized as an arterial road. Potential contaminants associated with this corridor may include the release of hazardous materials through spills or accidents, or the possible introduction of stormwater discharges.

Maximum Well Capacity Capture Zone

Two areas of surface excavation intersect the modelled 1-year travel time zone for the proposed Fishtrap Island Collector Well under maximum well capacity. A small portion of one excavation area is within the 60-day travel zone. Both mining operations were located south of Ospika Blvd. and adjacent to Foothills Blvd., one to the east and west, respectively. Sand and gravel extraction operations, both active and historical, may represent potential sources of groundwater contamination. As part of active excavations, hazardous materials are generally stored on-site, including gasoline, diesel, solvents and waste oils. Surface excavations remove ground cover, which causes contaminant transport times to the groundwater to be reduced. In some cases, old and abandoned excavations are used as dumping or landfill areas.

It is understood that the gravel extraction operation to the east is no longer active. The property to the west of Foothills Blvd. is registered in the MWLAP contaminated sites registry. Contaminated soil was discovered during the removal of underground storage tanks (USTs) containing diesel fuel and gasoline. However, the USTs were likely positioned on a portion of the property located outside of the capture zone. The USTs would also likely be positioned outside of the capture zone for maximum well capacity pumping conditions (Golder 2003).

Table 9.5 presents a summary of the key contaminant risks that were identified from the regional, detailed, and chemical inventories within the capture zone for the proposed Fishtrap Island Collector well. The table provides an assessment of the relative risk to the aquifer under long term loading and in the context of a sudden release or spill. A risk is composed of a hazard and a consequence. In this case, contaminant sources have been ranked in terms of their ability to act as a hazard. The proximity of the wellhead, as measured by the travel time for current pumping conditions, has been used to assess the consequence. Therefore, a source that is a high hazard and is in close proximity to the wellhead will provide the greatest relative risk to the aquifer.

Table 9.5 Key Contaminant Risks to the Capture Zone for the Proposed Fishtrap Island Collector Well.

Contaminant Source	Long-term Loading Risk	Sudden Release Risk
Chemical Storage	Low to Medium from incidental releases on residential properties and a sand and gravel extraction operation.	Low to medium from spills or leaks on residential properties and a sand and gravel extraction operation.
Existing Contamination (CSR Sites)	Low from existing contamination on a sand and gravel operation.	Not Applicable.
Abandoned Water Supply Wells	Medium from Incidental Release.	Not Applicable.
Transportation of Dangerous Goods	Low to Medium from incidental releases along roadways and rail line.	High from spills or leaks.
Sand and Gravel Extraction	Low to Medium from incidental release within extraction areas.	Medium from spills or leaks within extraction areas.
Surface Water Influences	Medium from ambient water quality (risk can be better defined with recommended studies).	Medium to high from spills or accidents on the Foothills Bridge.

Source: Golder 2003

Groundwater Quality

Investigation of water quality at the proposed location of the Fishtrap Island Collector Well was conducted by International Water Consultants Ltd. (IWC). As part of the assessment, three small diameter test wells (TW 1/02, TW2/02 and TW3/02) and one large diameter test well (TW 4/02) were installed near the location of the proposed Fishtrap Island Collector Well (IWC 2003, Appendix II). A 24-hour pumping test was conducted on TW4/02 at a pumping rate of 72 L/s, followed by 6 hours of recovery (IWC 2003). Water samples were collected from TW1/02, TW2/02, TW3/02 and TW4/02, together with test wells TW2/98, TW3/98 and TW4/71, during the testing in November 2002, and chemical analysis was conducted by ALS Environmental.

Water quality analysis from the small diameter test wells indicated low hardness and generally low iron and manganese. However, some iron and manganese variation was observed between each well, which likely reflects variable amounts of turbidity and sediment produced from the undeveloped test wells (IWC 2003). Specifically, iron was found at concentrations above the Guidelines for Canadian Drinking Water Quality (Sixth Edition, 1996, with revisions on Health Canada website, 2002) in three small

diameter test wells, and manganese, colour and turbidity were found above the Guidelines for Canadian Drinking Water Quality in one test well. Excellent water quality, with low hardness and non detectable iron, manganese, and coliform bacteria, were observed in the large diameter test well (TW 4/02), with all parameters meeting the Guidelines for Canadian Drinking Water Quality. In addition, no volatile organic compounds or chlorinated phenolics were found in a sample obtained from the large diameter test well. The draft report conclusions indicate that, in general, the Lower Nechako River Aquifer produces a high water quality (IWC 2003). Specific water quality testing for the proposed Fishtrap Island Collector Well is provided in Appendix II.

As discussed above, because the proposed Fishtrap Island Collector well is ultimately recharged by the river, there is a possibility that the groundwater quality at the well may be influenced by surface water from the Nechako River. Golder (2003) provides an overview of testing methods that may be used to assess the potential for microbial influence of surface water. The recommended testing program includes the use of microscopic particulate analysis (MPA), combined with measurements of turbidity and temperature in both the river and groundwater. Sampling would be performed during spring run-off and low-river flows. The City is committed to undertaking routine water quality analysis for detection of microbial elements, and to evaluate the degree to which water from the Lower Nechako River Aquifer supplying the proposed Fishtrap Island Collector Well is under the direct influence of surface water.

9.1.2 Hydrological Characteristics of the Nechako River

The Nechako River, within the vicinity of Fishtrap Island, drains an area of approximately 46 900 km^2. The predominant source of water in the Nechako River originates as controlled flow releases from the Skins Lake Spillway (Figure 9.11), and the river flows unregulated throughout the rest of the basin. The Skins Lake Spillway is managed by Alcan as part of the Nechako storage reservoir for hydroelectric power generation at Kemano. Annual maximum flows usually occur in June or July and are the result of spring melt, in the majority of the unregulated watershed, of the winter snow pack. The Skins Lake Spillway provides supplemental flows later in the summer to provide cooling water for migrating salmon.

Two Water Survey of Canada (WSC) hydrometric stations on the Nechako River upstream of Fishtrap Island were used for the hydrologic analysis for this study:

- Station 08JC001, Nechako River at Vanderhoof (drainage area = 25 000 km^2); and

- Station 08JC002, Nechako River at Isle Pierre (drainage area = 42 500 km^2).

The locations of these two hydrometric stations are shown on Figure 9.11. Pertinent data relating to these stations are presented in Table 9.6.

Table 9.6 Water Survey of Canada (WSC) Hydrometric Stations in Vicinity of Project Site

Station	Name	Year (start-end)	Flow Regime	Lat. (N) & Long (W)	Drainage Area (km^2)	Record Flow (m^3/s)	Q_{100} (D^2) (m^3/s)	PDF[1]
08JC001	Nechako River at Vanderhoof	1948-2000	Regulated	N54 01 34 W124 00 28	25 100	745 (1976)	865	LP[3]
08JC002	Nechako River at Isle Pierre	1950-2000	Regulated	N53 57 37 W123 14 01	42 500	1080 (1972)	1260	LP

Notes: 1. PDF= Probability Density Function, 2. D= Daily Maximum Discharge, 3. LP= Log Pearson Type III Distribution.

The seasonal variation in mean, maximum, and minimum flows at Station 08JC002 are listed in Table 9.7 and illustrated in Figure 9.12. These data are based on 51 years of record (1950 to 2000).

Average annual flow and peak flow conditions in the Nechako River in the vicinity of the proposed Fishtrap Island Collector Well were also estimated using the data provided above. Flow rates corresponding to various return periods for the two noted stations are presented in Table 9.8 and illustrated in Figure 9.13. These flow rates were estimated using the Consolidated Frequency Analysis (CFA) software. Peak flows for the project site were estimated using an areal adjustment of the data for Station 08JC002. The 100 year annual daily peak flow (D) at the site is estimated to be 1351 m^3/s (Table 9.8).

Similarly, an analysis of the low flows at the two hydrometric stations and at the proposed Fishtrap Island Collector Well site was undertaken, as illustrated in Table 9.9 and Figure 9.14.

A frequency histogram of daily flow rates in the Nechako River near the proposed Fishtrap Island Collector Well was prepared based on the 51 years of daily flow records from the WSC station 08JC002 (Nechako River at Isle Pierre), and area transferred to the

Table 9.7 Monthly Variation in Mean, Maximum, and Minimum Flows at Station 08JC002, Nechako River at Isle Pierre

Month	Mean Flow Rate (m^3/s)	Maximum Flow Rate (m^3/s)	Minimum Flow Rate (m^3/s)
January	128	426	53.5
February	131	370	49.4
March	128	398	46.3
April	200	561	44.7
May	401	848	132
June	523	988	200
July	548	1020	209
August	436	883	193
September	284	620	134
October	226	553	99.2
November	197	514	80.1
December	154	437	60.2

Fishtrap Island collector well location. These data, summarized in Table 9.10 and illustrated in Figure 9.15, indicate that a streamflow of 125 m^3/s or less has occurred during 20 percent of the streamflow records. Similarly, a daily streamflow of 484 m^3/s or higher has occurred during 20 percent of the streamflow records.

Table 9.8 Daily Peak Flows of Various Return Periods (QP_T in m^3/s) at WSC Hydrometric Stations in the Nechako River and Estimated Peak Flows at Fishtrap Island Collector Well Site.

		Return Period (years)								
Station	**D. A. (km^2)**	**1.25**	**2**	**5**	**10**	**20**	**50**	**100**	**200**	**500**
08JC001	25 00	251	365	509	600	683	788	865	941	1040
08JC002	42 500	470	617	803	920	1030	1160	1260	1360	1490
Estimated peak flow in the Nechako River near the Fishtrap Island Collector Well Site (D.A. = 46 900 km^2)										
	46 900	513	676	885	996	1112	1247	1351	1457	1593

Table 9.9 Single Day Low Flows of Various Return Periods (QLT in m^3/s) at WSC Hydrometric Stations in the Nechako River and Estimated Low Flows at Fishtrap Island Collector Well Site.

Return Period (years)									
Station	**D.A. (km^2)**	**1.25**	**2**	**5**	**10**	**20**	**50**	**100**	**200**
08JC001	25 100	64.6	45.2	28.6	21.5	16.6	12.1	9.7	7.8
08JC002	42 500	118	89	67	58	51	45	41	38
Estimated low flow in the Nechako River near the Fishtrap Island Collector Well Site ($D. A. = 46\ 900\ km^2$)									
	46 900	130	98	74	64	56.7	50	45	42

Table 9.10 Frequency Histogram of Daily Flow Rates (m^3/s) at Fishtrap Island Collector Well Site (based on 51 years of flow data at Station 08JC002, areal-transferred to the project site)

Flow Rate (m^3/s)	Percentage of Daily Flows (%)
0 - 100	8.40
101 - 200	35.10
201 - 300	14.80
301 - 400	12.50
401 - 500	10.50
501 - 600	7.67
601 - 700	5.00
701 - 800	2.30
801 - 900	1.10
901 - 1000	1.11
1001 - 1100	0.89
1101 - 1200	0.60

9.1.3 Active Wells and Water Licences

A review of water wells and surface water licenses within the City of Prince George was carried out to determine whether the development and operation of the proposed Fishtrap Island Collector Well will influence other water supply sources.

Active Water Licences

The active water licences for authorized water withdrawals within the Nechako River from the Isle Pierre Water Survey of Canada (WSC) gauging station downstream to the confluence of the Nechako and Fraser rivers were extracted from the Ministry of Sustainable Resource Management Water Licences Query for review (http://www.elp.gov.bc.ca:8000/pls/wtrwhse/water_licences.input). The total volume of licensed water use from Isle Pierre to the Nechako River near Fishtrap Island, and then downstream to the confluence with the Fraser River is 14.47 m^3/s. Identified water licences from Isle Pierre to the confluence of the Nechako River with the Fraser River are provided as Appendix V. In addition, confirmation was obtained from regional offices of the Ministry of Water, Land and Air Protection (MWLAP) that there are no applications for water licences on the Nechako River downstream of the Stuart River being adjudicated at present (T. Muirhead, Senior Water Allocation Technician, Land and Water BC, Prince George, B.C., pers. comm.).

Active Wells

Overview of Active Wells within the City of Prince George

An overview of active wells within the City of Prince George is presented below, based on information collected during the study conducted by Golder (Golder 2003).

9.1.3.1.1.1 City Wells

Currently, the City of Prince George has a total of eight active wells. The locations of City wells located near the site of the proposed Fishtrap Island Collector Well are presented in Figure 2.5, and a summary of the pumping rates associated with these wells is provided in Table 2.1.

9.1.3.1.1.2 Private Wells

A search of the water-well database maintained by MWLAP was conducted to identify private water wells located within the City. Over 800 private wells were identified from this search (Figure 9.9). Presumably, most of the domestic wells that are located in the areas currently serviced by the municipal water supply are no longer in use. However, private wells are known to be supplying domestic requirements for properties located outside of the City water supply system, together with the needs of private water purveyors and commercial properties, as described below.

9.1.3.1.1.3 Private Water Purveyors

Based on consultation with Bruce Gaunt, Chief Environmental Health Office for the Northern Health Authority, 24 private water purveyors, other than the City of Prince George, provide water to two or more connections within the City (Golder 2003). Table 9.11 provides a summary of these private water purveyors.

It is presumed that most of these purveyors likely obtain their water supply from community wells. Of the 24 private purveyors, 14 represent RV and mobile home parks, school and community water supply purveyors. The remaining 10 appear to provide water for commercial and industrial properties, including among others, Canfor's Prince George Pulp Mill, Canfor's Prince George Sawmill, Canfor's Northwood Pulp Mill, and Intercontinental Pulp Mill.

9.1.3.1.1.4 Commercial Well Users

A search of the water-well database was conducted to identify high-capacity wells, other than those operated by the City. The search identified three commercial/industrial wells with yields greater than 3273 m^3/day (500 Imperial gal/min). The potential influence of these wells was considered in the capture zone analysis (Golder 2003). One of the wells is the Canfor Collector Well, located on the north side of the Nechako River near the confluence of the Fraser and Nechako rivers (Figure 2.5). The average flow from the Canfor Well is estimated to be approximately 74 000 m^3/day (13 600 US gal/min). Other wells identified by the search include a well for the Spruce City Wildlife Fish Hatchery, located on the south side of the Nechako River across from the Canfor Well, and a well for the Pacific Western Brewing Company, located on the north side of the Nechako River between PW601 and PW608 (Figure 2.5). Yields reported by the MWLAP database were 3300 m^3/day (600 US gal/min) for the Canfor well and 2700 m^3/day (500 US gal/min) for the Pacific Western Brewing well.

Table 9.11
Permitted/Authorized Private Water Purveyors
Northern Interior Regional Health Board
City of Prince George, B.C.

Name	Address
Canfor PG Pulp Mill	2533 Pulp Mill Road
Blue Spruce RV Park	4433 Kimball Road
Caledonia MHP	5130 North Nechako
Evergreen MHP	4818 Delmar Place
Jackpine Water Association	10727 Jensen Rd
Northland RV & Trailer Park	41-10180 Hart Highway
South Shore MHP	22 7128 Otway
Spruce Capital MHP	29 - 1720 Prince George Pulp Mill Road
Sunrise Valley MHP	4058 Lansdowne Road
Swingers/Ponderosa MHP	3480 Lansdowne Road
Trailer Village MHP	7235 Eugene Road
Pacific Western Brewing	641 North Nechako
Canfor PG Sawmill	6988 Landooz Road
Southway Market	9912 Sintich Road
Yellowhead Grove Golf Course	5961 Leland Road
Shady Valley Elementary School	6144 Old Summit Road Road
JD Little Forest Centre	6677 Indian Reserve
Canfor PG Wood Treating	2711 Prince George Pump Mill Road
BC Chemical	2711 Prince George Pump Mill Road
FMC Canada	2147 Prince George Pulp Mill Road
Husky Oil Operations	2542 Prince George Pulp Mill Road
Intercon	2533 Prince George Pulp Mill Road
Canfor-Northwood Pulp Mill	5353 Northwood Pulp Mill Road
Lands End Water	10990 Jutland Road

9.1.3.1.1.5 Active Wells within the Zone of Influence of the Proposed Fishtrap Island Collector Well

A review of the water wells identified above was conducted to determine whether any of the wells lie within the zone of influence of the proposed Fishtrap Island Collector Well.

The zone of influence is defined as the area where pumping causes a distortion in the natural groundwater flow lines around a well. The aerial extent of the zone of influence for the proposed Fishtrap Island Collector Well differs from that of the capture zone, with the capture zone representing the entire area contributing water to the well. The zone of influence for the proposed Fishtrap Island Collector Well was defined under the four different pumping conditions (shown in Table 2.1) using the groundwater flow model developed as part of the study conducted by Golder (Golder 2003). The extent of the zone of influence under these four pumping conditions is presented in Figure 9.10. A review of water wells within these zones indicates that under the most extreme pumping conditions (Condition 4: maximum well capacity), where the zone of influence has the largest aerial extent, only two private wells fall within the zone of influence. A review of the water well record for one well indicates that it is screened in bedrock, and therefore should not be influenced by the pumping from surficial sediments associated with the proposed Fishtrap Island Collector Well. The second private well is reportedly owned by Rolling Mix, located on Otway Road and is completed in surficial sediments. The potential for interference between this well, if it still is active, and the proposed Fishtrap Island Collector Well is considered to be minor, since the estimated drawdown in the area of the private well under projected maximum pumping conditions ranges from only 0.2 m to 0.3 m. The other wells that lie within the zone of influence are test wells owned by the City of Prince George. Copies of well logs derived from the MWLAP database within the zone of influence are provided in Appendix IV for reference purposes.

A review of Figure 9.10 indicates that no interference effects should be observed between the proposed Fishtrap Island Collector Well and neighbouring City wells under current or projected average pumping conditions (Conditions 1 and 2, respectively). Minor interference effects between the proposed Fishtrap Island Collector Well and Wells PW605 and PW601 may be observed under projected maximum and maximum well capacity pumping conditions (Conditions 3 and 4, respectively).

As shown in Figure 9.10, the zone of influence for the proposed Fishtrap Island Collector Well does not extend north of the Nechako River. As such, no water wells located north of the Nechako River were identified within the zone of influence. The Nechako River provides a virtually complete hydraulic boundary and divide between the lower sections of the Lower Nechako River Aquifer located on the north and south sides of the river.

The reason for this is that, upon drawing down the water table, the aquifer is readily replenished by the Nechako River.

9.1.4 Climatic Characteristics

Climate data from Environment Canada (1993) are presented in Table 9.12 with estimates of recharge and run-off. In general terms, the climate borders on the arid (Lerner *et. al.* 1990) with a mean annual precipitation of 614 mm, of which two thirds falls as rain and one third falls as snow. The driest months, when precipitation is less than or equal to 35 mm per month, are February, March, and April. For the balance of the year precipitation for each month is relatively evenly distributed, ranging from about 50 mm per month to 65 mm per month. The majority of precipitation occurring as snowfall is associated with the period from November to March when average temperatures are close to, or below, freezing. For the balance of the year, precipitation falls mainly as rain.

Average daily temperatures are above freezing from April to October; the hottest month is July, with an average temperature of 15.3 ^{o}C. The coldest month is January, with an average temperature of -9.9 ^{o}C. For the entire year, there is very little excess moisture to recharge the soil. Potential evaporative and transpiration moisture losses, collectively referred to as evapotranspiration (*Et*), are only slightly less than precipitation. Based on precipitation, temperature, and estimates of potential *Et*, the only months where groundwater recharge resulting from direct precipitation is likely to occur are March, April, October, and November. All other months either have continuous sub-zero average temperatures or a potential *Et* that exceeds precipitation.

In general, rainfall provides the bulk of precipitation derived groundwater recharge during the summer months, with spring snowmelt providing the next highest percentage. More detailed analysis of the recharge of the Lower Nechako River Aquifer is provided in Golder (2003).

TABLE 9.12 CLIMATE DATA AND ESTIMATES OF Et AND RUNOFF

	Monthly climate normals		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year total	
	Rainfall	mm/ month	5.3	8.2	12.0	19.5	49.2	64.5	60.0	61.2	58.6	51.4	16.6	8.7	415.2	mm
	Snowfall	cm/month	60.1	31.6	25.2	8.8	2.5	0.0	0.0	0.0	0.8	8.0	42.7	54.1	233.8	cm
(1)	Total precipitation as water	mm/month	54.4	35.0	34.3	28.3	51.7	64.5	60.0	61.2	59.3	59.4	52.7	53.8	614.6	mm
(2)	Days in month		31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30	31		
(3)	Average monthly temperature	deg C	-9.9	-5.4	-0.7	4.7	9.4	13.1	15.3	14.6	9.8	4.8	-3.1	-8.4	3.7	deg C
(4)	Daylight hours (at mid month)	hours/day	8.1	9.9	11.8	14.0	15.9	17.0	16.5	14.8	12.7	10.6	8.61	7.5		
	Average sunshine hours 15th day of each month	hours/day	1.8	3.0	4.7	6.9	7.9	9.0	9.4	8.4	5.4	3.6	2.03	1.55		
(5)	Potential Et (Thornthwaite)	mm/month	0.0	0.0	0.0	35.3	75.4	103.9	119.2	102.6	60.3	28.1	0	0	525	mm/yr
	Windspeed	m/s	3.1	3.1	3.1	3.1	2.8	2.5	2.2	2.2	2.5	3.3	3.33	3.06		
(6)	Water available for recharge (1)-(5)	mm/month	54.4	35.0	34.3	-7.0	-23.7	-39.4	-59.2	-41.4	-1.0	31.3	52.7	53.8		
(7)	Groundwater recharge	mm/month	0.0	0.0	17.8	44.4	0.0	0.0	0.0	0.0	0.0	31.3	13.18	0	106.6	mm/yr
	Snowmelt														17%	
(8)	Snow available for runoff	mm as water				177.5										
(9)	Potential Snow Run-off per month High	mm/month	too cold	too cold	41.0	193.5						little snow	too cold	too cold		
(10)	Potential Snow Run-off per month Low	mm/month	too cold	too cold	24.2	73.9						little snow	too cold	too cold		
(11)	Estimated Run-off/ month (average value)	mm/month	0.0	0.0	32.6	133.7						11.9			178.2	mm/yr
(12)	Run-off from high ground	m3/month			162,054	664,135						59,022				
(13)	Recharge along strip at foot of high ground	mm/month			67.9	278.3						24.7			370.9	mm/yr

Details of Cranbrook Hill Drainage Area		
C (assumed run-off coefficient)	0.2	
Drainage Area (Da)	2484.072	ha
	24.84072	km^2
	24,840,720	m^2
Recharge strip at foot of Cranbrook Hills		
recharge strip L	11933	m
width of strip	200	m
Area of strip	2,386,600	m^2
recharge area/strip area	10.41	(factor)

Notes

Note groundwater recharge is for the flat area of Prince George on alluvial material
Run-off values are for the steep area to the south west of Prince George on rock and till

(5) Calculated using simplest Thornthwaite equation based on daylight hours

(7) 10%, 25%, 100%, & 25% of available snowpack for Mar, Apr& Oct, Nov respectively

(8) Sum of precipitation for December to March

(9) Equation from World Meteorological Organization (1975)

(10) Equation from World Meteorological Organization (1975)

(11) Average of high and low, should not exceed available snow pack

(12) C*(monthly rainfall/1000)*Da

(13) 14.27 km length 200 m wide, minus sub areas A and B of 2.34 km total length

9.2 Biological Characteristics and Conditions

9.2.1 Fisheries and other Aquatic Resources

The Fisheries Information Summary System (Ministry of Agriculture Food and Fisheries 2002) identifies several fish species present in the Nechako River watershed. Fish species documented and known to occur in the lower reaches of the Nechako River watershed include sockeye salmon (*Oncorhynchus nerka*), chinook salmon (*O. tshawytscha*), pink salmon (*O. gorbuscha*), coho salmon (*O. kisutch*), rainbow trout (*O. mykiss*), bull trout (*Salvelinus confluentus*), Dolly Varden (*Salvelinus malma*), mountain whitefish (*Prosopium williamsoni*), and white sturgeon (*Acipenser transmontanus*). Other non-salmonid species present in the Nechako River include leopard dace (*Rhinichthys falcatus*), longnose sucker (*Catostomus catostomus*), northern pikeminnow (*Ptychocheilus oregonensis*), peamouth chub (*Mylocheilus caurinus*), redside shiner (*Richardsonius balteatus*), slimy sculpin (*Cottus cognatus*), and white sucker (*C. commersoni*). In addition, the presence of brassy minnow (*Hybognathus hankinsoni*) and pygmy whitefish (*Prosopium coulteri*) have been noted in the Nechako River drainage area (MAFF 2002).

Fish Species Utilization and Distribution

The Nechako River is an important migratory route for upstream migrating salmon, such as sockeye salmon and chinook salmon, downstream migrating juvenile salmon (smolts), and other species such as bull trout and white sturgeon. This route leads from the Fraser River through the Nechako River to the other river systems. The Nechako River provides important rearing habitat and migratory routes for chinook salmon populations in the Nechako and Stuart river systems. The Nadina-Francois, Stellako-Fraser Lake, and Stuart-Takla systems sockeye salmon populations use the Nechako River as migration corridors (Nowotny and Hickey 1993, Marshall and Manzon 1980). These routes are indicated on Figure 9.16. In addition, coho salmon and pink salmon have been observed in the lower reaches of the Nechako River (Nowotny and Hickey 1993, Thibeault 2001).

Nechako River chinook salmon are classified as stream-type chinook, spending one or more years in freshwater and delaying migration until the spring following their emergence from the gravel. As a result, juvenile chinook salmon spend the spring through winter in freshwater prior to migrating downstream to the Fraser River, and eventually the Pacific Ocean. Typically, chinook salmon spawning takes place in the upper reaches of the Nechako River and its tributaries; however, upon emergence, downstream dispersion of juveniles from upper reaches and tributaries has been documented (Nowotny and Hickey 1993). Juvenile chinook salmon (less than a year old)

have been observed in November and recently emerged fry observed in March just upstream of the City limits on the Nechako River (Nowotny and Hickey 1993). After initial dispersion upon emergence, fry will inhabit the margins of the river, particularly back eddies, behind fallen trees, undercut tree roots, or other areas of bank cover (Healey 1991). As they grow larger, chinook will move away from the shore into midstream and higher velocity areas (Healey 1991). Instream cover is important to rearing juvenile chinook salmon as shelter from predators and from severe environmental conditions and for development of efficient feeding locations. Juvenile chinook salmon often overwinter in larger rivers, where they occupy deep pools or crevices between boulders and cobble, large rip rap and areas amongst organic debris, such as beaver lodges, during the winter (Healey 1991).

In fluvial populations of bull trout, such as the population in the Nechako River, large mature fish reside in rivers for the majority of the time. Bull trout utilize a variety of areas within the Nechako River for feeding and overwintering and are distributed throughout the length of the river. Nechako River bull trout appear to utilize a variety of geographically diverse habitats throughout their life history for spawning and rearing, overwintering, and feeding. Bull trout exhibit large-scale movements throughout the river during all seasons, and this movement is not restricted to mature fish (R.L.&L. 2002). In addition, migration of bull trout from the Nechako River to the Fraser River and its tributaries has been documented (R.L.&L. 2002). Consequently, Nechako River bull trout are susceptible to a greater variety of potential impacts than a more localized population.

The results of five years of research on white sturgeon in the Fraser River drainage documented the size of the white sturgeon population in the Nechako River as being low and composed mainly of older fish. The stock exhibited poor spawning success and recruitment (R.L.&L. 2000). Extensive movements of Nechako River sturgeon for feeding, overwintering, and spawning purposes were evident. White sturgeon spawning occurs in the spring and early summer (May to July). White sturgeon typically spawn in habitat with faster currents and rockier bottoms than their holding and rearing habitats. Spawning areas vary considerably and were characterized by pebble sized material intermixed with gravel, cobble, and sand (R.L.& L. 2000). There have been no spawning areas documented within the vicinity of the collector well site. Migration of white sturgeon from the Nechako River into the Fraser River has been documented (D. Hendricks, Fisheries Biologist, Golder Associates Ltd., Kamloops, B.C., pers. comm.) and white sturgeon may exhibit movements between the Nechako and Fraser rivers throughout the open-water season. White sturgeon generally exhibit little movement during the period from October to March. Generally, white sturgeon use deep, calm-water areas during the winter period (R.L.& L. 2000).

In the lower reaches of the Nechako River downstream of Fishtrap Island, coho salmon and pink salmon have been documented (Fisheries Information Summary System 2002); however, pink and coho salmon are not present in large numbers within the Nechako River. Pink salmon spawning habitat was identified on the left bank of the Nechako River at the toe of the cutbank across from Wilson Park (downstream of Fishtrap Island) and within the Cottonwood Island complex near the confluence with the Fraser River (Nowotny and Hickey 1993). In October 2001, personnel from DFO observed several pink salmon redds and collected several biological samples from pink salmon carcasses (Thibeault 2001). The majority of the pink salmon redds observed were located along the north and south banks of the Nechako River in the vicinity of Cottonwood Island Park and along the north bank within a back channel downstream of the John Hart Bridge (Thibeault 2001). Other spawning areas were identified near the confluence of the Nechako and Fraser rivers and on the south shore near the Spruce City Wildlife fish hatchery[3] (Thibeault 2001).

Back Channel Habitat Characteristics

Foothills Boulevard Bridge crosses the mainstem of the Nechako River near the upstream (west) end of Fishtrap Island. The original back channel, separating the south bank of the Nechako River from Fishtrap Island, is obstructed by Foothills Boulevard and the approach to Foothills Boulevard Bridge. Two partially blocked culverts, which are in-filled with gravel, are located beneath the south approach leading to Foothills Boulevard Bridge at the location of the remnant back channel between the south bank of the Nechako River and Fishtrap Island.

These two culverts substantially restrict water flow and are likely barriers to fish migration into the remnant back channel east of Foothills Boulevard along the south side of Fishtrap Island. During the spring months, water levels in the back channel to the east of Foothills Boulevard are higher due to the accumulation of groundwater, rainwater, snowmelt, and/or surface runoff from Foothills Boulevard. The back channel becomes undefined approximately 100 m east of Foothills Boulevard.

The existing gravel access road that parallels the south side of Fishtrap Island crosses a narrow portion of this back channel west of the abandoned gravel pit. There is limited flow through the culvert beneath the existing access road from the back channel. A beaver dam is present downstream of the road crossing which also partially obstructs flows. Gravel and cobble substrates are present in the back channel downstream of the road crossing.

[3] A private hatchery.

At the time of the site reconnaissance in October 2002 conducted as part of this assessment, there was no water flow present in the back channel. A large snye[4] is located at the downstream (east) end of the back channel. The snye may provide rearing and velocity refuge for juvenile and adult fish species, and there is abundant submergent vegetation within the area. At higher water levels, the back channel may be hydraulically connected to the Nechako River, but a beaver dam and culvert downstream of the road crossing may create an upstream barrier to fish movement from the snye into the back channel.

Nechako River Habitat Ranking

Nowotny and Hickey (1993) conducted a biophysical survey and rated the value of salmonid habitats along the major watercourses within the city limits of Prince George. Included in the survey was the mainstem Nechako River within the study area boundaries. Streambank sections were delineated along the mainstem Nechako River based on homogenous habitat features such as substrate type, water depth, flow characteristics, bank composition and stability, relative abundance and species composition of vegetation communities, and upland status.

Nechako River nearshore habitat on the right downstream bank near Fishtrap Island was assigned a "high value" (Nowotny and Hickey 1993). Nowotny and Hickey (1993) described the nearshore habitat as providing good overwintering habitat based on the substantial quantities of large (cobble, boulder, and large gravel) substrates. In addition, high water refuge and rearing habitat were provided within shallow gradient, low velocity nearshore areas. The banks of the Nechako River opposite Fishtrap Island were described as well developed with stable banks that may provide cover and function as a source of fish food production. Nowotny and Hickey (1993) described the back channel (snye) near the east end of Fishtrap Island as exhibiting stagnant conditions, poor water quality and prolific growths of submergent vegetation.

A site visit conducted on 16 October 2002 substantiates the nearshore habitat values and description provided by Nowotny and Hickey (1993). Nearshore habitat consisted primarily of cobble and boulder substrates. Slower water velocities occurred along the water margin. The combination of suitable substrates and slower water velocities provide cover for rearing salmonids and velocity refuge for juvenile and adult fish species. Stream bank substrates consisted of primarily fines and gravels. Bank vegetation is abundant and composed of mix forests (poplar, spruce, fir) with willow and grasses

[4] A snye is a discrete section of non-flowing water connected to a flowing channel only at its downstream end, generally formed in a side channel or behind a peninsula.

prevalent. Slopes appeared moderately stable with some evidence of slumping or erosion occurring during high water.

Rare and Endangered Fish Species

The Ministry of Sustainable Resource Management's BC Conservation Data Centre (CDC) has developed evaluation and tracking lists for vegetation and wildlife species indigenous to BC. The CDC assigns a provincial ranking for "Rare Element Occurrences" of species considered to be "endangered or threatened" (red[5]-listed), or "vulnerable and at risk" (blue[6]-listed). A species' rank is designated by a number from 1 to 5, preceded by G (Global), N (National), or S (for Sub-national) (Table 9.13). Assessment criteria include abundance, distribution, habitat integrity, population trends, reproductive potential, and national and international status.

Table 9.13 Conservation Data Centre (CDC) Status Ranks

Designation	Rank	Explanation
X	Presumed Extirpated or Extinct	Not located despite intensive searches and no expectation that it will be rediscovered.
H	Historical	Not located in the last 50 years, but some expectation that it may be rediscovered.
1	Critically Imperiled	Because of extreme rarity or some factor(s) making it especially susceptible to extirpation or extinction. Typically 5 or fewer existing occurrences or very few remaining individuals, e.g., fewer than 1000 spotted owl.
2	Imperiled	Because of rarity or some factor (s) making it very

[5] Red-listed species are any indigenous species or subspecies (taxa) considered to be Extirpated, Endangered, or Threatened in British Columbia. Extirpated taxa no longer exist in the wild in B.C., but do exist elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed. Red-listed taxa include those that have been, or are being, evaluated for these designations.

[6] Blue-listed species are any indigenous species or subspecies considered to be Vulnerable in British Columbia. Vulnerable taxa are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue-listed taxa are at risk but are not Extirpated, Endangered, or Threatened. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) also assigns a national status for rare and endangered species in Canada using similar designations.

		susceptible to extirpation or extinction. Typically 6 to 20 existing occurrences or few remaining individuals, e.g., 1000 to 3000 white sturgeon.
3	Vulnerable	Because rare and local, found only in a restricted range (even if abundant at some locations), or because of some other factor(s) making it susceptible to extirpation or extinction. Typically 21 to 100 existing occurrences, e.g., gopher snake.
4	Apparently Secure	Because uncommon but not rare, and usually widespread in the province. Possible cause for long-term concern. Typically more than 100 existing occurrences, e.g., olive-sided flycatcher.
5	Secure	Because common to very common, typically widespread and abundant, and not susceptible to extirpation or extinction under present conditions, e.g., red-osier dogwood.
?	Unranked	Rank not yet assessed.
U	Unrankable	Due to current lack of available information.

White sturgeon have been classified by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as a Species of Special Concern. The CDC has provincially listed white sturgeon as imperiled (the second highest 'at-risk' rating), designating it as a provincially red-listed species. The Nechako River white sturgeon population is one of three populations (Nechako, upper Columbia and Kootenay) that were given the highest possible ranking of critically imperiled. Bull trout and Dolly Varden are blue-listed species in the Prince George Forest District. A non-salmonid species, brassy minnow, has also been ranked provincially as blue-listed. The global and provincial rankings and status of these species considered endangered or at risk within the Nechako River, are summarized in Table 9.14. Regionally important fish species are defined by MWLAP by the following criteria:

- red-listed by the CDC;
- blue-listed by the CDC;
- comprising a fishery (sport, aboriginal, or commercial);
- isolated (stock or species is genetically isolated);

- special (species or stock is Regionally rare or exhibits characteristics unique to the Region); and

- species required to maintain populations of Red or Blue Listed species.

Table 9.14 Red- and Blue-Listed Fish Species Occurring within the Nechako River

Common Name	Scientific Name	Global Rank	Provincial Rank	BC Status
White Sturgeon (Nechako River population)	*Acipenser transmontanus*	G4T1Q	S1	Red
Bull Trout	*Salvelinus confluentus*	G3	S3	Blue
Dolly Varden	*Salvelinus malma*	G5	S3S4	Blue
Brassy Minnow	*Hybiognathus hankinsoni*	G5	S3S4	Blue

Source: Ministry of Sustainable Resource Management (2002)

Regionally important fish species found in the Fraser and Nechako river drainage areas include brassy minnow, chiselmouth (*Acrocheilus alutaceus*), Dolly Varden, bull trout, white sturgeon, and pygmy whitefish.

Enhancement Efforts and/or Compensation Programs

Cottonwood Island Park is a municipal park located at the confluence of the Nechako and Fraser rivers. In 1993, the Cottonwood Island Side Channel Organization (CISCO) conducted Phase I and II of the Cottonwood Island Habitat Enhancement Projects. Phases I and II included cleaning and rehabilitation of fish and wildlife habitat within a side channel at the eastern section of the island. The side channel was blocked by natural and anthropogenic debris. Specific work conducted, included replacing causeways and culverts with bridges, removing cut logs from the waterways, lowering the bottom of the channel, and installing interpretive signage (L. Kosec, Parks and Open Space Planner, City of Prince George, Prince George, B.C., pers. comm.). In 2001, CISCO completed Phase III of the project which included cleaning and rehabilitating the fish and wildlife habitat on the west-side channel (backwater channel) of Cottonwood Island Park. Over 14 000 m^3 of waterlogged debris, silt, and gravel were excavated and an outlet structure was installed. Tree planting efforts were conducted along the riparian area and

interpretive signage was subsequently installed (L. Kosec, Parks and Open Space Planner, City of Prince George, Prince George, B.C., pers. comm.).

Nechako River White Sturgeon Recovery Initiative

The Nechako River White Sturgeon Recovery Initiative has proposed the development and implementation of a pilot conservation aquaculture facility to maintain adult population abundance and genetic diversity in the Nechako River. MWLAP has proposed the construction of a fish transfer facility and white sturgeon conservation aquaculture facility on the left downstream bank of the Nechako River between the existing Cameron Street Bridge and the confluence with the Fraser River. It is the intent of the fish culture section of the MWLAP to commission the new fish transfer facility by the spring of 2003 (J. Bomford, Section Head, Engineering Services, MWLAP, Victoria, B.C., pers. comm.). The sturgeon hatchery is in the initial stages of planning. Both facilities will have their water needs supplied by on-site wells. Discharges resulting from facility operations will be directed to the Nechako River via a common discharge pipe located on site (J. Bomford, Section Head, Engineering Services, MWLAP, Victoria, B.C., pers. comm.).

9.2.2 Wildlife Resources

Species Utilization

Wildlife and waterfowl resources on Fishtrap Island, and generally along the proposed alignments of the water transmission line corridors leading to PW605 and PW607, include a variety of mammals, ungulates, nesting birds, waterfowl, and amphibians. Wildlife observations or signs (scat, tracks) observed during the site reconnaissance conducted as part of this assessment, included river otter (*Lutra canadensis*), beaver (*Castor canadensis*), red squirrel (*Tamiasciurus hudsonicus*), deer species, American widgeon (*Anas americana*), mallard (*Anas platyrhynchos*), belted kingfisher (*Megaceryle alcyon*), woodpecker species, American crow (*Corvus brachyrhynchos*), black-capped chickadee (*Parus atricapillus*), and bald eagle (*Haliaeetus leucocephalus*).

Deer tracks and scat were observed at the location of the proposed collector well site, and deer tracks were also observed along the BC Hydro powerline right-of-way and access road. In addition, canine tracks were observed. Species identification was, however, difficult because the area is used by local residents and their domestic dogs. Observations of coyote (*Canis latrans*) and red fox (*Vulpes vulpes*) have been recorded within the vicinity of the project area.

The BC Environment, Wildlife Watch Program and the Prince George Naturalist Club published a *Bird Viewing around Prince George* pamphlet identifying bird species observed at parks within the limits of the City of Prince George. Cottonwood Island Park, McMillan Creek Regional Park, and Wilkins Park occur along the Nechako River from the community of Miworth downstream to the confluence with the Fraser River (Figure 2.3). The large cottonwoods along the Nechako River attract a variety of birds, including great-horned Owl (*Bubo virginianus*), northern saw-whet owls (*Aegolius funereus*), pileated woodpecker (*Dryocopus pileatus*), and cavity-nesting ducks. The belted kingfisher burrow into the banks of the Nechako River. The willow and alder thickets attract American redstarts, northern waterthrushes, and many other birds of bottomland habitat, such as western tanager, winter wren, kinglets, warblers, and thrushes. Vaux swifts have been observed near Cottonwood Island Park. At McMillan Creek Regional Park, vireos (*Vireo* sp.) are among the many forest birds observed.

Members of the Prince George Naturalist Club regularly submit wildlife and bird observation information via an email list. Recent observations at Fishtrap Island and in parks downstream of Fishtrap Island confirmed sitings of the wildlife and bird species listed in Table 9.15.

Table 9.15 Wildlife and Bird Species Sitings on Fishtrap and Cottonwood Island

Wildlife and Bird Species Sitings	Location
Hooded mergansers, *Lophodytes cucullatus*	Cottonwood Island Park
Belted kingfisher	Cottonwood Island Park
Great blue heron, *Ardea herodias herodias*	Cottonwood Island Park
Bald eagle, *Haliaeetus leucocephalus*	Cottonwood Island Park
Common mergansers, *Mergus merganser*	Cottonwood Island Park
Hairy woodpecker, *Picoides villosus*	Fishtrap Island
Redhead, *Aythya americana*	Fishtrap Island
Black bear, *Ursus americanus*	Fishtrap Island
Muskrat, *Ondatra zibethicus*	Fishtrap Island

Source: Prince George Naturalist Club

Habitat Characteristics

Wildlife habitat on Fishtrap Island generally provides good forage potential for ungulates such as moose and deer, although the quality of foraging capability is limited due to previously disturbed areas and activities such as the BC Hydro powerline right-of-way, access road, and former gravel mining operations on the island. Moose (*Alces alces*) are the most common large ungulate in the Sub-Boreal Spruce biogeoclimatic zone (SBS).

In addition, areas of dense deciduous and coniferous forest in the riparian areas along the Nechako River provide thermal protection and cover for ungulate species and small mammals. Shrubs are plentiful throughout the project area and provide forage for large mammals (e.g., bear). Table 9.16 provides a listing of typical habitats for selected wildlife species within the sub-boreal spruce biogeoclimatic zone.

The backwater channel area along the south side of Fishtrap Island provides habitat for a variety of waterfowl and amphibian species. During the reconnaissance site visits September and October 2002, a pair of mallard ducks was observed in the back channel just upstream of the culvert crossing along the existing access road and a pair of American widgeon was observed in the back channel (snye) downstream of the culvert. The back channel provides lowland habitat and a shallow waterbody with abundant macrophytes, preferred by dabbling duck species such as mallards and widgeons. The riparian habitat upstream and downstream of the culvert consists of second growth stands of coniferous and deciduous trees, shrubs, and grasses which provide protection from predators, nesting areas, and feeding areas.

Amphibian species that are likely to occur, but were not observed during the reconnaissance site visits, within the study area, include western toads (*Bufo boreas*), Columbia spotted frogs (*Rana luteiventris*), wood frogs (*Rana sylvatica*), and long-toed salamanders (*Ambystoma macrodactylum*) (P. Hengeveld, Biologist, Wildlife Infometrics Inc., Mackenzie, B.C., pers. comm.).

Unique wildlife habitats, such as raptor nests, heron rookeries, or cavity nests were not observed within the vicinity of the proposed collector well site and ancillary facilities during the site reconnaissance conducted in September and October 2002.

Table 9.16 Selected Wildlife Habitats and Species in the Sub-Boreal Spruce Biogeoclimatic Zone

Common Name	Scientific Name	Habitat Type
Moose	*Alces alces*	RA, W, M, F, MDC
Mule deer	*Odocoileus heminonus*	RA, W, M, F, MDC
Black bear	*Ursus americanus*	RA, W, M, F, MDC
Beaver	*Castor canadensis*	RA, W, M, F
Meadow jumping mouse	*Zapus hudsonius*	RA, W, M, F
Gray wolf	*Canis lupus*	MDC
Lynx	*Lynx canadensis*	MDC
Marten	*Martes Americana*	MDC

Common Name	Scientific Name	Habitat Type
Ermine	*Mustela erminea*	MDC
Red squirrel	*Tamiasciurus hudsonicus*	MDC
Porcupine	*Erithizon dorsatum*	MDC
Snowshoe hare	*Lepus americanus*	MDC
Deer mouse	*Peromyscus maniculatus*	MDC
Bald eagle	*Haliaeetus leucocephalus*	RA, W, M, F
Ruffed Grouse	*Bonasa umbellus*	RA, W, M, F
Trumpeter swan	*Olor buccinator*	RA, W, M, F
Canada goose	*Branta Canadensis*	RA, W, M, F
Herring gull	*Larus argentatus*	RA, W, M, F
Ring-billed gull	*Larus delawarensis*	RA, W, M, F
Black tern	*Chlidonias niger*	RA, W, M, F
Eared grebe	*Podiceps nigricollis*	RA, W, M, F
Common loon	*Gavia immer*	RA, W, M, F
Barrow's Goldeneye	*Bucephala islandica*	RA, W, M, F
Harlequin duck	*Histrionicus histrionicus*	RA, W, M, F
Rusty blackbird	*Euphagus carolinus*	RA, W, M, F
Northern goshawk	*Accipiter gentiles*	MDC
Northern hawk-owl	*Surnia ulula*	MDC
Great horned owl	*Bubo virginianus*	MDC
Common raven	*Corvus corax*	MDC
Northern flicker	*Colaptes auratus*	MDC
Downy woodpecker	*Picoides pubescens*	MDC
Yellow-bellied sapsucker	*Sphyrapicus varius*	MDC
Pine siskin	*Carduelis pinus*	MDC
Yellow warbler	*Dendroica petechia*	MDC
Dark-eyed junco	*Junco hyemalis*	MDC
Black-capped chickadee	*Parus atricapillus*	MDC
Chipping sparrow	*Spizella passerine*	MDC
Common garter snake	*Thamnophis sirtalis*	RA, W, M, F
Western toad	*Bufo boreas*	RA, W, M, F
Spotted frog	*Rana pretiosa*	RA, W, M, F
Wood frog	*Rana sylvatica*	RA, W, M, F

Notes: RA = riparian area, W = wetlands, M = meadows, F = floodplains, MDC = mixed deciduous and coniferous forests (Source: Meidinger, J. Pojar, and W. L. Harper 1991).

Rare and Endangered Wildlife Species

Table 9.17 lists rare and endangered wildlife species that may potentially occur in wetland, stream, riparian forest, meadows, floodplains, and mixed deciduous and coniferous forest habitat in the SBS Biogeoclimatic Zone (CDC 2002). Although there were no records of Rare Element Occurrences for these species on Fishtrap Island based on the CDC database, suitable habitat for some of these species may exist within the general vicinity of the project footprint. There were no sitings or observations of red- and blue-listed wildlife species identified in Table 9.17 at the Fishtrap Island Collector Well site or along the water transmission line corridors during the field reconnaissance. However, white sturgeon (red listed) and bull trout (blue listed) use the Nechako River near the proposed Fishtrap Island collector well site as a migration corridor. As well, great blue heron (blue listed) were observed just downstream near Cottonwood Island Park.

9.2.3 Vegetation Resources

An Ecoregion classification system has been developed for British Columbia to provide a systematic view of the small-scale ecological relationships in the province (Meidinger and Pojar 1991). There are five hierarchical levels in the Ecoregion Classification system, two of which place BC in a global context. The remaining three levels are progressively more detailed and describe areas of similar climate, physiography, vegetation, and wildlife potential (Meidinger and Pojar 1991). The project area is classified using this system as listed in Table 9.18.

Table 9.17 Red- and Blue-Listed Vertebrate Species Potentially within the Project Area

Common Name	Scientific Name	Global Rank	Provincial Rank	BC Status
Short-eared Owl	*Asio flammeus*	G5	S3B, S2N	Blue
Great Blue Heron, *herodias* subspecies	*Ardea herodias herodias*	G5T5	S3B, S4N	Blue
American Bittern	*Botaurus lentiginosus*	G4	S3B, SZN	Blue
Trumpeter Swan	*Cygnus buccinator*	G4	S3S4B, S4N	Blue
Bobolink	*Dolichonyx oryzivorus*	G5	S3B, SZN	Blue
Beaverpond Baskettail	*Epitheca canis*	G5	S3	Blue
Sandhill Crane	*Crus canadensis*	G5	S3S4B, SZN	Blue
Wolverine	*Gulo gulo luscus*	G4T4	S3	Blue

Common Name	Scientific Name	Global Rank	Provincial Rank	BC Status
Grizzly Bear	*Ursus arctos*	G4	S3	Blue
Fisher	*Martes pennanti*	G5	S3	Blue
Northern Long-eared Myotis	*Myotis septentrionalis*	G4	S2S3	Blue
Mead's Sulphur (butterfly)	*Colias meadii*	G4G5	S3	Blue

Table 9.18 Ecoregion Classification for the Project Area

Classification	Study Area
Ecodomain	Humid Temperate
Ecodivision	Humid Continental Highlands
Ecoprovince	Sub-Boreal Interior
Ecoregion	Fraser River
Ecosection	Nechako Lowland

Sub-Boreal Spruce Biogeoclimatic Zone

The British Columbia Ministry of Forests has further subdivided the province by Biogeoclimatic Zones based primarily on the influence of regional climate and topography on the terrestrial ecosystem. The project area is located within the Sub-Boreal Spruce zone (SBS), and can be further described as being in the Stuart Dry Warm Sub-boreal Spruce (SBSdw3) variant (DeLong, *et. al.* 1993). The SBS is the montane zone dominating the landscape of the central interior of British Columbia (Meidinger and Pojar 1991). Upland coniferous forests dominate the sub-boreal landscape. Hybrid white spruce (*Picea engelmannii* x *glauca*) and sub-alpine fir are the dominant climax tree species. Within the project area, alluvial black cottonwood are present, which are common on active floodplains of the major streams and rivers in the SBS zone (Meidinger and Pojar 1991).

Vegetation Types on Fishtrap Island

Vegetation types on Fishtrap Island generally consist of second growth stands of coniferous and deciduous trees and shrubs. The vegetation on Fishtrap Island near the proposed collector well site and along portions of the water transmission main alignments leading to PW605 and PW607 consist primarily of hybrid white spruce, sub-alpine fir, black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), paper birch (*Betula*

papyrifera), alder (*Alnus* spp.), western mountain ash (*Sorbus scopulina*) mixed with various other deciduous tree and shrub species. The understory consists primarily of prickly rose (*Rosa acicularis*), highbush-cranberry (*Viburnum edule*), willow (*Salix* spp.), slender wheatgrass (*Agropyron trachycaulum*), and bluegrass (*Poa* spp.).

The water transmission main alignments leading to each of PW605 and PW607 have been selected by the City of Prince George to minimize areas of required vegetation clearing. For example, the proposed water transmission main leading towards PW605 initially parallels the B.C. Hydro transmission line corridor in a southerly direction, before turning eastward across a grassed area parallel to the access road leading to the former gravel pit at the east end of the island. The extent of tree and shrub clearing along this alignment will be limited to approximately 270 m including segments west of the culvert crossing along the existing access road and a segment east of the gravel pit leading to PW605. Similarly, the water transmission main leading to PW607 initially parallels the existing B.C. Hydro transmission line corridor in a southerly direction before turning westward along the gravel access road leading toward Foothills Boulevard, and then northward within the un-vegetated right-of-way along Foothills Boulevard.

The City of Prince George proposes to utilize, as much as possible, existing cleared rights-of-way, such as the B.C. Hydro transmission line corridor and gravel access road on Fishtrap Island, and along Foothills Boulevard to minimize area of vegetation disturbance.

Rare and Endangered Plant Species

Rare plant species and communities throughout the entire Prince George Forest District are included in Appendix V (CDC 2002). Based on the listed plant species throughout the entire Prince George Forest District, it is possible that the plant species identified in Table 9.19 could occur within the footprint of the collector well and/or along the corridors for the water transmission mains based on site-specific suitability requirements (Douglas *et. al.* 2002).

Table 9.19 Red- and Blue-Listed Plant Species Occurring throughout the Prince George Forest District

Common Name	Scientific Name	Global Rank	Provincial Rank	BC Status
Western dogbane	*Apocynum floribundum*	G4G5	S2S3	Blue
Two-edged water-starwort	*Callitriche heterophylaa* ssp. *heterophylla*	G5T5	S2S3	Blue

Short-flowered evening-primrose	*Camissonia breviflora*	G5	S1	Red
Swollen beaked sedge	*Carex rostrata*	G5	S2S3	Blue
Pointed broom sedge	*C. scoparia*	G5	S2S3	Blue
Tender sedge	*C. tenera*	G5	S2S3	Blue
Bog rush	*Juncus stygius*	G5	S2S3	Blue
White adder's-mouth orchid	*Malaxis brachypoda*	G4	S2S3	Blue
Bog adder's-mouth orchid	*M. paludosa*	G4	S2S3	Blue
Smith's medic	*Melica smithii*	G4	S2S3	Blue
Fragrant white rein orchid	*Platanthera dilatata* var. *albiflora*	G5T	S2S3	Blue
Water bur-reed	*Sparganium fluctuans*	G5	S2S3	Blue

Source: Ministry of Sustainable Resource Management (2002)

Although no Rare Element Occurrences have been mapped on Fishtrap Island, tender sedge (*Carex tenera*) and fragrant white rein orchid (*Platanthera dilatata* var. *albiflora)* were classified as Rare Element Occurrences located downstream of Fishtrap Island and could possibly occur at the project site (BC CDC 2002, Appendix VI).

While the above table of red- and blue-listed plant species does not specifically apply to Fishtrap Island, or even the lower portion of the Nechako River watershed, it is provided here to emphasize the diversity in rare and endangered plant species occurrence throughout the Prince George Forest District.

Although none of these red- or blue-listed species were observed during the field reconnaissance conducted as part of this assessment, the presence of rare and endangered plant species cannot be entirely discounted based on the information reviewed and fieldwork undertaken for this study.

9.3 Cultural Characteristics and Conditions

9.3.1 Archaeological Resources – Background

The Cultural Resources component of this environmental assessment consisted of an archaeological impact assessment (AIA), conducted under Heritage Inspection Permit 2002-349. Consistent with Provincial guidelines, the AIA comprised two components as follows:

- an office-based review to determine whether any archaeological sites have previously been recorded within the proposed project area; and

- a field component designed to assess whether unrecorded archaeological sites are present and would potentially be affected by the proposed development.

In conducting the AIA, the following tasks were undertaken:

- existing archaeological site records on file with the Archaeology and Recreation Inventory Section, Resource Information Department (Ministry of Sustainable Resource Management) were reviewed;

- the Lheidli T'enneh First Nation, Carrier-Sekani Tribal Council, and Nazko Band Government were contacted to solicit knowledge of unrecorded archaeological resources in the project area;

- available site plans and aerial photographs of the project site and components were reviewed;

- the project area was visited and development areas were visually inspected by a Registered Professional Consulting Archaeologist to evaluate the potential for archaeological sites and cultural features; and

- subsurface testing was conducted in areas considered to have archaeological site potential, in accordance with a Heritage Inspection Permit (Permit No. 2002-349).

9.3.2 Cultural Conditions– Background

According to Statement of Intent maps obtained from the BC Treaty Commission, the Fishtrap Island Collector well project location is within the traditional territory of the Lheidli T'enneh First Nation. Statement of Intent maps are submitted by First Nations to the Treaty Commission as part of the treaty negotiation process. The traditional territory of the Nazko First Nation is in close proximity to the study area, but the Nazko Band Government has elected not to participate in this project review. There are four Indian Reserves affiliated with the Lheidli T'enneh First Nation within approximately 10 km to 12 km of the study area. The Clesbaoneecheck Reserve, located on the north bank of the Nechako River, about 7 km west of the project area is the nearest Reserve to the project site. The Fort George reserve, north of the confluence of the Nechako and Fraser Rivers, is about 11 km northwest of the project area. The Salaquo Reserve is located on the

Nechako River, about 11 km southwest of the project area, and the Fort George Cemetery Reserve is south of the confluence of the Nechako and Fraser Rivers, about 7 km from the project location.

The Lheidli T'enneh and Nazko First Nations are members of the Carrier Nation of north-central interior British Columbia. The Lheidli T'enneh are considered Central Carrier, and the Nazko are Southern Carrier. Some published sources on Carrier culture include Morice (1893), Jenness (1943), Hall (1992), Tobey (1981), and Furniss (1993).

Traditional Carrier subsistence relied heavily on fishing. In late summer and early fall, Carrier people gathered to catch and trap salmon in the local rivers. Salmon were taken with weirs, using large conical basketry traps, and also netted, harpooned, or gaffed from scaffolds. Freshwater fish were caught primarily in late fall, winter and spring. Other important food and raw material resources included deer, bear, goats, moose (historically), caribou, beavers, rabbits, marmots, and a wide variety of berries, roots, and bulbs. In addition to hunting and collecting these and other resources, the Carrier traded with neighbouring First Nations, notably the Gitksan and Nuxalk.

Major Carrier settlements were located primarily on riverbanks and lakeshores, and smaller, more temporary camps were situated near resources and along travel corridors. Based on this general land use information, and supported by the name "Fishtrap Island," it is likely that fishing and related activities historically took place in the vicinity of the Project Site.

9.3.3 Archaeological Resources – Archaeological Impact Assessment

On 9 November 2002, a Registered Professional Consulting Archaeologist from Golder conducted an impact assessment within the footprint of the Hart Water Supply Improvement Project in accordance with a Heritage Inspection Permit 2002-349. The Lheidli T'enneh First Nation was invited to participate in the field inspection, but their archaeological staff was not available at the time of the assessment. The AIA encompassed the site of the proposed Fishtrap Island Collector Well and surrounding area, and each of the proposed water transmission main alignments. The alignments are as follows:

- Ospika Boulevard to existing production wells PW605 near the entrance to Fishtrap Island; and

- the proposed Fishtrap Island Collector Well to PW607 near the intersection of Foothills Boulevard and North Nechako Road.

The AIA consisted of a visual inspection, supplemented by judgmental subsurface testing to search for buried archaeological resources.

Fishtrap Island Collector Well Site

The site of the proposed collector well is situated on flat ground with no defining landform features, and is located approximately 50 m from the south bank of the Nechako River. No cultural depressions, modified trees, or other visible archaeological materials or features were observed within the vicinity of the well and surrounding area. A total of 57 shovel tests were dug by hand in a 150 m (north-south) by 100 m (east-west) area centered over the proposed well location. No archaeological sites were found. The shovel tests indicate that the stratigraphy in the examined area is generally uniform, and is described as follows:

- 0-5 cm Litter mat; and
- 5-60 cm+ Brown silt with occasional gravel inclusions.

Proposed Water Transmission Main Leading to PW605

The alignment of the proposed water transmission main leading to PW605 generally extends east a short distance (40 to 50 m) from the Fishtrap Island Collector Well, and then southward along the BC Hydro powerline right-of-way to the existing gravel road which parallels the south side of Fishtrap Island. From there, the pipeline alignment runs generally in a southeasterly direction parallel to the gravel road for a distance of approximately 750 m, and crosses the back channel at the same location as the existing gravel road. The pipeline alignment then crosses the abandoned gravel pit and ties in to the existing collector well PW605 near the eastern end of the island (Figure 5.4).

Five shovel tests were dug by hand just south of the centre section of the proposed pipeline alignment and south of the existing access road. Three additional shovel tests were dug by hand on a remnant gravel terrace immediately west of PW605. The stratigraphy was similar to that described above for the site of the collector well.

No archaeological resources were found along the alignment of the water transmission main leading to PW605.

Proposed Water Transmission Main Leading to PW607

The proposed alignment for the water transmission main leading to PW607 initially runs east from the Fishtrap Island Collector Well site, then south along the BC Hydro

transmission line right-of-way, and then west along the existing gravel road leading to Foothills Boulevard. The alignment continues north for a distance of approximately 1.9 km along the east shoulder of Foothills Boulevard, and would be installed beneath the Foothills Bridge within the existing block-outs. No terrain features considered to have archaeological site potential were observed along the proposed alignment, and no subsurface testing was undertaken.

9.4 Economic and Social Characteristics and Conditions

9.4.1 Historical Land Use

From its early beginnings as an important settlement at the confluence of the Fraser and Nechako rivers, the City of Prince George has grown to a population estimated at 81 000. Population projections for 2026 range between 105 000 to 175 000. For the Hart area, the current population level is approximately 16 000.

Based on a review of available historical aerial photographs, land use activities on Fishtrap Island have been predominantly parkland with some agricultural and gravel mining (Table 9.20).

Table 9.20 Historical Aerial Photo Review

Year	Airphoto Number	Feature
1946	BC:281:91, 92	Cleared area, possibly agricultural, no buildings observed, railway, Otway Road.
1963	BC5070 – 15, 16	Road crossing at back channel (south east end), cleared area, possibly agricultural, railway, Otway Road.
1977	BC77052 No. 211, 212	Railway, Otway Road, BC Hydro right-of-way, gravel pit, PW605.
1984	BC84058 No. 177	Railway, Otway Road, Foothills Boulevard Bridge, gravel access road, gravel pit, PW605.
1994	30BCB94032 No. 127, 128	Railway, Otway Road, Foothills Boulevard Bridge, gravel access road, gravel pit, PW605.

Based on interviews with municipal staff familiar with the area, it is understood that a farming operation was located along the proposed pipeline alignment for PW605 in the early 1960s (K. Sanregret, Supervisor, Utility Operations, City of Prince George, pers. comm.). In addition, a gravel mining extraction operation occurred near the eastern end of the island from approximately 1977. The City does not have any records or

knowledge of spills or hazardous materials having been discharged or released on Fishtrap Island associated with these or other activities (Golder 2003). One contaminated site was identified close to maximum well capacity capture zone for the proposed Fishtrap Island Collector Well (Golder 2003).

9.4.2 Land Use Zoning and Site Activities

The City combines both urban and rural living, but has grown in a manner that makes the provision of utilities, amenities, and services complex. Costs associated with provision of services are, therefore, relatively high. Recognizing this development pattern and seeking ways to address such costs, the City prepared the first Official Community Plan (OCP) in 1993. In 2001, this Plan was updated to reflect more contemporary issues.

In the last decade, urban growth has been most prominent in the centrally located Bowl area. However, the relative proportion of total population growth has been declining in the Bowl area since the opening of the Hart area and southwest sector (Figure 2.3). Furthermore, the City has a young population relative to the rest of the province that suggests that demands for housing will continue to increase, particularly in the Hart area and southwest sector. Presently, the Hart area faces a limited capacity of existing well supply and water storage systems. Given the current population and the potential for population growth and urban expansion, these infrastructure shortfalls are a key issue to be addressed in the first of four phases of priority development identified by the City of Prince George (OCP 2001: 95).

Sand and gravel resource extraction is the dominant land use surrounding the proposed well and water transmission mains. Areas highlighted in the OCP as current and potential sand and gravel resources lie in the North Nechako region, located on the north side of Foothills Boulevard Bridge, and the areas both south and west of Fishtrap Island (Figure 9.17). In the long-range land-use plan, these areas will be converted to urban areas.

Two types of rural designation identified in the OCP lie near the proposed Fishtrap Island Collector Well and ancillary facilities. Less than 1 km to the west is zoned "Rural A," consisting of one 4-hectare lot intended for low intensity rural and hobby farm use. Northwest of the proposed well, west of the North Nechako area and approximately 1 km west of Foothills Boulevard is zoned "Rural C", an area slated for rural residential development with a maximum density of 4000 m^2 per lot. These low-density options will help to minimize sources of potential contamination of the aquifer. The Hart Water Supply Area is slated for low and medium density residential development that requires the provision of basic services such as the supply of water.

Well Site Zoning

The proposed Fishtrap Island Collector Well, within the Lower Nechako River Aquifer, is located on the south bank of the Nechako River on Fishtrap Island, which is designated as a Green Belt (GB) zone. Permitted land uses for this zoning classification include, but are not limited to, single-family dwellings; kennels; mobile homes; public park; and travel trailer. Section 17.3 of the City of Prince George's Zoning Bylaw specifies that *"any Public Utility use to accommodate local distribution collection or appurtenant facilities only, with no related vehicle or equipment storage, maintenance or repair, or material storage shall be permitted in any zoning district"* (Zoning Bylaw No. 3482, 1980 and updated 24 June 24 2002). However, the more appropriate zoning district for the well compound on Fishtrap Island would be the P4-A Zoning District. The intent of this district is to "*provide for electrical, water supply, storm drainage, natural gas, telephone, radio, television or other public utility facilities including all major installations, and transmission facilities, and related offices, but excludes local distribution and appurtenant facilitie*s." (Zoning Bylaw No. 3482, 1980 and updated June 24, 2002). A public utility is the only use permitted in this district. The proposed collector well site is located on land owned by the City of Prince George.

Access to the well site and pump station will be via existing roads and a BC Hydro powerline right-of-way, the latter zoned as Public Utility (P-4A) zoning district.

Water Transmission Mains Zoning

The route of the 1.9 km long 750 mm diameter water transmission main that is proposed to run north across the Nechako River to the PW607 has been described above (in Section 9.3.3) and is shown on Figure 5.4. From the collector well site, the water transmission main will travel southwards along the BC Hydro right-of way (P-4A district), turn west along an existing gravel access road (GB district), turn north along the Foothills Boulevard Bridge and into the North Nechako area (GB district and AFO-1 district) before reconnecting with the BC Hydro powerline right-of-way alongside Foothills Boulevard (P-4A district). North of the Foothills Boulevard Bridge, the water transmission main will travel through land that is already disturbed, largely from gravel mining operations. As noted above for the well site, it would be appropriate to rezone the watermain rights-of-way from the existing Green Belt to P4-A to better comply with the land use definition in the City's Zoning Bylaw.

The Forestry and Agriculture (AFO-1) zoning district is intended to "*designate and encourage the conservation and management of forest and wild lands, regardless of their current condition or status for assessment and taxation in a manner reflecting their*

existing and potential use for wood production, agriculture, livestock range, fish and wildlife habitat, watershed protection and erosion control, and recreation recognizing they may have potential for conversion to residential or other urban development or incorporation into the GB District" (Zoning Bylaw No. 3482, 1980 and updated June 24, 2002). However, this particular zone in the North Nechako area is currently used for gravel mining operations, and thus, there are few remaining trees within the corridor proposed for the water transmission main leading to PW607 next to Foothills Boulevard.

The proposed water transmission main connection leading to PW605 has been described above (in Section 9.3.3) and is shown on Figure 5.4. It will start and travel southwards along the BC Hydro right-of-way (P-4A district), turn east along the southern edge of Fishtrap Island (GB district) and continue near the existing gravel access road leading to the non-active gravel pit near the southeastern end of Fishtrap Island (M-4 district) before connecting with PW605 (P-4B district). The Mineral-Resource Industrial (M-4) zoning district is intended to provide for all major mineral-resource-processing operations subject to the provisions of the City of Prince George Soil Removal and Deposit Bylaw, No. 7022. Sand and gravel resource extraction is permitted within this district although the current gravel pit is inactive. Land uses permitted in the Public Works (P-4B) zoning district include public works, the intent is to provide for *"works or uses of any government agency or public or private utility operated for vehicle or equipment storage, maintenance or repair, or materials storage, and related office"* (Zoning Bylaw No. 3482, 1980 and updated 24 June 2002).

The proposed water transmission main directed towards PW607 from Fishtrap Island to North Nechako Road is situated entirely within dedicated Road allowance and the proposed water transmission main from Fishtrap Island to PW605 is situated on City owned land with the exception of the portion that crosses the gravel extraction area which is legally described as the Remainder of District Lot 2400 and is privately owned.

Environmentally Sensitive Areas

Fishtrap Island is currently classified as a park and a 2 km long and 100 m wide strip of riverside land on the north side of the Nechako River (across the Foothills Boulevard Bridge) is listed in the OCP as a proposed major park. On Fishtrap Island, the park is classified for passive recreational use.

Neither the proposed Fishtrap Island Collector Well nor ancillary facilities lie within environmentally sensitive areas identified by the OCP. The development of the collector well is in keeping with the environmental quality policies of the OCP. For example, the

siting of the well will be an *"adequate distance from all rivers, streams, wetlands and other watercourses to ensure a natural leave strip is maintained"* (OCP 2001: 22). As indicated above, the collector well will be located more than 50 m away from the Nechako River and is therefore beyond the Development Permit Area.

The construction of the Fishtrap Island Collector well will take into account the provincial *Streamside Protection Regulations, pursuant to the Fish Protection Act* administered by the MWLAP and DFO, which require a minimum setback of 30 m from top of bank in order to protect the banks of the Nechako River and the river itself.

9.4.3 Environmental Development Permit Area (EDPA)

As indicated in Section 5.2.1, the OCP designates all lands within 50 m of the Nechako River as Environmental Development Permit Areas. The purpose of this designation is to protect and maintain the integrity of the riparian and other environmentally sensitive areas. Provided that the construction and staging area required for the proposed Fishtrap Island Collector Well does not encroach within 50 m from top of bank of the Nechako River, an Environmental Development Permit will not be required.

Project components will be outside of the 50 m setback from the Nechako River with the exception of the approximately 100 m of water transmission main leading to PW607 that would be installed within the Road allowance approaches to the Foothills Boulevard Bridge. Depending on the final alignment of the water transmission main determined at the detailed design stage of the project, this installation may trigger an Environmental Development Permit in accordance with the City's Official Community Plan.

10.0 POTENTIAL ENVIRONMENTAL EFFECTS

This section evaluates the potential adverse effects to each of the physical, biological, cultural, and socioeconomic resources identified in Section 9.0 above associated with the construction and operation of the Fishtrap Island Collector Well and ancillary facilities comprising the Hart Water Supply Improvement Project. In addition, potential effects of the environment on the project (i.e., such as those from flooding, ice encroachment, or wind) are evaluated in Section 11.0.

This section of the Application/Comprehensive Study Report is consistent with Section 16(1)(a) of the *Canadian Environmental Assessment Act*, which requires an assessment of the environmental effects of the project. With respect to a project, an environmental effect is defined by the Canadian Environmental Assessment Act (CEAA, Section 2(1)) as follows:

(a) any change that the project may cause in the environment, including the effect of any such change on health and socioeconomic conditions, on physical and cultural heritage, on the current use of land and resources for traditional purposes by aboriginal persons, or on any structure, site or thing that is of historical, archaeological, paleontological, or architectural significance; and

(b) any change to the project that may be caused by the environment.

The determination of the "significance" of changes that the project may cause to each of the environmental resources requires a level of professional judgment to be applied. As discussed above in Section 3.0 of this Application/Comprehensive Study Report, certain impact parameters and evaluation criteria are applied to help make a systematic determination of significance (Table 3.1). The application of the impact parameters and evaluation criteria listed in Table 3.1 are also intended to reduce or eliminate biases in deciding the importance of adverse impacts to environmental resources.

The following Sections 10.1 through 10.5 provide an assessment of potential environmental effects to existing biophysical resources based on available data and quantitative analysis, where data supports these methods. In cases where existing data do not support quantitative analysis, potential environmental effects are discussed in qualitative terms. Table 10.2 at the end of this section summarizes the significance of potential environmental effects prior to mitigation to each of the resources within the context of the impact parameters and evaluation criteria listed in Table 3.1.

10.1 Hydrogeological Effects of Drawdown on the Lower Nechako River Aquifer

An estimate of the zone of influence for the proposed Fishtrap Island Collector Well and adjacent Collector Wells PW601 and PW605 was made using the three-dimensional finite difference groundwater flow model (Golder 2003). The extent of the zone of influence, defined under the four different pumping conditions summarized in Table 2.1 is presented in Figure 9.10. For illustrative purposes, "the zone of influence" was defined as the area where a drawdown of 0.2 m or greater was predicted. In our opinion, a drawdown of 0.2 m represents a relatively minor hydrogeological effect.

A review of Figure 9.10 indicates that even under projected maximum day demand (37 900 m^3/day) the zone of influence of the proposed Fishtrap Island Collector Well is limited to a discrete area that extends little more than 1 km to the south and 1500 m in an east-west direction. Under the maximum well capacity pumping condition of 93 200 m^3/day, the zone of influence is larger.

No interference effects are predicted between the proposed Fishtrap Island Collector Well and neighbouring City wells under current or projected average pumping conditions (Conditions 1 and 2, respectively). Minor interference effects between the proposed Fishtrap Island Collector Well and Wells PW605 and PW601 are predicted under projected maximum and maximum well capacity pumping conditions (Conditions 3 and 4, respectively).

A review of other water wells within these zones indicates that under the most extreme pumping conditions (Condition 4: maximum well capacity), where the zone of influence has the largest aerial extent, only two private wells fall within the zone of influence. A review of the water well record for one well indicates that it is screened in bedrock, and therefore should not be influenced by the pumping from surficial sediments associated with the proposed Fishtrap Island Collector Well. The second private well is reportedly owned by Rolling Mix, located on Otway Road and is completed in surficial sediments. The potential for interference between this well, if it still is active, and the proposed Fishtrap Island Collector Well is considered to be minor, since the estimated drawdown in the area of the private well under projected maximum pumping conditions ranges from only 0.2 m to 0.3 m. The other wells that lie within the zone of influence are test wells owned by the City of Prince George. Furthermore, there is no interference between the proposed Fishtrap Island Collector Well and three high capacity (yields in excess of 500 IGPM) private wells identified in Section 9.1.1.

10.2 Hydrological Effects on Available Flows in the Nechako River

Virtually all of the water withdrawn from the Fishtrap Island Well will originate from the Nechako River, hence its design flow of 93 200 m^3/day (1.079 m^3/s) can be compared with the flows in the Nechako River. Hydrological information indicates that the lowest mean monthly flows of the Nechako River occur in March with mean monthly flow rate of 141 m^3/s. The highest mean monthly flows occur in July with a mean monthly flow rate of 605 m^3/s. Consequently, the total withdrawal from the proposed Fishtrap Island Collector Well is approximately 0.76% of the lowest mean monthly flow and only 0.18% of the highest mean monthly flow.

The proposed withdrawal rate can also be compared with the statistical evaluations of river flow. The proposed maximum pumping rate of 93 200 m^3/day (1.079 m^3/s) represents approximately 1.1% of the estimated 2 year, 1 day low flow rate at the project site. It is also noted that over the 51 years of record approximately 8.4% of the daily flow rates lie below 100 m^3/s and about 29% lie below 150 m^3/s. Thus, the proposed maximum pumping rate falls below 1% of the daily flow rate over 90% of the time.

The effect on water levels in the Nechako River is expected to be marginal, as 1% of the base flow is well within the level of accuracy of the data being used to estimate flow rates.

10.3 Biological Effects

10.3.1 Water Quality

The following activities have the potential for generating and releasing sediments and/or other deleterious substances, particularly where excavated surfaces or stockpiles of material are encountered during construction of the collector well, water transmission mains, and along the access road:

- clearing and grubbing for the site of the collector well, water transmission mains, and access road;
- clam shell excavation and removal of gravels for development of the collector well;
- construction of a concrete caisson for the collector well;
- dewatering of sediment-laden water from the caisson chamber;
- trench excavation for the water transmission mains, particularly where the water transmission main leading to PW605 crosses the back channel at the constriction within the existing access road; and
- inadvertent release of fuels, oils, or lubricants during fuelling and/or maintenance of construction machinery on-site.

It will be necessary to minimize, and preferably prevent, any deleterious discharges associated with construction activities from entering the Nechako River, or any watercourses leading to the Nechako River, such as where the water transmission main leading to PW605 will cross the back channel along the existing access road. Recommended mitigation measures for controlling potential releases of deleterious substances include development of a Sediment and Erosion Control Plan, Spill Prevention and Emergency Response Plan, and Construction Waste Management Plan as described below in Section 14.0 (Mitigation Measures).

Following construction and assembly of the collector well and water transmission mains, it will be necessary to hydrostatically pressure test and flush the system of foreign debris such as welding residue, metal cuttings, and sources of bacteria. Typically, this will involve pressuring the system with chlorinated water to disinfect the newly constructed infrastructure.

Prior to the hydrostatic test, water being discharged to either municipal storm sewer systems or to any surface watercourse, chlorine concentrations in the test water will be tested. Concentrations of less than the 2 µg/L will have to be confirmed before discharge to meet the criterion required for the protection of aquatic life (Canadian Council of the Ministers of the Environment 1986).

Disposal of superchlorinated water may follow one or more methods including passive disposal or chemical dechlorination. Chlorine is a relatively unstable, moderately reactive element that is neutralized in the environment by reaction with the air, sunlight, or contact with organic or inorganic substances. Passive disposal may include disposal into sanitary sewers, retention holding tanks, or release to soil surfaces.

Dechlorination using chemicals may include the use of sodium bisulfite, sodium sulfite, or sodium thiosulfate. These chemicals are added to the superchlorinated water as it is being discharged from the water transmission main. The preferred method of dechlorination is to dispose of the superchlorinated water to the local sanitary sewer system. The City's procedure is to neutralize heavily chlorinated water used to disinfect watermains after construction in accordance with American Water Works Association (AWWA Standard C651-92, Appendix C). The neutralizing chemical used is sodium bisulfite. Whenever possible, the heavily chlorinated water is discharged into the City's sanitary sewer system. For the Hart Water System Improvement Project, a discharge point into the City's sanitary sewer system is available at North Nechako Road and Fairburn Road, near PW607. Using appropriate methods for testing and disposal of superchlorinated water, it is anticipated that the pressure tests, flushing, and disinfection of the system will have no considerable impact on the environment.

10.3.2 Fisheries and Other Aquatic Resources

Activities associated with the construction, development, and operation of the proposed collector well, water transmission mains, and associated access roads that could potentially have an adverse effect on fisheries and aquatic resources include the following:

- disturbance and removal of riparian vegetation that may be required for the installation of the water transmission mains and/or upgrading the existing access road;

- instream works that may be required for installation of the proposed water transmission main leading to PW605 at the crossing with the back channel;

- effects of pumping from the well on potential presence of river bottom upwellings; and

- modifications to the water levels within the Nechako River associated with drawdown caused by operation of the collector well.

It is not anticipated that construction of the collector well itself will result in the harmful alteration, disruption, or destruction (HADD) of aquatic habitat because the footprint for the well and pump house will be more than 50 m from top of bank of the Nechako River. As indicated in Section 5.2.1, allowing for a fenced compound and access requirements around the perimeter of the collector well, it is proposed that the northern edge of the collector well site would still be located more than 50 m from the top of bank of the Nechako River.

The preferred proposed water transmission main from the collector well to the Foothills Boulevard Bridge will, for the most part, be constructed outside the 50 m buffer from the top of bank of the Nechako River. The only exception will be approximately 100 m of water transmission main leading to PW607 that would be installed within the Road allowance approaches to the Foothills Boulevard Bridge. This installation may trigger an Environmental Development Permit in accordance with the City's Official Community Plan depending on the final alignment of the water transmission main determined at the detailed design stage of the project. The construction of the water transmission main will follow the existing gravel road to the Foothills Boulevard Bridge. As indicated in Section 5.0, this option is also considered to be the least environmentally intrusive and would result in no adverse impacts to aquatic, terrestrial, or cultural resources. This will avoid encroaching within the riparian zone along the riverbank.

The proposed transmission main to be constructed southeast from the collector well to PW605 will remain outside the City's EDPA (50 m from top of bank) on Fishtrap Island. This water transmission main is proposed to cross the existing gravel pit to PW605 (Figure 5.4).

Potential adverse effects, such as disturbance or removal of riparian vegetation and introduction of sediment downstream of the existing right-of-way may occur during the installation of the water transmission mains and/or upgrading the existing access road within the vicinity of the back channel. The only instream works associated with construction of the project will be those required for upgrading the existing access road and installing the 750 mm diameter water transmission main beneath the back channel. Activities undertaken adjacent to sensitive areas, such as the back channel along the south side of Fishtrap Island, will be performed in isolation from any flowing water. During low water conditions, there is typically no flow through the existing culvert beneath the access road, and the section of the back channel immediately downstream of the access road is often dry. A large snye is located at the downstream (east) end of the back channel. The snye may provide rearing and velocity refuge for juvenile and adult fish species, and there is abundant submergent vegetation within the area. At higher water levels, the back channel may be hydraulically connected to the Nechako River, but a beaver dam and culvert downstream of the access road crossing may create an upstream barrier to fish movement from the snye into the back channel.

To facilitate installation of the water transmission main across the back channel, it is recommended that flows that are normally conveyed through the culvert beneath the road be directed into a steel flume supported with sandbags. Alternatively, flows should be pumped and diverted around the trench excavation to enable installation of the water transmission main to be undertaken in the dry. If practical, however, this work will be performed when the culvert is dry.

Suitable detention facilities, such as sedimentation ponds for the containment of sediment-laden water, and/or installation of the above-referenced sediment control works are recommended to prevent accidental releases of sediments or sediment-laden water during construction of the water transmission main. Areas of disturbed ground should be re-vegetated as quickly as possible after installation of the water transmission main and during upgrading of the access road.

It is apparent from the groundwater flow modelling that recharge from the Nechako River is rapid; hence, no long-term drawdown of the Lower Nechako River Aquifer will result from operation of the proposed Fishtrap Island Collector Well (Golder 2003). In addition, the results of the modelling indicate that the portion of the Lower Nechako River Aquifer lying north of the Nechako River will be unaffected by operation of the well.

The proposed maximum pumping rate for the Fishtrap Island Collector Well is less than one percent of the daily flow rate of the Nechako River over 90% of the time. Since this

one percent is well within the level of accuracy of the estimated base flow rates (see Section 13.0), the effect of pumping on water levels in the Nechako River is expected to be marginal. Therefore, there are no potential impacts to fish and fish habitat within the Nechako River.

River Bottom Hydraulic Gradients

Under natural conditions, and in general, it is expected that the Nechako River is a losing stream[7] along most of its reach between Fishtrap Island and the Fraser River, with groundwater gradients directed to the southeast or away from, but sub-parallel to, the general flow direction of the river. In localized areas, slight changes in river direction or gradient may make small stream sections gaining sections. In these cases, there is the potential for the groundwater flow that originates from the Nechako River to re-enter the river.

During operation of the proposed Fishtrap Island Collector Well, it is anticipated that there will be steeper downward hydraulic gradients developing on the wetted perimeter of the Nechako River. These steeper hydraulic gradients are likely to bring higher concentrations of dissolved oxygen into the river bottom, possibly increasing the thickness of the hyporheic[8] zone.

Therefore, it is anticipated that operation of the well would not result in the loss of groundwater upwellings (river bottom springs), as the hydrogeological characteristics of the aquifer are not currently amenable to upwellings. The only losses of groundwater re-entering the Nechako River could occur in the localized gaining stream sections described above. The flow in these sections is little more than Nechako River water that has flowed a short distance through the aquifer and is then re-entering the river, and the water is likely depleted in dissolved oxygen as a result of interaction with chemical and organic demanding materials in the aquifer. It is assessed that there will be no adverse impact on the river bottom gradient.

[7] a *losing* stream is one in which flow of water is out of the stream into the stream bed and the surrounding groundwater. A *gaining* stream is the opposite and groundwater recharges the streamflow.

[8] the *hyporheic zone* is the interface between surface and groundwater that occurs in the stream bed. It is biologically active and is a transition area between the chemistry of the river and the chemistry of the groundwater.

10.3.3 Wildlife Resources

Potential impacts to wildlife resources and terrestrial habitat associated with development and construction activities for the collector well and ancillary facilities include temporary, localized reductions in nesting and breeding areas for birds, and over-wintering habitats for some ungulates. Wildlife habitats may be lost or temporarily altered during construction, resulting in some species being displaced and/or needing to relocate to seek other suitable habitats for refuge, shelter, and food.

Potential impacts or disturbance to wildlife that may result from construction of the Hart Water Supply Improvement project can be summarized as follows.

- Permanent but limited habitat loss resulting from the removal of trees and shrubs within the footprint of the collector well site, which currently provides limited refuge and shelter habitat for some wildlife and bird species.

- Temporary habitat loss along the vegetated portion of the water transmission main alignments. These impacts are likely to be short-term and minor since the proposed alignments of the water transmission mains will follow existing cleared areas, such as the BC Hydro powerline right-of-way, the access road along the south side of Fishtrap Island, and the Foothills Boulevard right-of-way.

- Sensory disturbance to wildlife resulting from construction noise, air emissions, and potential harassment of wildlife species by construction activity. This could result in temporary displacement of some wildlife species, and potential reduction in nesting activities and breeding success by some bird species during construction.

- Project-related wildlife injuries and mortalities resulting from accidents with construction equipment and project vehicles, incidences involving wildlife falling into or entering the trench excavation for the water transmission mains, and/or increased predation on small birds and mammals by raptors following site clearing.

However, areas of disturbance for the proposed collector well, water transmission mains, and access roads do not support unique wildlife habitats, such as raptor nests or heron rookeries, nor do they constitute integral components of wildlife corridors. Furthermore, the overall footprint of disturbance resulting from clearing activities required for the

project components is relatively small, and unlikely to have an impact on wildlife populations.

Under current average pumping conditions and projected average pumping conditions, no measurable drawdown is anticipated from operation of the proposed Fishtrap Island Collector Well in the vicinity of the back channel along the south side of Fishtrap Island. Under maximum projected pumping conditions, the drawdown is estimated to be approximately 0.4 m in the vicinity of the back channel. Therefore, drawdown caused by the operation of the collector well will not result in the loss of wetland habitat or impact the back channel habitat along the south side of Fishtrap Island.

10.3.4 Vegetation Resources

Potential impacts to vegetation resources near the proposed collector well will be limited to clearing required for excavation of the collector well, construction of the concrete caisson, and installation of the ancillary structures including the pump house, and chlorination and fluoridation facilities. The footprint of the collector well and associated facilities will be limited to an approximately 50 m by 50 m work area, most of which is only partially treed due to prior disturbances. As indicated above, the location of the collector well would respect a 50 m setback from the Nechako River to avoid removal of riparian vegetation and encroachment within the City's EDPA on Fishtrap Island.

Similarly, limited vegetation removal will be required for construction of the water transmission mains leading to existing wells at PW605 and PW607. It is anticipated that the width of the right-of-way required for construction of each water transmission main will be approximately 9 metres to facilitate pipeline installation. This includes the requisite temporary work area required for the stripping of soils and excavation of subsurface materials. It is proposed that the organic layer would be segregated for subsequent use as a growing medium during site restoration and reclamation following backfilling of the trench.

From the collector well, the proposed alignment for both transmission mains is located along the western periphery of the BC Hydro powerline right-of-way. The proposed water transmission main to service the Hart area would then turn west and be constructed within the right-of-way of the existing gravel road parallel to the south side of Fishtrap Island, and then along the Foothills Boulevard right-of-way to the pump station at PW607. The proposed water transmission main to connect with the pump station at PW605 near the southeastern tip of Fishtrap Island will also follow existing cleared areas that are generally devoid of vegetation, including through the abandoned gravel pit near the eastern end of the island.

Although there may be some limited felling and limbing of trees required, construction of these water transmission mains will not require extensive removal of existing vegetation. Any trees and shrubs that are removed during construction of the water transmission mains will be replaced as part of an overall landscaping and revegetation plan to be implemented upon completion of construction. A framework for a landscaping and revegetation plan is outlined in Section 14.0 (Mitigation Measures), which is predicated on the following objectives:

- re-establish and enhance wildlife habitat;
- control and prevent proliferation of non-native weed species through planting with a heterogeneous mixture of native tree and shrub species; and
- establish ground cover to minimize sediment sources and areas of exposed soils prone to erosion.

The continuous operation of the Fishtrap Island Collector Well will lower groundwater levels on the island, particularly in close proximity to the well. Under current average and projected average pumping conditions, the zone of influence, or area where measurable drawdown is expected, will be limited to within a few metres of the well. Under projected maximum pumping rates, the model predicts a drawdown of the water table of up to 0.6 m in the immediate vicinity of the well. This estimated drawdown declines to a maximum of 0.3 m south of the Fishtrap Island. The change in water table is expected to have little or no effect on shallow rooted plants. Vegetation close to the riparian area of the Nechako River is unlikely to be affected due to high transmissivity and local recharge characteristics of the Lower Nechako River Aquifer. It is possible that more deeply rooted tree and shrub species in close proximity to the well could be affected due to the lowering of the groundwater table. As indicated below in Section 14.0, the City of Prince George is proposing to implement a post-construction monitoring program during the initial 3 years of operation of the collector well to inspect and evaluate the general health and survivability of existing and newly planted tree and shrub species within the vicinity of the project. Among other things, the post-construction monitoring program will determine whether root systems of trees and shrubs are receiving sustainable quantities of groundwater supply.

10.4 Cultural and Heritage Effects

10.4.1 Archaeological Resources

A number of construction-related activities have the potential to impact archaeological sites should they exist in the project area. For example, clearing, excavation, and trenching have the potential to impact archaeological sites by disturbing cultural deposits and features, damaging artifacts, and destroying contextual information essential for interpreting site function and age. Less intensive activities, such as tracked vehicle travel across open ground may also damage intact archaeological sites. Increased access to archaeological sites may lead to site vandalism and/or unauthorized disturbance of deposits.

However, as no previously recorded archaeological sites have been recorded in the area of the proposed development, and the archaeological impact assessment did not find any cultural resources, little or no adverse impacts to archaeological resources are anticipated to occur as a result of the proposed project as planned. An Archaeological Resource Protection Plan (Section 14.0) is incorporated into this report which outlines the process contractors should follow in the unlikely event that archaeological materials are encountered during construction.

10.4.2 Traditional Use Resources

The Lheidli T'enneh First Nation was contacted in order to elicit traditional use information concerning the project area. No record of any information specifically referring to Fishtrap Island, the reason for its name, or traditional use activities carried out in the vicinity were found. The Lheidli T'enneh Band have completed a Traditional Land Use study for their area through a funding program with the Ministry of Forests (R. Krehbiel, Krehbiel Consulting, c/o Lheidli T’enneh First Nation, Prince George, B.C., pers. comm.). The Lheidli T'enneh First Nation communicated to Golder that there was insufficient time and capacity to perform a detailed traditional use study for the project area, and that a lack of recorded information should not be interpreted as evidence that no such activities took place in the past.

Based on general models of First Nations land use, it is considered likely that fishing, hunting and gathering activities were pursued in the vicinity of the Project Site in the past. The back-channel separating Fishtrap Island from the main shoreline appears to be good habitat for waterfowl and fish, and fur-bearing animals. Such areas tend to be a

focus for hunting, trapping and fishing activities. The historic and prehistoric vegetation regime is not known, but it is possible that the area was also used for gathering activities.

The above-noted construction activities would have temporary effects on potential traditional use activities, primarily through disturbance of vegetation and disruption of waterfowl and animals. The long-term impacts are considered to be minimal.

10.5 Economic, Social, and Health Effects

The need for improvements to the Hart Water Supply is clearly identified in the City of Prince George's Official Community Plan (OCP). Once constructed and operational, the supply of potable water from the Fishtrap Island Collector Well will enhance socio-economic conditions for the current and future population in the Hart Water Supply Area, and provide a reliable source of clean water that is relatively isolated from potential sources of contamination.

Planning for population growth is a key component of the OCP. Two of the guiding principles to growth management are as follows:

- utilize existing infrastructure in the City to encourage cost-effective development and an efficient use of land; and

- enhance existing neighbourhoods through the provision of amenities (OCP 2001: 16).

Development of the Fishtrap Island Collector Well Project fulfills both of these guiding principles. Where possible, existing infrastructure will be utilized when constructing the water transmission mains. For example, from the site of the Fishtrap Island Collector Well, the proposed alignment of both water transmission mains will be located along the western edge of the BC Hydro powerlines to the intersection with the existing gravel road along the south side of the island. The water transmission main, which will transport water to the Hart Water Supply Area leading to PW607, would then be located within the right-of-way of Foothills Boulevard and would be suspended beneath the deck of the Foothills Boulevard Bridge. As indicated above in Section 5.0 in the review of alternatives considered for the project, this represents the most technically and economically efficient method of constructing the water main.

With respect to the OCP's second guiding principle regarding growth management of the enhancement of existing neighbourhoods through the provision of amenities, the project will be designed and maintained to respect environmentally sensitive areas. For example,

and as indicated above, the footprint of the Fishtrap Island Collector Well and staging area will be situated a minimum of 50 m from the Nechako River, to avoid any undertakings within the City's Environmental Development Permit Area (EDPA).

While the proposed project is in keeping with several key components of the OCP, it is still useful to consider the City of Prince George's land use decision checklist relative to the proposed Hart Water Supply Area Improvements. This checklist is summarized in Table 10.1.

Table 10.1 Considerations for Land Use Decisions relative to the Proposed Hart Water Supply Improvement Project

Land Use Decision Check List	Response related to Hart Water Supply Improvement Project
Will this decision enhance the quality of life for residents of Prince George?	Fishtrap Island Collector Well will provide a secure, reliable source of potable water supply that is isolated from potential sources of contamination. It will enable discontinuing the use of PW607 (which is vulnerable to potential contamination from landfill leachate) and will serve as a back-up water supply to PW605. (see Sections 10.1, 10.3.1, and 14.1)
Do these decisions support the growth and re-development of the downtown? Will this decision or action make the downtown a more successful and beautiful part of the city?	Fishtrap Island Collector Well will support current and future demands for a continued source of reliable, secure, clean potable water to service various areas of the City. (see Section 4.0)
Will this decision create long-term, sustainable jobs that are an asset to the community and the local economy?	Construction of Fishtrap Island Collector Well and ancillary facilities will generate short-term demand for skilled and unskilled labour. Most of the skilled labour and trades required for construction of Fishtrap Island Collector Well are expected to originate from Prince George area. (see Section 6.4)
Is this decision compatible with the growth management objectives and in the best long-term interests of the community?	Fishtrap Island Collector Well meets the growth management objectives of utilizing existing infrastructure and enhancing amenities, as indicated above. Fishtrap Island Collector Well meets the long-term interests of the community by providing a reliable, secured source of water while enabling the discontinuing the use of PW607, which is prone to contamination. (see Section 4.0)
Has the community been given full information on this decision, have they been consulted, and does the decision have the understanding of the community?	Consultation has been initiated with key stakeholders who rely on the Nechako River and/or the Lower Nechako River Aquifer for water supply within the City limits, downstream of Fishtrap Island and/or who may have traditional or territorial rights to the water

Land Use Decision Check List	Response related to Hart Water Supply Improvement Project
	resources within the lower reaches of the Nechako River watershed. Once the Application/Comprehensive Study Report is submitted to the British Columbia Environmental Assessment Office, the Canadian Environmental Assessment Agency, and other regulatory review agencies, the City of Prince George will engage in a broader public consultation campaign. Typically, this would consist of placing advertisements in the local newspaper, and posting notices of the assessment on the City's website. (see Sections 16.0 and 17.0)
Does this decision respect the character and nature of the local neighbourhood? Does it make this neighbourhood a better place?	The Footprint of Fishtrap Island Collector Well and ancillary facilities is relatively small, unobtrusive, and less conspicuous than nearby industrial land uses, such as nearby gravel mining operations.
Are the needs of all members of the community being met, including those who cannot speak for themselves?	The City of Prince George has a fiduciary responsibility to supply a reliable, clean, disease- and contaminant-free supply of drinking water to residents.
Is the decision such that community development is economically sound and cost effective from an overall community perspective?	Based on a review of alternative means of undertaking the project, with respect to the location of the Fishtrap Island Collector Well and alignment for the water transmission mains, the preferred option was determined to be the most technically and economically efficient. Furthermore, it is consistent with the City's existing water supply system and obviates the need for a treatment plant. (see Section 5.0)
Will this decision support the City's commitment to sustainability and does it respect and enhance the natural environment? Will our children be proud of this decision?	Operation of the Fishtrap Island Collector Well is deemed sustainable because recharge of the Lower Nechako River Aquifer is sustained by virtually immediate exchange from the Nechako River. Based on maximum design pumping rates,

Land Use Decision Check List	Response related to Hart Water Supply Improvement Project
	groundwater withdrawal from the proposed Fishtrap Island Collector Well represents only approximately 0.8% of low flows in the Nechako River. Siting of the Fishtrap Island Collector Well and ancillary facilities has been selected to avoid encroachment into, or alteration of, environmentally sensitive areas or municipally designated Environmental Development Permit Areas (EDPA). (see Sections 9.0)
Does this new development reflect the unique character of this place? Does it bring a positive change to the community? Does it reflect the beauty of the natural surroundings, and encourage community pride? Does it account for climatic variations and does it enhance the winter environment?	The Fishtrap Island Collector Well and ancillary facilities will support positive change to the community by providing a reliable source of water supply, while supporting sustainable growth management objectives.

The majority of the responses in Table 10.1 suggest that the proposed project will enhance socio-economic conditions within the City of Prince George, while maintaining the ecological values of the existing environment.

10.5.1 Financial and Health Benefits Associated with the Project

The installation of a new collector well at Fishtrap Island, similar to the two existing City operated collector wells, PW605 and PW601, can be expected to deliver a highly productive, reliable, high quality, source of water at relatively low capital cost and low operation and maintenance (O&M) costs in comparison to other possible water source alternatives.

For example, the City has operated its oldest collector well, PW605, for thirty years and the source continues to provide water of excellent quality at an O&M cost of about 1.8 cents per cubic metre of production. It produced 11.6 million cubic metres in 2002 or about 32 000 cubic metres per day (information provided by City Utility Division). An alternative to the collector would be a river intake system to extract water directly from the Nechako River. Dayton & Knight Ltd. advises that the O&M costs for producing similar volumes of water with a river water intake supply system, which would require filtration and treatment facilities, are typically between 3 and 4 cents per cubic metre.

Likewise, the capital costs of constructing a river water intake system are considerably higher than that of a collector well. The estimated capital cost to install a collector well and pump station at Fishtrap Island is $5.5M, whereas a river water intake system with filtration and treatment facilities would start at approximately $12M, according to Dayton & Knight Ltd., who have recently completed water treatment plant installations in other municipalities within British Columbia such as Revelstoke.

The existing Prince George collector wells have a proven track record for providing a reliable source of potable water virtually free of pathogenic sources of contamination. The City has never had a confirmed positive coliform bacteria test result in any of its collector wells (Marco Fornari, Manager of Utilities, City of Prince George, pers. comm.). Because of this, the City's water is used as a baseline reference for comparing the presence of pathogens in municipal water supplies.

As indicated in Section 5.0, the proposed location and general arrangement for the Fishtrap Island Collector Well and ancillary facilities, including the water transmission mains and new access road from Foothills Boulevard, meet certain criteria for being the most technically and economically feasible compared to alternative means for undertaking the project that were considered.

In addition, the proposed Fishtrap Island Collector Well would enable the decommissioning of PW607, which is vulnerable to contamination from landfill leachate. In doing so, the new collector well will provide a secure and reliable source of potable water free from potential contaminants. In turn, this would ensure that the City maintains the integrity and quality of a healthy drinking water source while meeting current and projected demands in the Hart Water Supply Area. Furthermore, the proposed Fishtrap Island Collector Well would provide a backup water supply source to PW605, which supplies water to the West Bowl area and southern part of the City.

10.5.2 Surrounding Land Uses

Fishtrap Island Collector Well Site

The proposed Fishtrap Island Collector Well site and pump station would be constructed adjacent to, and be accessed in part via, a BC Hydro powerline right-of-way. Fishtrap Island is surrounded by industrial land uses, most notably the nearby Canadian National Railway (CNR) line, which parallels the south side of Fishtrap Island; a public works yard for PW605; active gravel mining operations north of the Nechako River along Foothills Boulevard; and an inactive gravel pit near the southeastern end of the island.

Zoning changes require not a necessity for the construction or operation of the collector well.

Given that Fishtrap Island is currently classified as a municipal park within a Greenbelt Zone, the construction of the collector well and pump station may generate short-term and localized impacts to recreation enthusiasts. Construction of the well may temporarily conflict with recreation, particularly as there may be some increased traffic, noise and air emissions that might diminish the quality of the experience for the recreation enthusiasts. Such impacts will cease once construction is completed, and the collector well is in operation. These impacts are not expected to adversely change the current recreational values or activities on Fishtrap Island given their short duration and low magnitude, and the presence of numerous alternative recreation sites nearby.

As indicated above in the evaluation of project alternatives, the site of the Fishtrap Island Collector Well has been chosen because it meets the following criteria:

- maintains a 50 m vegetated buffer from the Nechako River, and is therefore outside of the municipally designated EDPA and DFO's riparian requirement;
- minimizes disturbance to trees and other vegetation, as it is located in a small clearing and can be accessed from the BC Hydro powerline right-of-way; and
- provides the greatest degree of protection from potential sources of contamination from the south (CN railway) and from the north (gravel mining operations and landfill).

A few residents in the area south of Fishtrap Island may experience minor and temporary traffic disruptions as well as increased air emissions and noise levels during operation of the construction machinery. However, this is unlikely to be substantial given that the closest resident is approximately 670 m away. Implementing best management practices (BMPs) and abiding by the City of Prince George's Noise Control Bylaw can mitigate potential air emissions and noise impacts associated with the project.

It is not anticipated that noise from the proposed Fishtrap Island Collector Well pump station will adversely impact the local residents. The proposed pump station is approximately 560 m from the nearest residence. However, during the design stage an acoustic consultant will review the project and establish design criteria, and provide recommendations for mitigating noise from the building ventilation fans, and the exhaust from the standby generator.

Public safety during construction and operation of the project will be of utmost importance. Training in safety and WHMIS standards will occur to ensure that all personnel involved in the construction and operation of the project comply with safe practices and procedures for bulk storage and delivery of the disinfection product (i.e., chlorine) and for the power supply connection from the existing BC Hydro right-of-way to the Fishtrap Island Collector Well.

Active work sites will be secured with fencing and signage to minimize potential for unauthorized public access. The City will require its contractors to develop and implement a traffic management plan should it be necessary to redirect or divert traffic along existing access roads within the vicinity of the well site.

Water Transmission Mains

The proposed water transmission mains are surrounded by existing industrial land uses, including sand and gravel resource extraction sites (both active and inactive) and a public works yard (PW605). No zoning changes will be required for construction or commissioning of the proposed water transmission mains. There may be localized disruptions to traffic patterns during construction of the water transmission mains along Foothills Boulevard leading to PW607 and along the existing gravel access road leading through the abandoned gravel pit to PW605. To minimize the extent of these disturbances and to ensure that public safety is not compromised, it is proposed that a new off-ramp be constructed from Foothills Boulevard to Fishtrap Island. Specifically, the off-ramp would start at Foothills Boulevard and tie into the existing gravel road that parallels the south side of the island and then leads to the BC Hydro powerline right-of-way.

There are three benefits to establishing a new access ramp during construction of the water transmission mains and the collector well. First, this option would provide a shorter (approximately 500 m) travel distance to the collector well site rather than accessing the site from Otway Road. Second, the new ramp would greatly reduce the requirement for construction traffic to travel through residential areas and to cross over the CN railway line, thereby affording greater safety benefits. Third, development of this access corridor from the west would provide an alternate egress route from the collector well site in the event of an emergency, especially if there was a train blocking access to Fishtrap Island.

A few residents may experience minor and temporary traffic disruptions as well as increased air emissions and noise levels during operation of the construction machinery for the installation of the water transmission mains. Near its northern end, the proposed water transmission main comes within approximately 200 m of the nearest residential

area. Implementing BMPs and abiding by the City of Prince George's Noise Control Bylaw can mitigate potential air emissions and noise impacts associated with the project.

10.5.3 Wells and other Water Licences

As has been shown, the impact of the proposed Fishtrap Island Collector Well is limited, and even under the most extreme pumping conditions, its zone of influence only encompass two existing private wells which the impact will be minimal. Users of the Lower Nechako River Aquifer upstream and downstream, and across the river will not notice any discernible effect from the proposed Fishtrap Island Collector Well.

With regards to other water licence holders downstream of Fishtrap Island, the potential withdrawal rate will not have an impact on their licensed amount of water withdrawal. The total volume of flow to be withdrawn will be on the order of 1.079 m^3/s, whereas the net withdrawals on the reach from Isle Pierre downstream to the confluence with the Fraser will be 14.47 m^3/s. It is expected that the potential to reduce water supply to downstream users is minimal, as the total incremental withdrawal for the collector well constitutes less than 10% of the existing water licences on this reach of the river and less than 1% of the actual river flow over 90% of the time.

10.5.4 Renewable Resources

The primary impact of the proposed collector well could result in drawdown of the groundwater levels in the Lower Nechako River Aquifer, particularly in the area close to the well. The groundwater levels and quality will return to the natural condition if the well is shut down for an extended period. The project is not anticipated to result in any adverse changes or effects in the productive capacity of the aquifer to meet present or future needs.

Secondary impacts may occur during the construction phase of the proposed project that will require the use of both non-renewable and renewable resources, including such materials as gravel, sand, steel, glass, concrete, asphalt, paper products, and wood. The demand for these materials will be limited to the duration of the construction period, and will not be required on an ongoing basis during operation of the Fishtrap Island Collector Well.

Natural gas or propane would be consumed in small quantities during the construction process. Typical uses would be in some construction equipment and in heaters during winter construction. Diesel fuel and gasoline consumption for portable generators,

vehicles, and other construction equipment during the construction phase may be required but should have no adverse impacts on renewable resources.

During construction, electricity will be used for lighting and heating in construction offices, temporary lighting at the facility, and to provide power to construction equipment. During non-working hours, electricity consumption will primarily be for lighting for security purposes.

Some onsite soil will be removed and disposed of at approved sites. Various quantities of fill, including sand and gravel, will also be imported to the site. In addition, construction materials will be brought to the site including concrete, steel, and metal piping for the water transmission mains. Acquisition of fill material and sand and gravel would be the responsibility of the City's construction contractor, so specific sources have not been identified. No adverse impacts are anticipated from the use of these resources.

Conservation of renewable resources will take place through the implementation and use of industry standard best management practices (BMPs) by the City's selected contractor. These BMPs may include the use of energy-efficient lighting, lighting of only critical areas during non-working hours, efficient scheduling of construction crews, minimizing idling of construction equipment, recycling of used motor oils and hydraulic fluids, and implementation of signage to remind construction workers to conserve energy and water.

10.6 Potential Environmental Effects Summary

Based on the impact parameters and evaluation criteria described in Section 3.0, development of the Hart Water Supply Improvement Fishtrap Island Collector Well Project is not anticipated to result in significant adverse effects to any of the environmental components. Table 10.2 summarizes the assessment of potential environmental effects discussed in this section of the Application/Comprehensive Study Report. In most cases, potential environmental effects associated with the project are considered to be negligible, low, or moderate when the evaluation criteria described in Section 3.0 are applied.

The City of Prince George is committed to further reducing the degree of potential impacts by developing and implementing the mitigation measures and protection plans described below in Section 14.0. Section 15.0 provides a comparative summary of the significance of potential environmental effects presented here, with residual environmental effects following mitigation.

Table 10.2 Summary of Potential Environmental Effects Before Mitigation for the Hart Water Supply Improvement Fishtrap Island Collector Well Project

Issue	Impact Characteristics	Environmental Consequence (prior to mitigation)
Hydrogeology		
Impacts on groundwater quantities in conjunction with other wells in the Lower Nechako River Aquifer	• Magnitude: Negligible (0) – two private wells identified within zone of influence; minor interference effects with adjacent City wells • Geographic Extent: Local (0) - zone of influence under projected maximum pumping conditions is limited to 1 km south of Fishtrap Island Collector Well, and 1500 m east-west • Duration: Long-term (+2) - as groundwater withdrawals will be in effect during operation phase of Project, thereby exceeding 60 days duration • Frequency: High (+2) - as groundwater withdrawal will be ongoing during Project operation • Reversibility: No (+3) - does not return to baseline conditions during operation of Fishtrap Island Collector Well	Low (+7)
Hydrology		
Impacts on near surface water tables, and flows and levels in the Nechako River	• Magnitude: Negligible (0) - less than 1% change over baseline 90% of the time. Groundwater withdrawals from the Fishtrap Island Collector Well represents approximately 0.76% of lowest mean monthly flows and 0.18% of highest mean monthly flow in the Nechako River • Geographic Extent: Local (0) - as influence of groundwater withdrawals on Nechako River will be limited to a 1500 m radius (hence less than 2 km) • Duration: Long-term (+2) - as groundwater withdrawals will be in effect during operation phase of Project, thereby exceeding 60 days duration • Frequency: High (+2) - as effects would be continuous during Project operation • Reversibility No (+3) - does not return to baseline conditions during operation of Fishtrap Island Collector Well	Low (+7)

Issue	Impact Characteristics	Environmental Consequence (prior to mitigation)
Biological Effects		
Water Quality		
Impacts on water quality during construction of the collector well, water transmission mains, and access road	• Magnitude: Low (+5) - based on a qualitative assessment of construction impacts • Geographic Extent: Local (0) - as influence of water quality impacts during construction will be limited to less than 2 km radius from construction activities • Duration: Long –term (+2) - since duration of construction will be greater than 60 days • Frequency: High (+2) - since impacts on water quality could exceed 10 times per year without implementation of mitigation measures • Reversibility: Yes (-3) – since water quality conditions will return to baseline levels following construction of project components	Low (+6)
Fisheries and Aquatic Resources		
Impacts to fisheries and aquatic resources related to habitat alteration and introduction of deleterious substances	• Magnitude: Low (+5) - because project design and layout avoids most fisheries sensitive zones (i.e., 30 m from top of bank), with the exception of the proposed watercourse crossing along the access road over the constriction in the back channel for the water transmission main leading to PW605 • Geographic Extent: Local (0) - as potential impacts to fisheries resources will be limited to less than 2 km radius from project area • Duration: Short term (0) - since water transmission main construction across back channel can be undertaken in less than 30 days • Frequency: Low (0) - since only 1 crossing is required for the water transmission main construction to PW605, and since the water transmission main leading to PW607 will be installed within the structural girders of the Foothills Boulevard Bridge • Reversibility: Yes (-3) - since habitat conditions will return to baseline conditions following construction	Negligible (+2)

Issue	Impact Characteristics	Environmental Consequence (prior to mitigation)
Impact to fisheries and aquatic resources related to potential drawdown and lowered water levels in the Nechako River, during operation of the collector well	• Magnitude: Negligible (0) - since the maximum pumping rate of the Fishtrap Island Collector Well is less than 1% of the base flow rate within the Nechako River • Geographic Extent: Local (0) - since potential effects of drawdown in the Nechako River will be limited to less than 2 km distance from the collector well • Duration: Long term (+2) - during operation of collector well (i.e. exceeds 60 days duration) • Frequency: High (+2) - since the collector well will operate more than 10 times per year • Reversibility: No (-3)	Negligible (+1)
Impacts to fisheries and aquatic resources resulting from loss of groundwater upwellings	• Magnitude: Negligible (0) - since the existing hydrogeological gradient of the Lower Nechako River Aquifer is generally away from the Nechako River ; therefore, operation of the Fishtrap Island collector well is not anticipated to result in loss of groundwater upwellings (since they are not a naturally occurring phenomena) • Geographic Extent: N/A • Duration: N/A • Frequency: N/A • Reversibility: N/A	Negligible (0)
Wildlife Resources		
Loss of wildlife habitat and disturbance to wildlife resources	• Magnitude: Low (+5) - since the footprint of the collector well and water transmission line corridors do not support important wildlife habitats including raptor nests, heron rookeries, or other unique features. Drawdown in water table level from operation of collector well is not expected to adversely affect back channel • Geographic Extent: Local (0) - within a 2 km radius • Duration: Long term (+2) - greater than 60 days • Frequency: Moderate (+1) - disturbance during site clearing and excavation activities throughout construction of well and water transmission mains • Reversibility: No (+3) - since once the collector well is constructed, it will occupy an area which is currently vegetated and supports wildlife habitat	Moderate (+11)

Issue	Impact Characteristics	Environmental Consequence (prior to mitigation)
Vegetation Resources		
	• Magnitude: Low (+5) • Geographic Extent: Local (0) - since footprint of collector well would be limited to approximately a 50 m by 50 m area, most of which is only partially vegetated due to previous disturbances. Clearing for water transmission line mains would utilize, as much as possible, previously cleared and disturbed areas such as the BC Hydro transmission line right-of-way, the Foothills Boulevard right-of-way, and the access road on Fishtrap Island • Duration: Medium term (+1) - since clearing of vegetation for collector well and water transmission mains will likely be undertaken in less than 60 days • Frequency: Low (0) - since clearing activities will be limited to a one-time event at the start of construction • Reversibility: No (+3) - vegetation to be cleared for the footprint of the compound for the collector well will not be replaced, although surrounding areas will be revegetated to enhance wildlife habitat	Low (+9)
Cultural and Heritage Resources		
Impact to archaeological sites and artifacts	• Magnitude: Negligible (0) - since the archaeological impact assessment (AIA) confirmed there was no cultural resources within the project area • Geographic Extent: N/A • Duration: N/A • Frequency: N/A • Reversibility: N/A	Negligible (0)
Impact on traditional land use activities by the Lheidli T'enneh First Nation	• Magnitude: Low (+5) - since construction and operation of the collector well and water transmission mains are unlikely to result in measurable changes to potential traditional uses of Fishtrap Island over existing conditions • Geographic Extent: Local (0) - since it is possible that the back channel separating Fishtrap Island from the main shoreline may have been used for hunting, trapping, and fishing activities • Duration: Long term (+2) - since construction activities will create disturbances to vegetation and disruption of waterfowl and animals greater than 60 days	Negligible (+4)

Issue	Impact Characteristics	Environmental Consequence (prior to mitigation)
	• Frequency: Low (0) • Reversibility: Yes (-3)	
Economic, Social, and Health Effects		
Impacts on economy and workforce	• Magnitude: Negligible (0) - impacts will be positive since development of Fishtrap Island Collector Well will support current and future demands for reliable source of potable water supply, while supporting sustainable growth management objectives • Geographic Extent: Municipal (+1) - skilled labour and trades required for construction of Fishtrap Island Collector Well and ancillary facilities some of which are expected to originate from Prince George area • Duration: Long term (+2) – since construction of collector well and water transmission mains is anticipated to span a 20 month period (therefore, greater than 60 days) • Frequency: N/A • Reversibility: N/A	Negligible (+3)
Impacts on social/ recreational values of Fishtrap Island as a municipal park within a Greenbelt Zone	• Magnitude: Low (+5) - since site disturbance associated with construction of the collector well and water transmission mains will affect less than 5% of the area on Fishtrap Island, most which has already been disturbed by existing access roads, the BC Hydro transmission line right-of-way, and the abandoned gravel pit near the east end of the island; no zoning or land use changes will be required for the construction and operation of the collector well; in addition, there will be some traffic disturbances during construction of the collector well and water transmission mains • Geographic Extent: Local (0) • Duration: Long term (+2) - since construction of collector well and water transmission mains is anticipated to span a 20 month period (therefore, greater than 60 days) • Frequency: N/A • Reversibility: No (+3) - even though recreational activities and values on Fishtrap Island are expected to resume to existing conditions following construction of the well and water transmission mains, there will be low-level noise and glare (lighting) impacts during the operation of the well	Low (+10)

Issue	Impact Characteristics	Environmental Consequence (prior to mitigation)
Impacts on wells and licensed surface water withdrawals	• Magnitude: Negligible (0) – no effect on two private wells within Lower Nechako River Aquifer; total incremental withdrawal from collector well constitutes less than 1% of river flow discharge over 90% of the time • Geographic Extent: Local (0) - since zone of influence of other wells and licensed surface water withdrawals will be limited to less than 2 km from collector well • Duration: Long-term (+2) - as groundwater withdrawals will be in effect during operation phase of Project, thereby exceeding 60 days duration • Frequency: High (+2) - since groundwater withdrawal from collector well will be ongoing during Project operation • Reversibility: No (+3) – does not return to baseline conditions during operation of Fishtrap Island Collector Well	Low (+7)
Impact on renewable resources	• Magnitude: Negligible (0) - relatively small demand for consumption of renewable and non-renewable resources during construction and operation of the project • Geographic Extent: Local (0) • Duration: Long-term (+2) - requirements for small quantities of fuel for diesel generator as a back-up power source in the event of power outages • Frequency: Low (0) • Reversibility: Yes (-3)	Negligible (-1)

11.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

11.1 Flooding and Erosion Hazards

The proposed location for the collector well is situated within the 1 in 200 year floodplain of the Nechako River. The topography of Fishtrap Island in the vicinity of the proposed works varies from approximately 573 to 575 m ASL, which lies below the 1 in 200 year flood level of approximately 575.5 m ASL.

Spot elevations range up to about 574.8 m on Fishtrap Island; thus, consideration of the potential for flooding is to be included in the overall design criteria for the project. Adequate flood proofing measures for instrumentation, controls and working areas are to be achieved by way of filling to raise site grade or other structural means.

11.2 Ice Encroachment and Scour Hazards

The potential for scour due to river forces and possibly ice forces does exist. Erosion of Fishtrap Island itself will likely occur from the upstream end, with likely deposition in the lee of the island (or downstream end).

11.3 Wind Hazards

Prince George is not considered an area of high wind load. All structures and ancillary features constructed as part of this project will conform to applicable building codes with regards to wind load.

11.4 Earthquake Hazards

The project site is located in Seismic Zone 2 for BC. All structures and ancillary features constructed as part of this project will conform to applicable building codes with regards to seismic effects.

12.0 ACCIDENTS, MALFUNCTIONS AND ADVERSE CONDITIONS

In this section, potential accidents, malfunctions, and adverse conditions that might occur during the construction and operation phases of the Hart Water Supply Improvement Project are reviewed, and preventative measures that would need to be taken to minimize the risk of accidents and malfunctions occurring are identified.

12.1 Construction Phase

Potential accidents and malfunctions that could occur during the construction phase of the project include the following:

- Spills or releases of fuels, hydrocarbons (i.e., hydraulic oil, motor oil, etc.), or antifreeze from construction machinery.

- Damage to other utilities such as the BC Hydro powerline poles on Fishtrap Island.

- Accidents involving motorists, recreation enthusiasts, and the general public entering and leaving Fishtrap Island or traveling along Foothills Boulevard during water main construction activities. Accident prevention and protection of public safety will be of particular concern during the excavation for the water transmission mains and construction of the collector well and pump station.

- Leak or rupture along the water transmission main, such as along a weld seam, hydrostatic pressure testing procedures, resulting in potential release of chlorinated water to the Nechako River.

To minimize the likelihood and severity of the occurrence of accidents and malfunctions occurring, it is recommended that the following mitigation measures and environmental management component plans be developed and implemented.

12.1.1 Emergency Response and Spill Contingency Plan

An Emergency Response and Spill Contingency Plan are to be implemented during all construction activities dealing with procedures related to re-fueling of construction machinery, storage and handling of hazardous materials. As indicated in Section 14.0, it is recommended that the City's contractors have in place a Spill Prevention and Emergency Response Plan. This is critical in view of undertaking the works within the Lower Nechako River Aquifer and near the Nechako River. Typically, the Spill Prevention and Emergency Response Plan should address the following:

- a general measure of the probability and severity of an adverse effect to health, property, or the environment on the basis of fuel, oil, and other hazardous materials consumed, handled, and stored;

- spill or release notification and alerting procedures;
- containment, recovery, and clean-up procedures;
- on-site spill or release clean-up materials, equipment, and locations; and
- names and telephone numbers of persons and organizations that may be contacted in the event of a potential environmental incident.

12.1.2 Traffic Management Plan

A Traffic Management Plan should be prepared for diverting traffic away from construction areas, for coordinating flow of construction traffic to and from Fishtrap Island, and for restricting public access from active construction areas.

12.1.3 Health and Safety Management Plan

A Health and Safety Management Plan dealing with specific procedures and protocols for working around construction sites should be prepared. It is recommended that location of other utility rights-of-way and structures are clearly identified and/or barricaded (as in the case of the BC Hydro power transmission poles on Fishtrap Island) in the field prior to mobilization of construction equipment. Development and implementation of this plan will be the responsibility of the City of Prince George's contractor.

12.1.4 Hydrostatic Pressure Testing Plan

The Hydrostatic Pressure Testing Plan should include specific procedures and protocols for the supply and disposal of test water required for the hydrostatic pressure testing of the water transmission mains to ensure that there are no releases of chlorinated water to the Nechako River, or any of its tributaries. Development and implementation of this plan will be the responsibility of the City of Prince George's contractor.

12.1.5 Caisson Safety Plan

The well constructors have their own Caisson Safety Plan. This plan is designed to protect the safety of both the site workers and the general public. In general terms it consists of the following:

- confined entry procedures when workers re-enter the caisson (testing for H_2S and oxygen concentration at the base of the caisson using a drop tube from the top of the caisson and surface sensors);

- forced fresh air provided to the bottom of the caisson when personnel are in caisson;

- steel safety basket, winch line and safety lines for entry and exit of the caisson;

- filling of the caisson with water during down periods and provision of a side ladder to avoid long falls when the caisson is not being worked on;

- temporary construction cover for the caisson when it is not being worked on;

- provision of required personal protective equipment for the work being conducted;

- general good safety practice with respect to the work performed and hoisting of heavy equipment and materials up and down the caisson; and

- contact and discussion with WCB prior to construction.

12.2 Operation Phase

During the operation phase of the Fishtrap Island Collector Well, the potential risk for accidents and malfunctions will be minimal. The potential exists for a spill or release of the disinfection compound (i.e., chlorine) during the storage or transportation of this product within the vicinity of the well site. However, the likelihood of an accidental release of disinfection compound is considered minimal, recognizing that the City has strict safety requirements for the storage and handling of chlorine in accordance with the *Workplace Hazardous Materials Information Systems* (WHMIS) and *Workers Compensation Board* (WCB) Regulations. Furthermore, since the collector well site would be greater than 50 m from the Nechako River, and because the topography of the island at this location is relatively flat, a potential spill or release of chlorine to the ground would be unlikely to travel to or enter the Nechako River.

The City has operated parts of the existing water system network since the 1930s and in 1963 opened a major pump station, PW603, to distribute water throughout the City. Utilities Division has advised that to their knowledge there has never been an incident

involving a chemical spill or release of disinfection product during the operation of the system.

Back-up power for the collector well will be provided by a diesel generator at the wellhead pump house. Approximately 400 L of diesel fuel will be stored in a double-walled tank within a room containing the tank and the diesel generator. The generator room will be designed to act as secondary containment for any potential diesel fuel spills or releases. Containment will be provided for fueling trucks at the wellhead by way of a covered pad with containment volume equal to the volume of the largest fuel truck that will deliver fuel. Spill kits will be kept at the wellhead to allow ready clean up of any spills.

13.0 CUMULATIVE ENVIRONMENTAL EFFECTS

In addition to the above project-related environmental effects associated with the construction and operation of the proposed Hart Water Supply Improvements Project, it is necessary to consider potential cumulative environmental effects of the Project in combination with other proposed or existing projects and activities within the same general vicinity.

The total potential major groundwater withdrawals from the Lower Nechako River Aquifer are summarized below (Table 13.1).

Table 13.1 Cumulative Withdrawals from Lower Nechako River Aquifer and the Nechako River Compared with Seasonal Flows in the Nechako River

Well	Withdrawals		Percent of Nechako River Flow	
	m^3/day	m^3/s	Low Flow	High Flow
Fishtrap Well [a]	93 200	1.08	0.8	0.1
PW601 [a]	93 200	1.08	0.8	0.1
PW605 [a]	68 190[d]	0.79	0.6	0.1
Total City	**254 590**	**2.95**	**2.3**	**0.3**
Water licences [b]	1 250 208	14.47	11.3	1.4
Canfor Collector Well	74 000	0.86	0.7	0.1
Fishery Well [c]	3 273	0.04	0.0	0.0
Brewery Well	300	0.00	0.0	0.0
Total Aquifer		**18.31**	**14.3**	**1.8**

Notes: Nechako River low mean monthly flow 141 m^3/s
Nechako River high mean monthly flow 605 m^3/s

[a] potential withdrawal

[b] surface water withdrawal from the Nechako River Isle Pierre to Fraser River
[c] inferred flow rate
[d] for the capture zone analysis, a withdrawal rate of 93 200 m^3/day was assumed for PW605, resulting in a more conservative (larger) capture zone

The potential withdrawal rates from the Lower Nechako River Aquifer for the City's collector wells represent the maximum design capacity of the wells. The design capacities of the wells are greater than current and 20 year projected withdrawal rates from the wells by a factor of almost three times. It is noted that all of these withdrawals from the aquifer are replenished principally from the Nechako River, with minor replenishment from the Fraser River for City wells located close to the Fraser and possibly the Canfor Collector Well. Replenishment is virtually instantaneous. The total cumulative withdrawal from the Lower Nechako River Aquifer by the operation of the proposed Fishtrap Island Collector Well under design flow conditions is 2.95 m^3/s. As noted previously, the lowest mean monthly flow of the Nechako River occurs in March with an estimated average flow rate of approximately 141 m^3/s. The highest mean monthly flow occurs in July with a mean monthly flow rate of 605 m^3/s. Hence, the design withdrawal flows represent approximately only 2.1% of the lowest mean monthly flow and less than 0.5% of the highest mean monthly flow of the Nechako River. The actual 20-year projected demand is considerably less, and hence, the cumulative withdrawal from the Nechako River accounting for all wells operating simultaneously is considerably less.

Demands from other wells in the Lower Nechako River Aquifer within the City limits raise the total potential demand of wells in the Lower Nechako River Aquifer to approximately 3% of the mean monthly low flow, and 0.4% of the maximum mean monthly flow. Other than the collector wells (PW601 and PW605), the City of Prince George's wells are not considered. If the design flows were realized for the City, then the three operational collector wells would more than satisfy the demand of the population for the Fraser-Fort George area.

Figure 9.8 shows the modelled capture areas developed by the three City wells operating concurrently under four different pumping conditions. Figure 9.10 shows the zone of influence of the three City collector wells operating under four different pumping conditions. All of the drawdown occurs south of the wells in a band (the outer limits of which represents 20 cm of drawdown induced by the City Collector Wells). There is no modelled influence from the wells across the Nechako River to the north. The drawdown induced by the Canfor Collector is also shown. There is no influence from the Canfor Collector to the south across the Nechako River, and there is no interference between the City's Collector Wells and the private Canfor well. Thus, based on the design flows of

the wells operating concurrently and using the calibrated model, the following has been determined.

- The influence of the City's wells is limited to an area southwest of the locations of the wells shown on Figure 9.10. The capture area of the wells is substantially smaller. There is no influence on wells on the north side of the Nechako River nor is there influence on wells more than approximately 1 km west of the proposed Fishtrap Island Collector Well.

- The influence of the Canfor Well is limited to the north of the Nechako River, and there is no interference between it and the City's wells.

- Wells completed in the western part of the Lower Nechako River Aquifer will be unaffected by the operation of the collector wells.

14.0 MITIGATION MEASURES: ENVIRONMENTAL MANAGEMENT PLAN

This Section provides details of mitigation measures and environmental management plans to be implemented during construction and operation of the Fishtrap Island Collector Well project to minimize or avoid adverse effects.

14.1 Wellhead and Aquifer Protection Plan

14.1.1 Groundwater Protection Planning

The City of Prince George has made significant efforts towards groundwater protection planning through the commissioning of two phases of work over the period of March 2002 through March 2003. The work consisted of: determining the capture zones and travel time zones for all the municipal groundwater supply wells in the City; identifying potential sources of contamination that may serve as a threat to groundwater quality; and providing a review of the current groundwater monitoring programs conducted by the City. The results of the study were presented in Golder's March 27, 2003 report titled "*Capture Zone Analysis, Contaminant Inventory and Preliminary Groundwater Monitoring Plan, City of Prince George"*.

The results of the capture zone analysis and contaminant inventory for the proposed Fishtrap Island Collector Well from the Golder (2003) study were presented in Section 9.1.1. A number of recommendations for additional work were provided in Golder's 2003 report, including but not limited to: refinement of the numerical model and associated capture zones (following the collection of additional water-level

monitoring data), identification of additional contaminant concerns in the refined capture zones, designation of formal groundwater protection areas, implementation of the proposed groundwater monitoring program, development of groundwater protection measures, initiation of a public awareness campaign, development of partnerships, and contingency and emergency response planning.

In our opinion, work related to the refinement of the capture zones and contaminant inventory is required, together with the designation of formal groundwater protection areas, before groundwater protection measures can be fully implemented. Furthermore, groundwater protection measures considered for the proposed Fishtrap Island Collector Well should be developed in the context of the other municipal water supply wells to ensure that any such measures are defensible and consistent with those that may be developed elsewhere for the City. This work is on-going and will be completed by the City of Prince George before the proposed Fishtrap Island Collector Well is commissioned, as part of an overall groundwater protection strategy that includes the proposed Fishtrap Island Collector Well, as well as the existing active wells PW601 and PW605.

Groundwater protection measures may include non-regulatory measures, such as public education and best management practices, and/or regulatory measures, such as the use of municipal land use planning and zoning bylaws to restrict certain high-risk land use activities. As an alternative to land use restrictions, some communities have chosen to restrict the types and quantities of chemicals used within groundwater protection areas. Some examples of groundwater protection measures that could be considered in the vicinity of the proposed Fishtrap Island Collector Well and elsewhere in the City are presented in Appendix VII. At a minimum, consideration should be given to the proper decommissioning of any test wells within the capture zone of the Fishtrap Island Collector Well that are not designated for monitoring purposes (as discussed previously, no abandoned private wells were identified within the capture zone that would require decommissioning).

14.1.2 Groundwater Monitoring

Groundwater Quality

Golder (2003) presents a proposed groundwater quality monitoring program for the City's municipal wells, including the proposed Fishtrap Island Collector Well, to address issues raised by the contaminant inventory. A proposed suite of constituents for analysis, under a proposed monitoring frequency of six months, are presented for the Fishtrap Island Collector Well in Table 14.1. This suite of constituents in conjunction with

microbiological tests for total and fecal coliforms and *E. coli* would form the basis for ensuring that water quality discharged form the proposed Fishtrap Island Collector Well is of potable quality. The frequency of sampling and the exact constituents to be analyzed would be prescribed by the Regional Health Unit. The report also recommended the installation of one monitoring well located west of the proposed Fishtrap Island Collector Well at the edge of the 60-day time of travel (under current pumping conditions) for monitoring of the same suite of constituents under a proposed monitoring frequency of every two months (Table 14.1). Prior to commissioning the well, a discharge water quality monitoring plan will be developed in conjunction with the Chief Environmental Health Officer of the Northern Health Authority to confirm the potability of the discharge water from the proposed Fishtrap Island Collector Well. The exact location(s) of monitoring (or sentinel) wells around the proposed Fishtrap Island Collector Well is presently being evaluated by Golder on behalf of the City of Prince George. The City of Prince George is committed to installing sentinel wells and developing a sentinel well monitoring plan prior to commissioning the proposed Fishtrap Island Collector Well, and to undertaking routine monitoring and inspection of those wells.

Table 14.1 Preliminary Groundwater Monitoring Program for Fishtrap Island Collector Well

Municipal Water Well	Analysis	Frequency	Monitoring Well	Analysis	Frequency
Proposed Fishtrap Island Collector Well	Field parameters physical parameters dissolved anions dissolved metals VOCs EPH PAHs	6 months	MW1	Field parameters physical parameters dissolved anions dissolved metals VOCs EPH PAHs	2 months

Note:
Field parameters include pH, specific conductance, alkalinity, redox and dissolved oxygen
VOCs = volatile organic compounds
EPH = extractable petroleum hydrocarbons
PAHs = polycyclic aromatic hydrocarbons

The proposed groundwater quality monitoring program outlined in Golder's 2003 report is considered preliminary. The City of Prince George has commissioned Golder to investigate the most suitable locations for additional monitoring (sentinel) wells and the frequency and type of groundwater quality monitoring that should be undertaken at these wells. The results of these efforts will be presented under a separate cover as part of the

project pre-design report. The monitoring program will also include recommendations for assessment and monitoring of the potential for surface water influence through microscopic particulate analysis, together with turbidity and temperature measurements. These works will allow aquifer monitoring to be implemented to ensure that contamination within the aquifer is addressed quickly and, therefore, remains isolated.

In general, contaminants of concern identified in Golder (2003) will be analyzed for samples collected from the proposed sentinel well network. Sampling frequency will be between every two months and yearly, depending on the location of the sentinel well with respect to the travel time zones of the proposed Fishtrap Island Collector Well. The contaminants of concern to be sampled for a likely to be similar to those indicated in Table 14.1. Where possible surrogates of contaminants that are likely to occur will be selected or early indicators of contaminant plumes. In general these indicators would be compounds that are found with the contaminants of concern, that travel at the advective flow rate of the groundwater, and act as a conservative tracer (i.e., they are effectively un-reactive in the groundwater).

Groundwater Quantity

Golder (2003) report recommended the collection of additional water-level monitoring data to refine the numerical model and associated capture zones. It was recommended that an inventory of wells be conducted to identify existing wells that may be suitable for water-level monitoring. In the vicinity of the Fishtrap Island Collector Well, some of the neighbouring test wells may provide suitable monitoring locations. The provincial Observation Well no. 342 is also located in this vicinity. In other areas, the installation of new monitoring wells may be required. In addition to providing water-level data that can be used to refine the groundwater flow model, the data can be used to assess the well performance and the drawdown predicted by the model. Once the Fishtrap Island Collector Well is operational, adjustments to the pumping rate will be made if the measured drawdown is significantly different than that predicted by the refined groundwater flow model. On behalf of the City of Prince George, Golder will collect such water level data deemed necessary to make any model refinements.

14.2 Well Closure Plan

A Well Closure Plan, consistent with the provisions of *Draft Code of Practice for Construction, Testing, Maintenance, Alteration and Closure of Wells, Province of B.C.* (Interim Water Well Drilling Advisory Committee, March 25th, 1994) is provided below. Among other things, the Well Closure Plan will identify the details of eventual

abandonment of the collector well showing placement and amounts of sealants and fill materials.

Abandonment of the collector well can be achieved in several ways. It is probable that if the well were ever abandoned, the well constructors would be contacted to aid in this. It is also noted that, as we understand the City is doing with the abandoned Collector Well #2, the caisson might provide useful service as a reservoir. However, at this time we suggest the following procedure that assumes the caisson will be abandoned as well:

- well lateral valves closed off to isolate laterals well screens from the caisson centre;
- all pumps and piping removed from well;
- concrete plug cast in the wet and tremmied to the bottom of the well with sufficient volume to bring the plug to 0.6 m above the highest point of the highest lateral;
- high solids bentonite slurry brought to 0.6 m above the concrete plug, this latter will provide a seal that will not crack;
- well back-filled with clean sand to its mid-point;
- second 0.6 m bentonite plug poured in the wet; and
- well filled to 1 m below ground surface with sand, concrete plug poured with its upper elevation approximately 0.3 m above finish grade if the above ground caisson is to remain in place or to grade if the above ground caisson is to be removed.

This method will mean that the hydraulic conductivity of the inside of the caisson is less than the formation and, therefore, it will not be a preferential pathway for contaminants to reach the aquifer.

14.3 Fish and Aquatic Habitat Protection

Potential effects to fish and fish habitat could result from the following:

- disturbance and removal of riparian vegetation that may be required for the installation of the water transmission mains and/or upgrading the existing access road;

- instream works that may be required for installation of the proposed water transmission main leading to PW605 at the crossing with the back channel;

- clearing and grubbing for the site of the collector well, water transmission mains, and access road;

- clam shell excavation and removal of gravels for development of the collector well;

- construction of the concrete caisson for the collector well;

- dewatering of sediment-laden water from the caisson chamber;

- trench excavation for the water transmission mains, particularly where the water transmission main leading to PW605 crosses the back channel at the constriction within the existing access road; and

- inadvertent release of fuels, oils, or lubricants during fuelling or maintenance of construction machinery on site.

The overall risk of impacts to aquatic and terrestrial resources is considered to be low and manageable based on the type of project and the mitigation measures recommended below, which reflect standard regulatory requirements and BMPs. Mitigation measures are as follows.

- Delineating construction boundaries along environmentally sensitive areas with high-visibility snow fencing to minimize potential for unauthorized encroachment beyond the approved footprint required for each of the work areas (i.e., 50 m setback from top of bank of the Nechako River, 30 m setback from top of bank from the back channel along the south side of Fishtrap Island, including where the alignment for the water transmission main leading to the pump station at PW605 crosses the back channel).

- Undertaking instream work that may be required for upgrading the existing access road and installing the water transmission main at the crossing of the back channel during an approved instream works window, corresponding to

seasonal low flows and to the period of least sensitivity to anadromous and resident fish populations with respect to spawning and rearing patterns. Typically, the instream works window for the Prince George region are from July 15 to August 15 of any given year, subject to review and approval by regional habitat biologists with DFO and MWLAP.

- Maintaining unobstructed flows and downstream water quality from the constricted portion of the back channel along the existing access road during construction of the water transmission main leading to the pump station at PW605. It is recommended that flows leading from the back channel adjacent to the existing access road be directed into a steel flume supported with sandbags, or alternatively, pumped and diverted around the trench excavation.

- Undertaking a fish salvage by qualified personnel and isolating the work area from flows prior to commencement of approved instream works.

- Implementing and maintaining a Sediment and Erosion Control Plan, as described below, to minimize potential release of sediments from exposed soils into fish-bearing waters.

It is not anticipated that construction of the collector well itself will result in the harmful alteration, disruption, or destruction (HADD) of aquatic habitat because the footprint for the well and pump house will be approximately 50 m from top of bank of the Nechako River. Potential impacts to instream and riparian habitats during the installation of the proposed water transmission main leading to PW605 at the crossing with the back channel and installation of the water transmission mains and/or upgrading the existing access road can be precluded by implementing the mitigation measures proposed above, such that the construction and operation of the Fishtrap Island Collector Well will not result in a harmful alteration, disruption or destruction (HADD) of fish habitat.

14.4 Wildlife and Terrestrial Habitat Protection

Potential impacts to terrestrial resources and wildlife habitat, associated with the construction of the Hart Water Supply Improvement Project can be mitigated by implementing the following strategies.

- Prior to any site clearing and grubbing activities that commence during the period from April 1st to August 1st, the City of Prince George will retain an independent and qualified biologist to conduct a breeding bird and nest survey to confirm results of the original site reconnaissance survey conducted in

September and October 2002 to identify the presence and/or absence of any active nest sites, so that appropriate mitigation measures can be taken to avoid contravention of Section 34 of the B.C. *Wildlife Act*, and concurrently, Article V of the *Canada Migratory Birds Convention Act* for the protection of migratory birds and their nests. The B.C. *Wildlife Act* makes it an offence to "destroy nests occupied by a bird, its eggs or its young or the nests of eagles, peregrine falcons, gyrfalcons, ospreys, herons or burrowing owls." The *Canada Migratory Birds Convention Act* prohibits "The taking of nests or eggs of migratory game or insectivorous or nongame birds." Under the *Canada Migratory Birds Convention Act*, it is an offence to "kill, capture, injure, take, or disturb migratory birds, or damage, destroy, remove, or disturb their nests (Section 12(1)(h)).

- The proposed survey will help assess the potential for red- or blue-listed wildlife species, noted in Section 9.2.2, to be present. This would further reduce the likelihood of listed species being affected by construction of the collector well, water transmission mains, and access roads.

- Implementing a Landscaping and Revegetation Plan immediately following construction. Planting of native riparian shrubs and trees should be conducted with suitable native plant species, consistent with the *Recommended Native Tree and Shrub Planting* Criteria *for the Enhancement and Restoration of Riparian Habitat* (MELP, 1998), and in accordance with applicable requirements of the *City of Prince George's Tree Protection Bylaw No. 6343.*

- Implementation of a Landscaping and Revegetation Plan will help to re-establish terrestrial breeding, nesting, and shelter habitat for various wildlife species, while providing ground cover to minimize sources of sediment and exposed soils that may be prone to erosion. The Landscaping and Revegetation Plan will also help to minimize the proliferation on non-native weed species, which have lower habitat values that the native tree and shrub species.

- Implementing BMPs during construction to minimize the potential for the proliferation of non-native weed species. This would include, for example, ensuring that all equipment and machinery used during construction of the project be steam-cleaned and/or otherwise thoroughly cleansed and inspected prior to being mobilized onsite. This standard weed control measure in conjunction with the planting of high quality, weed-free native grass seed

mixes and native trees and shrubs would be implemented to prevent importation and distribution of non-native noxious weeds.

14.5 Archaeological Resource Protection Plan

Based on the archaeological overview and impact assessment, the potential for locating archaeological sites within the study area is considered to be low. Accordingly, no additional archaeological work is deemed necessary at this time. An Archaeological Site Alteration Permit will not be required for construction.

In the unlikely event that archaeological materials are encountered during development activities, work in proximity to the resource should immediately cease, and Golder, the Archaeological Planning and Assessment office, and the Lheidli T'enneh First Nation should be contacted for further guidance. If an archaeological site is encountered, it may be necessary to obtain a Site Alteration Permit prior to recommencing construction, and mitigative work, such as emergency data recovery or monitoring, may be necessary.

14.6 Emergency Response and Spill Prevention Plan

Reporting of spills is regulated (provincially) under the *Spill Reporting Regulation* BC Reg. 263/90 under the *Waste Management Act.* To minimize the potential for a permanently deleterious spill or release of hydrocarbons or other hazardous materials, it is recommended that the City's contractors implement a Spill Prevention and Emergency Response Plan. Included in this written plan would be the schedule from the *Spill Reporting Regulation*, indicating reportable spills. This plan is critical in view of the works being undertaken within the Lower Nechako River Aquifer and near the Nechako River.

Among other things, the Spill Prevention and Emergency Response Plan to be prepared by the City's contractors will need to include and address the following:

- a general measure of the probability and severity of an adverse effect to health, property, or the environment on the basis of fuel, oil, and other hazardous materials that will be consumed, handled, and stored during the project;

- spill or release notification and alerting procedures;

- prepared spill incident report forms;

- containment, recovery, and clean-up procedures;
- on-site spill/release clean-up materials, equipment, and locations; and
- names and telephone numbers of persons and organizations that may be contacted in the event of a potential environmental incident.

The general provisions of the Spill Prevention and Emergency Response Plan can be met by ensuring that all machinery used for construction and operation of the Hart Water Supply Improvement Project, is in good repair and free of external oil and grease or other substances that may cause adverse environmental impacts. Furthermore, on-site refueling should be monitored so that there are personnel stationed both at the fuel source (i.e., the fuel truck, tidy tank, etc.) and the equipment receiving the fuel. During refueling an effective communication protocol should be followed to prevent accidental release or overfilling of the equipment. Any refueling should occur at least 50 m away from the Nechako River.

Should a reportable spill occur involving any hazardous materials, including but not limited to fuels, oils, antifreeze, and drilling fluids, written incident reports should be submitted to Environment Canada, DFO, the Provincial Emergency Program (PEP), the City of Prince George, and other agencies having jurisdiction within 24 hours. Notification of the Provincial Emergency Program (PEP) may be required if the spill is in a quantity that exceeds amounts listed in *Spill Reporting Regulation* of the *Waste Management Act*, whereas spills of any quantity of hazardous materials, chemicals, or any other materials that could be deleterious to fish or fish habitat should be reported to Environment Canada and DFO.

An incident report should identify the reporting organization, date, time, location, hazardous materials or dangerous goods involved, source and persons or organizations notified. In addition, the report should describe how the spill or release occurred, remedial action taken or planned, and actions necessary to prevent recurrence.

As far as possible, the spill should be contained and isolated immediately. Furthermore, work to clean up the spill should occur immediately.

14.7 Environmental Construction Monitoring and Management Plan

This section provides information regarding.

- Preparation of the framework for an Environmental Management Plan (EMP), the details of which would be provided during the detailed design of the project. The approved EMP would be included in the contract documents provided to the contractor(s) selected for construction of the Fishtrap Island Collector Well Project.

- The EMP would typically provide performance-based environmental specifications on matters related to the following:

    - sediment and erosion control;
    - site clearing and riparian vegetation removal;
    - terrestrial habitat mitigation plan;
    - well excavation and caisson construction;
    - trench excavation for the ancillary facilities;
    - dewatering procedures;
    - spill prevention and emergency response planning;
    - hazardous materials management and storage;
    - construction waste materials management;
    - air quality management;
    - noise management;
    - archaeological resource protection; and
    - landscaping and site restoration.

As required by CEAA, the purpose of this section of the environmental assessment report is to outline the City's proposed approach to evaluating and reporting progress of the project, and specifically, occurrences of both forecasted and unforeseen environmental effects, success of mitigation measures, and compliance with regulatory requirements.

To achieve effective implementation of the above-recommended environmental mitigation measures, the City will retain qualified, independent environmental resource monitors. The roles, responsibilities, and general duties of the Environmental Monitor are summarized below.

14.7.1 Environmental Monitoring

The role of the Environmental Monitor will be to inspect, evaluate, and report on the performance of construction activities, and effectiveness of environmental control strategies and mitigation measures with respect to regulatory permits, approvals, and authorizations, environmental legislation, and BMPs. Environmental monitoring by

qualified personnel will also reduce the likelihood of activities, whether accidental or intentional, which contravene environmental legislation and regulations.

During construction, the City's Environmental Monitor will have the primary responsibility to confirm that the environmental management measures, controls, and specifications are properly implemented as per the terms and conditions of the Environmental Assessment Certificate, and/or other regulatory permits and approvals.

Other responsibilities of the Environmental Monitor typically include the following:

- liaison with regulatory agencies, and other key stakeholders;
- delivering environmental awareness programs to the City's contractors;
- providing technical assistance on environmental matters to construction personnel and regulatory agencies;
- inspecting activities during construction to evaluate and report on compliance with terms and conditions of approvals and permits;
- providing recommendations for modifying and/or improving environmental mitigation measures, as necessary;
- documenting construction activities by field notes and photographs;
- suspending construction activities that are causing, or potentially causing, risk of environmental damage; and
- preparing factual environmental monitoring summary reports throughout the duration of construction, to summarize activities and actions taken to minimize impacts during each of the construction activities.

The success of environmental protection programs during construction will depend largely on the ability of project staff, including project management, engineering personnel, and contractor's personnel, to comply with environmentally sensitive construction procedures and government regulations. The Environmental Monitor will help identify and resolve potential problems through effective communication with the City's Project Manager and with the regulatory agencies. The Environmental Monitor will be obliged to advise both the City and regulatory agencies when construction

activities do not comply with regulatory requirements, and when corrective action is required.

14.7.2 Cultural Resource Monitoring

Based on the AIA conducted as part of this study and input received by local First Nations, it is our opinion that the potential for encountering any archaeological sites or artifacts during construction of the Fishtrap Island Collector Well and ancillary facilities is low. Therefore, no archaeological monitoring during construction is recommended.

14.8 Post-Construction Environmental Monitoring

Following completion of the construction phase of the project, the City of Prince George will evaluate the effectiveness of site restoration and reclamation works and compliance with site enhancement initiatives outlined in this Application for an Environmental Assessment Certificate/Comprehensive Study Report.

The City of Prince George will evaluate and report on the success rate, survivability, and general health of existing vegetated and newly planted areas on an annual basis over a minimum period of 3 years to achieve an 80% plant survival rate, or as otherwise specified in any permits, approvals, or authorizations to be issued by the regulatory agencies for this project. Copies of post-construction annual monitoring reports will be filed with the City, and made available to the public and agencies having jurisdiction upon request.

Typically, the post-construction monitoring program will include regular maintenance of newly planted trees and shrubs, including watering, fertilizing, pruning if necessary, and removal of invasive non-native weed species. The maintenance schedule will be determined by the City of Prince George, but will likely be a minimum of twice annually.

Monitoring of the survivability of the re-vegetation will be conducted by qualified municipal personnel. The post-construction monitoring program will examine all of the restored areas, documenting failures in re-seeding and/or plant mortalities. If any noxious weeds are observed during the 3 years of post-construction monitoring efforts, they will be controlled by physical/ mechanical means by the City.

Typically, plant survival should achieve a minimum 80% or greater survival rate after the period of three years during operation of the well. If an overall survival rate of 80% of re-vegetation efforts has not been achieved by the end of the third year, the City of Prince George will continue annual inspections and replanting until such time that 80% survival

rate has been achieved. Any expired plants will be replaced with like species and size, in accordance with the DFO/MELP *Planting Criteria and Recommended Native Tree and Shrub Species for the Restoration and Enhancement of Fish and Wildlife Habitat* (1998) planting guidelines.

With respect to operational inspections of the proposed water transmission mains, the City of Prince George has systems in place to continually monitor its water supply and distribution system by skilled technicians using sophisticated computerized equipment that, in the unlikely event of a leak, can immediately shut down the operation to facilitate repair of the system. The City also has comprehensive emergency response plans in place that would be executed by well-trained employees in the unlikely event of an emergency.

14.9 Energy Efficiency and Conservation Plan

Collector wells constructed adjacent to surface bodies of water, are inherently more efficient (they have less drawdown for a given flow) than conventional vertical wells. Less energy is required to withdraw the same volume of water from an aquifer using a collector well as opposed to conventional wells. In fact, it is our opinion that collector wells are probably among the most energy efficient methods of providing potable water. In productive aquifers, they require similar amounts of energy to that required for a surface water intake yet typically provide water that is satisfactorily filtered and, in the case of the City of Prince George, requires no further treatment. The method of water supply selected by the City must be considered to be one of the most energy efficient available to them and will provide substantial energy conservation over the coming years.

14.10 Sediment and Erosion Control Plan

To minimize the potential for water quality impacts associated with sediment releases and erosion of exposed soils, it is recommended that a detailed, site-specific Sediment and Erosion Control Plan be prepared by the City of Prince George's contractor. Key elements of a Sediment and Erosion Control Plan would include the following mitigation measures.

- Restrict the movement of surface water or seepage where there is a potential for discharge of sediment-laden water into the Nechako River or any other watercourse, resulting from construction of the collector well, water transmission mains, or access road improvements.

- Conducting trench excavation at times of low river to avoid the need for construction dewatering. In the event that dewatering of the trench excavation for the water transmission mains is necessary, it should be done in a manner that will not cause surface erosion or sediment-laden runoff to enter the Nechako River, including the back channel along the south side of the island. It is recommended that sediment-laden water from the caisson excavation be pumped or decanted off into an approved settling area or to a containment tank for offsite disposal.

- Refraining from placing excavated soils or equipment on, or below, the crest of any adjacent embankments, particularly during the trench excavation for the water transmission main across the back channel, to minimize potential for slope failure and erosion.

- Covering and protecting excavated soils with polyethylene sheeting in areas where there is potential for runoff into watercourses and installing, and maintaining, silt fencing along the toe of excavated slopes next to watercourses. This would include, for example, along the construction access road(s) and along excavated soils for the water transmission main construction near the back channel, which are tributary to the Nechako River.

- Installing sediment and erosion control measures (such as silt fences or straw hay bales) adjacent to work areas to control potential release of soils or sediment-laden water from entering nearby watercourses during caisson excavation and trenching and backfilling operations for the water transmission mains.

Suitable detention facilities, such as storage tanks and sedimentation ponds, for the containment of sediment-laden water and installation of the above-referenced sediment control works are recommended to prevent accidental release of sediments or sediment-laden water during construction activities. Areas of disturbed ground are to be re-vegetated as quickly as possible after construction.

14.11 Discharge of Water from the Caisson During Construction and Pumping Test

During construction of the concrete caisson it will be necessary to discharge accumulated groundwater to dewater the caisson after the bottom concrete plug is set and during installation of the lateral well screens.

Following completion of construction of the concrete caisson, the bottom of the collector well will be sealed with concrete placed under water to create an impermeable surface. Prior to dewatering the caisson following placement of the concrete base, the accumulated groundwater in the caisson will be tested for pH and total suspended solids to confirm that it complies with the *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (Canadian Council of Ministers of the Environment, 1986), and that it is suitable for discharge to the river. In the event that the accumulated groundwater within the caisson is unsuitable for direct discharge to the river, the water will be discharged at an appropriate area that will not affect surrounding watercourses, such as a settling tank or an open field. During the pumping test river-bottom erosion will be minimized by discharging the pumping test water to deeper parts of the river and/or by protecting the riverbank from erosion.

14.12 Impacts to Air Quality and Noise Generation

14.12.1 Air Quality

As indicated above in Section 10.5.2, construction activities associated with the Fishtrap Island Collector Well and related ancillary facilities are expected to temporarily result in short-term increases in noise and air emissions. Potential impacts associated with these disturbances are anticipated to cease following completion of the construction phase of the project.

Currently, and subject to receipt of an Environmental Assessment Certificate, it is proposed that construction of the collector well would commence in the spring of 2004, followed by construction of the two water transmission pipelines and the well pump station, which would be completed in December of 2005. As a result, construction activities would occur throughout all months of the year. Potential air quality impacts from fugitive dust associated with excavation activities and construction traffic onto, and away from, the site are likely to be more prevalent during extended periods of dry weather in the summer months, compared to the fall, winter, and spring months when precipitation levels are typically higher.

Potential impacts to air quality can be mitigated by the implementation of design mitigation measures and BMPs to control fugitive dust and other airborne emissions arising from Project activities. For example, to control the generation and release of fugitive dust associated with excavation equipment and construction traffic entering and leaving Fishtrap Island, the City of Prince George is proposing to place clean, crushed angular rock, such as low-fines, 19-mm minus surfacing along the access road leading to the site of the collector well. During periods of dry weather, water may need to be

sprayed onto the construction access roads from a water tanker truck to further limit the generation of fugitive dust associated with movement of heavy trucks and machinery onto and from the site.

The use and application of chemical dust suppressants, such as calcium chloride, by the City's contractor(s) to control fugitive dust and other airborne emissions will be prohibited unless otherwise approved by the Ministry of Water, Land and Air Protection (MWLAP) and other regulatory agencies and authorities having jurisdiction. Onsite open burning of organic materials, wood, refuse or other material related to the Fishtrap Island Collector Well Project will be prohibited, as the Fishtrap Island area is within the Open Burning Ban Boundaries as identified in the City of Prince George Clean Air Bylaw No. 7232, 2000. Prior to commencing construction and operation of any equipment or machinery with point-source air emissions such as exhaust vents or stacks, the City's contractor(s) will obtain, and retain, all necessary regulatory permits for inspection by the City and other agencies, if requested.

In addition to these dust and air emission control measures, it is anticipated that the setting of the site of the collector well and water transmission pipelines on Fishtrap Island within a naturally vegetated area, will also help to control the spread of fugitive dust by wind. The City plans to limit the removal of trees within the vicinity of the well and along the alignment for the water transmission pipelines for aesthetic purposes in keeping with the natural parkland characteristics of the site, and to maintain terrestrial wildlife habitat resources. The retention of these trees and other vegetation is also expected to limit the spread of fugitive dust during construction phase of the project.

14.12.2 Noise Control

Noise generation can be reasonably minimized through the use of "Best Available Control Technology" on construction equipment, and compliance with all applicable noise level regulations or guidelines established by the Worker's Compensation Board (WCB), the City of Prince George, and other regulatory agencies and jurisdictions having authority for noise levels.

Presently, the City of Prince George is reviewing its Clean Air Bylaw and Noise and Nuisance Bylaw; however, the review will not include consideration for present and future pump stations (D. Dyer, Manager, Infrastructure Planning, City of Prince George, B.C. pers. comm.). The only possible application for either of these bylaws to this project is during construction if the Contractor desires to work outside the permitted hours. In general, construction of the collector well and water transmission mains will be restricted to the hours of between 6:00 a.m. to10:00 p.m. daily as per the City's *Noise, Nuisance,*

and Disturbances Bylaw No. 3848. However, should it be necessary for the City's contractor(s) to undertake construction activities between the hours of 10:00 p.m. to 6:00 am, a Noise Permit will be required from the City as per this bylaw.

15.0 SIGNIFICANCE OF RESIDUAL ENVIRONMENTAL EFFECTS

Table 15.1 provides a comparison of the significance of potential environmental effects associated with the development and operation of the City of Prince George Hart Water Supply Improvement Fishtrap Island Collector Well Project, both before mitigation as discussed in Section 10.0, and with implementation of the mitigation measures.

Residual impacts are defined as environmental changes that result from the project after mitigation measures have been incorporated. "Significance" of residual impacts is described in terms of the following impact parameters and evaluation criteria, as described in Section 3.0.

As indicated in Section 3.0, and for the purposes of this assessment, a residual impact with an aggregate total rating of 15 or higher would be considered "significant". For example, if a residual impact was considered to have a moderate magnitude (i.e., 5 to 10% change over baseline conditions), with a regional geographic extent (i.e., affecting an area within a 2 to 5 km radius of the project site), having a long-term duration (i.e., greater than 60 days), and a high frequency of occurrence (i.e., greater than 10 times per year), then it would be assigned a score of 16, and therefore, considered "significant".

As indicated in Table 15.1, development of the proposed Hart Water Supply Improvement Project is not anticipated to result in significant residual impacts, providing that the impact mitigation measures identified in this Application for Environmental Assessment Certificate and draft Comprehensive Study Report are implemented. In general, the significance of residual impacts with mitigation for most environmental components are considered to be either "negligible" or "low", based on the magnitude, geographic extent, duration, frequency, and reversibility of the impacts. In cases where mitigation measures are anticipated to result in reduced significance of residual impacts, relative to the pre-mitigation scenario, the corresponding impact parameter is highlighted in bold face text in Table 15.1.

15.1 Construction Phase

Construction-related activities such as site preparation, caisson excavation, access road construction, and excavation and backfilling for the water transmission mains will

generally be of a short-term duration. Where possible, construction activities will be scheduled to avoid sensitive periods of the year for wildlife resources.

During the construction phase of the project, potential impacts to biophysical and cultural resources will be minimized, and in some cases avoided, as a result of the design, configuration, and construction methodologies associated with the collector well, water transmission mains, and access roads.

As indicated above, based on review and evaluation of project design alternatives, the proposed concept and layout of project components effectively reduces the magnitude of potential impacts. For example, the collector site will be located approximately 50 m from the Nechako River, thereby minimizing potential disturbance to ecological receptors within the riparian zone of the Nechako River. Potential impacts resulting from air and noise emissions, increased traffic, and clearing and excavation, are anticipated to result in temporary disturbances to ecological and human receptors.

Among other things, the project will result in the following:

- minimal vegetation removal and minimal loss of wildlife habitat;
- no disturbance to raptor nests or heron rookeries;
- avoidance of a harmful alteration, disruption, or destruction of aquatic habitat within the riparian and instream areas of the Nechako River, it is proposed that the water transmission main leading from Fishtrap Island northward to the Hart Area will be installed within the existing highway bridge infrastructure;
- no disturbance to cultural or archaeological resources; and
- minimal disturbance to the aesthetics or regional setting of the parkland characteristics of Fishtrap Island.

15.2 Operation Phase

The operation of the new collector well will enable decommissioning of PW607, which is vulnerable to contamination, thereby providing a more secure and safe source of water supply. Thus, operation of the new well will help alleviate potential impacts associated with the existing infrastructure.

The collector well pump house surrounding the compound will be set within a forested buffer zone, and will be designed to optimize the park-like character of the western portion of Fishtrap Island. The infrastructure necessary to support the proposed collector well will be completely contained within, or immediately adjacent to, existing cleared rights-of-way.

Table 15.1 Comparative Summary of Potential Environmental Effects Before Mitigation and Residual Environmental Effects After Mitigation for the Hart Water Supply Improvement Fishtrap Island Collector Well Project

Issue	Impact Characteristics	Environmental Consequence (prior to mitigation)	Mitigation Measures / Impact Characteristics (bold denotes change as a result of mitigation)	Residual Impacts (post mitigation)
Hydrogeology				
Impacts on groundwater quantities in conjunction with other wells in the Lower Nechako River Aquifer	• Magnitude: Negligible (0) – two private wells identified within zone of influence; minor interference effects with adjacent City wells • Geographic Extent: Local (0) - zone of influence limited to 1 km south of Fishtrap Island Collector Well, and 1500 m east-west • Duration: Long-term (+2) - as groundwater withdrawals will be in effect during operation phase of Project, thereby exceeding 60 days duration • Frequency: High (+2) - as groundwater withdrawal will be ongoing during Project operation • Reversibility: No (+3) - does not return to baseline conditions during operation of Fishtrap Island Collector Well	Low (+7)	None required, no change	Low (+7)
Hydrology				
Impacts on near surface water tables, and flows and levels in the Nechako River	• Magnitude: Negligible (0) - less than 1% change over baseline 90% of the time. Groundwater withdrawals from the Fishtrap Island Collector Well represents approximately 0.76% of lowest mean monthly flows and 0.18% of highest mean monthly flow in the Nechako River • Geographic Extent: Local (0) - as influence of groundwater withdrawals on Nechako River will be limited to a 1500 m radius (hence less than 2 km) • Duration: Long-term (+2) - as groundwater withdrawals will be in effect during operation phase of Project, thereby exceeding 60 days duration • Frequency: High (+2) - as effects would be continuous during Project operation	Low (+7)	None required, no change	Low (+7)

Issue	Impact Characteristics	Environmental Consequence (prior to mitigation)	Mitigation Measures / Impact Characteristics (bold denotes change as a result of mitigation)	Residual Impacts (post mitigation)
	• Reversibility No (+3) - does not return to baseline conditions during operation of Fishtrap Island Collector Well			
Biological Effects				
Water Quality				
Impacts on water quality during construction of the collector well, water transmission mains, and access road	• Magnitude: Low (+5) - based on a qualitative assessment of construction impacts • Geographic Extent: Local (0) - as influence of water quality impacts during construction will be limited to less than 2 km radius from construction activities • Duration: Long –term (+2) - since duration of construction will be greater than 60 days • Frequency: High (+2) - since impacts on water quality could exceed 10 times per year without implementation of mitigation measures • Reversibility: Yes (-3) – since water quality conditions will return to baseline levels following construction of project components	Low (+6)	• Sediment and Erosion Control Plan • Emergency Response and Spill Prevention Plan Magnitude: Low (+5) Geographical Extent: Local (0) Duration: Long-term (+2) **Frequency: Low (0)** Reversibility: Yes (-3)	Negligible (+4)

Issue	Impact Characteristics	Environmental Consequence (prior to mitigation)	Mitigation Measures / Impact Characteristics (bold denotes change as a result of mitigation)	Residual Impacts (post mitigation)
Fisheries and Aquatic Resources				
Impacts to fisheries and aquatic resources related to habitat alteration and introduction of deleterious substances	• Magnitude: Low (+5) - because project design and layout avoids most fisheries sensitive zones (i.e., 30 m from top of bank), with the exception of the proposed watercourse crossing along the access road over the constriction in the back channel for the water transmission main leading to PW605 • Geographic Extent: Local (0) - as potential impacts to fisheries resources will be limited to less than 2 km radius from project area • Duration: Short term (0) - since water transmission main construction across back channel can be undertaken in less than 30 days • Frequency: Low (0) - since only 1 crossing is required for the water transmission main construction to PW605, and since the water transmission main leading to PW607 will be installed within the structural girders of the Foothills Boulevard Bridge • Reversibility: Yes (-3) - since habitat conditions will return to baseline conditions following construction	Negligible (+2)	• Fish and Aquatic Habitat Protection • Emergency Response and Spill Prevention Plan Magnitude: Low (+5) Geographical Extent: Local (0) Duration: Short-term (0) Frequency: Low (0) Reversibility: Yes (-3)	Negligible (+2)
Impact to fisheries and aquatic resources related to potential drawdown and lowered water levels in the Nechako River, during operation of the collector well	• Magnitude: Negligible (0) - since the maximum pumping rate of the Fishtrap Island Collector Well is less than 1% of the base flow rate within the Nechako River • Geographic Extent: Local (0) - since potential effects of drawdown in the Nechako River will be limited to less than 2 km distance from the collector well • Duration: Long term (+2) - during operation of collector well (i.e. exceeds 60 days duration) • Frequency: High (+2) - since the collector well will operate more than 10 times per year • Reversibility: No (-3)	Negligible (+1)	None required, no change	Negligible (+1)

Issue	Impact Characteristics	Environmental Consequence (prior to mitigation)	Mitigation Measures / Impact Characteristics (bold denotes change as a result of mitigation)	Residual Impacts (post mitigation)
Impacts to fisheries and aquatic resources resulting from loss of groundwater upwellings	• Magnitude: Negligible (0) - since the existing hydrogeological gradient of the Lower Nechako River Aquifer is generally away from the Nechako River ; therefore, operation of the Fishtrap Island collector well is not anticipated to result in loss of groundwater upwellings (since they are not a naturally occurring phenomena) • Geographic Extent: N/A • Duration: N/A • Frequency: N/A • Reversibility: N/A	Negligible (0)	None required, no change	Negligible (0)
Wildlife Resources				
Loss of wildlife habitat and disturbance to wildlife resources	• Magnitude: Low (+5) - since the footprint of the collector well and water transmission line corridors do not support important wildlife habitats including raptor nests, heron rookeries, or other unique features. Drawdown in water table level from operation of collector well is not expected to adversely affect the back channel • Geographic Extent: Local (0) - within a 2 km radius • Duration: Long term (+2) - greater than 60 days • Frequency: Moderate (+1) - disturbance during site clearing and excavation activities throughout construction of well and water transmission mains • Reversibility: No (+3) - since once the collector well is constructed, it will occupy an area which is currently vegetated and supports wildlife habitat	Moderate (+11)	• Wildlife and Terrestrial Habitat Protection Magnitude: Low (+5) Geographical Extent: Local (0) Duration: Long-term (+2) Frequency: Moderate (+1) **Reversibility: Yes (-3)**	Negligible (+5)

Issue	Impact Characteristics	Environmental Consequence (prior to mitigation)	Mitigation Measures / Impact Characteristics (bold denotes change as a result of mitigation)	Residual Impacts (post mitigation)
Vegetation Resources				
	• Magnitude: Low (+5) • Geographic Extent: Local (0) - since footprint of collector well would be limited to approximately a 50 m by 50 m area, most of which is only partially vegetated due to previous disturbances. Clearing for water transmission line mains would utilize, as much as possible, previously cleared and disturbed areas such as the BC Hydro transmission line right-of-way, the Foothills Boulevard right-of-way, and the access road on Fishtrap Island • Duration: Medium term (+1) - since clearing of vegetation for collector well and water transmission mains will likely be undertaken in less than 60 days • Frequency: Low (0) - since clearing activities will be limited to a one-time event at the start of construction • Reversibility: No (+3) - vegetation to be cleared for the footprint of the compound for the collector well will not be replaced, although surrounding areas will be revegetated to enhance wildlife habitat	Low (+9)	• Wildlife and Terrestrial Habitat Protection Magnitude: Low (+5) Geographical Extent: Local (0) Duration: Medium-term (+1) Frequency: Low (0) **Reversibility: Yes (-3)**	Negligible (+3)
Cultural and Heritage Resources				
Impact to archaeological sites and artifacts	• Magnitude: Negligible (0) - since the archaeological impact assessment (AIA) confirmed there was no cultural resources within the project area • Geographic Extent: N/A • Duration: N/A • Frequency: N/A • Reversibility: N/A	Negligible (0)	None required, no change	Negligible (0)

Issue	Impact Characteristics	Environmental Consequence (prior to mitigation)	Mitigation Measures / Impact Characteristics (bold denotes change as a result of mitigation)	Residual Impacts (post mitigation)
Impact on traditional land use activities by the Lheidli T'enneh First Nation	• Magnitude: Low (+5) - since construction and operation of the collector well and water transmission mains are unlikely to result in measurable changes to potential traditional uses of Fishtrap Island over existing conditions • Geographic Extent: Local (0) - since it is possible that the back channel separating Fishtrap Island from the main shoreline may have been used for hunting, trapping, and fishing activities • Duration: Long term (+2) - since construction activities will create disturbances to vegetation and disruption of waterfowl and animals greater than 60 days • Frequency: Low (0) • Reversibility: Yes (-3)	Negligible (+4)	None required, no change	Negligible (+4)
Economic, Social, and Health Effects				
Impacts on economy and workforce	• Magnitude: Negligible (0) - impacts will be positive since development of Fishtrap Island Collector Well will support current and future demands for reliable source of potable water supply, while supporting sustainable growth management objectives • Geographic Extent: Municipal (+1) - skilled labour and trades required for construction of Fishtrap Island Collector Well and ancillary facilities are expected to originate from Prince George area • Duration: Long term (+2) – since construction of collector well and water transmission mains is anticipated to span a 20 month period (therefore, greater than 60 days) • Frequency: N/A • Reversibility: N/A	Negligible (+3)	None required, no change	Negligible (+3)

Issue	Impact Characteristics	Environmental Consequence (prior to mitigation)	Mitigation Measures / Impact Characteristics (bold denotes change as a result of mitigation)	Residual Impacts (post mitigation)
Impacts on social/ recreational values of Fishtrap Island as a municipal park within a Greenbelt Zone	• Magnitude: Low (+5) - since site disturbance associated with construction of the collector well and water transmission mains will affect less than 5% of the area on Fishtrap Island, most of which has already been disturbed by existing access roads, the BC Hydro transmission line right-of-way, and the abandoned gravel pit near the east end of the island; no zoning or land use changes will be required for the construction and operation of the collector well; in addition, there will be some traffic disturbances during construction of the collector well and water transmission mains • Geographic Extent: Local (0) • Duration: Long term (+2) - since construction of collector well and water transmission mains is anticipated to span a 20 month period (therefore, greater than 60 days) • Frequency: N/A • Reversibility: No (+3) - even though recreational activities and values on Fishtrap Island are expected to return to existing conditions following construction of the well and water transmission mains, there will be low-level noise and glare (lighting) impacts during the operation of the well	Low (+10)	• Best Management Practices (BMPs) to control fugitive dust, airborne emissions, and noises from construction equipment **Magnitude: Negligible (0)** Geographical Extent: Local (0) Duration: Long-term (+2) Frequency: N/A Reversibility: No (+3)	Negligible (+5)
Impacts on wells and licensed surface water withdrawals	• Magnitude: Negligible (0) – no effect on private wells within the Lower Nechako River Aquifer; total incremental withdrawal from collector well constitutes less than 1% of river flow discharge over 90% of the time • Geographic Extent: Local (0) - since zone of influence of other wells and licensed surface water withdrawals will be limited to less than 2 km from collector well • Duration: Long-term (+2) - as groundwater withdrawals will be in effect during operation phase of Project, thereby exceeding 60 days duration • Frequency: High (+2) - since groundwater withdrawal from collector well will be ongoing during Project operation • Reversibility: No (+3) – does not return to baseline conditions during	Low (+7)	None required, no change	Low (+7)

Issue	Impact Characteristics	Environmental Consequence (prior to mitigation)	Mitigation Measures / Impact Characteristics (bold denotes change as a result of mitigation)	Residual Impacts (post mitigation)
	operation of Fishtrap Island Collector Well			
Impact on renewable resources	• Magnitude: Negligible (0) - relatively small demand for consumption of renewable and non-renewable resources during construction and operation of the project • Geographic Extent: Local (0) • Duration: Long-term (+2) - requirements for small quantities of fuel for diesel generator as a back-up power source in the event of power outages • Frequency: Low (0) • Reversibility: Yes (-3)	Negligible (-1)	None required, no change	Negligible (-1)

The collector well site will be illuminated at night. Lighting will consist of low-level lighting around the 50 m by 50 m fenced compound around the well. This lighting will be provided for purposes of general operator access and safety under regular operating conditions. Precise numbers and placement of lighting fixtures has not yet been determined, but outdoor lights will be a combination of pole-mounted and structure-mounted lights. Outside lighting around the exterior of the pump house building and ancillary equipment likely will be placed above doorways. Generally, lighting angles will vary, determined by economic evaluation of fixture wattage, light patterns, and light levels. No high-mast, wide-area lighting is planned.

Emergency lighting will be provided for purposes of personnel egress and continuance of critical activities during failure of the normal power source or during emergency conditions. These instances are anticipated to be infrequent. Emergency lighting will be incandescent.

Thus, residual impacts to the social/ recreational values of Fishtrap Island as a municipal park within a Greenbelt Zone associated with an operating collector well on Fishtrap Island and related ancillary facilities are considered to be negligible.

16.0 PUBLIC INFORMATION DISTRIBUTION AND CONSULTATION

A structured, two-phased approach to undertaking and documenting public notification and information efforts as part of the Application for Environmental Assessment Certificate/ draft Comprehensive Study Report for the City of Prince George's Hart Water Supply Improvement Project is being undertaken.

After review of the technical assessments for the Application/Comprehensive Study Report by the City and senior members of our project team, the City will be in a better position to provide supportable responses to general public comment. Therefore, the two-phased approach to responding to public enquiries will be designed to ensure that responses regarding the project are based on the completed technical assessments for the Application/Comprehensive Study Report. This approach will help ensure that only reliable, accurate, and defensible information is distributed to the general public. The two phases are as follows.

Phase 1

Initial consultation has been undertaken with key stakeholders who rely on the Nechako River or the Lower Nechako River Aquifer for water supply within the City limits downstream of Fishtrap Island (hence, downstream of the point of diversion). Some of these stakeholders may also have traditional or territorial rights to water resources within

the lower reaches of the Nechako River watershed. Correspondence with key stakeholders who were consulted during this first phase of the public consultation process are provided in Appendix VIII.

Specifically, the following stakeholders have been consulted as part of this phase to solicit input and identify potential issues or concerns associated with the Hart Water Supply Improvement Fishtrap Island Collector Well Project:

- Canadian Forest Products Ltd. (Canfor), who operate a private well for industrial purposes near the confluence of the Nechako and Fraser rivers, and withdraw approximately 27 010 000 m^3/year (personal communications with Canfor during capture zone analysis for the City of Prince George's three collector wells) from the Lower Nechako River Aquifer.

- Pacific Western Brewery, who withdraw approximately 110 000 m^3/year (personal communications with Pacific Western Brewery during capture zone analysis for the City of Prince George's three collector wells) from the Lower Nechako River Aquifer.

- Fraser Basin Council, which is a not-for-profit charitable organization dedicated to the sustainability of the Fraser Basin. Among the initiatives and programs of the Fraser Basin Council, has been assisting the Nechako Watershed Council with consultations on enhancement priorities within the Nechako River watershed area.

- Lheidli T'enneh Band, whose traditional territory includes Fishtrap Island and the Nechako River downstream to the confluence with the Fraser River.

- Nazko Band, to confirm if their traditional territory includes Fishtrap Island and to solicit knowledge of unrecorded archaeological resources in the project area.

- Carrier-Sekani Tribal Council, to confirm if their traditional territory includes Fishtrap Island and to solicit knowledge of unrecorded archaeological resources in the project area.

Phase 2

Once the Application/Comprehensive Study Report is submitted to the British Columbia Environmental Assessment Office, the Canadian Environmental Assessment Agency, and other regulatory review agencies, the City of Prince George will engage in a broader

public consultation campaign. This public consultation campaign will consist of advertisements in the local newspaper, posting notices of the assessment on the City's website, and scheduled meetings and/or open houses.

Phase 2 of the public consultation period will commence once the Application/ Comprehensive Study Report has been accepted by the Environmental Assessment Office and the Canadian Environmental Assessment Agency. This will coincide with the posting of the Application/ Comprehensive Study Report on the British Columbia Environmental Assessment Office's (BCEAO's) electronic Project Information Centre website, and on the Canadian Environmental Assessment Agency's Project Registry. It is understood that the public comment period would include a 30-day duration following acceptance of the Application/Comprehensive Study Report by the BCEAO and the Canadian Environmental Assessment Agency.

In accordance with the Section 11 Order for this project issued by the BCEAO on February 24, 2003, and following acceptance of the Application/Comprehensive Study Report by the BCEAO, the City of Prince George will:

- develop a Publication Plan for review and approval by the BCEAO, outlining procedures and schedules for advising the public on the availability and distribution of the Application/Comprehensive Study Report for public comment, input, and venues for receiving information on the project;

- schedule one or more open houses, public meetings, and/or public information sessions within the 30-day public comment period;

- provide records, such as meeting minutes, letters, facsimiles, and email correspondence based on public comments and feedback received; and

- incorporate public input and feedback into the Application/Comprehensive Study Report, and/or how comments will be addressed.

16.1 Public Information Distribution and Consultation Responses Phase 1

Golder provided Canfor, the Fraser Basin Council, Pacific Western Brewing Company, and the Lheidli T'enneh First Nation with a copy of the Executive Summary/Project Description for review and comment. Written comments received to date by these stakeholders are also included in Appendix VIII. Any additional comments that may be received after submission and acceptance of the Application/Comprehensive Study Report will be submitted as an addendum to the Application/Comprehensive Study Report.

17.0 FIRST NATIONS CONSULTATION, ISSUES AND RESPONSES

Local and nearby First Nations were contacted to evaluate their interest in the area in view of potential cultural resources and traditional territories. Specifically, the following First Nations were contacted with respect to their traditional interests in the study area, and specifically in regard to the AIA component of the project:

- Lheidli T'enneh First Nation;
- Nazko Band Government; and
- Carrier-Sekani Tribal Council.

Each of these organizations was contacted by telephone to determine whether the study area is within their asserted traditional territory. Mr. Harold Prince (Vice Chief of the Carrier-Sekani Tribal Council) advised that Fishtrap Island is not within the traditional territory of any of its member Bands.

Ms. Jane Calvert, Referral Coordinator for the Lheidli T'enneh First Nation Natural Resource Office, indicated that Fishtrap Island is within their traditional territory, and that they wished to participate in the AIA. Ms. Calvert provided a digital copy of the Lheidli T'enneh traditional territory map, and she also requested that a change be made to the Heritage Inspection Permit application such that the repository for any archaeological artifacts that may be collected would be the University of Northern British Columbia. This change was made. Golder invited the Lheidli T'enneh to participate in the archaeological field inspection, but no archaeological staff members from the Band were available at the time of the assessment.

17.1 June 11, 2003 Site Meeting/ Tour and Presentation to the Lheidli T'enneh Community Treaty Council

On June 11th, 2003, the City of Prince George organized a site tour and meeting which was attended by various members of the Lheidli T'enneh First Nation, and federal and provincial regulatory agency personnel. In addition, the City of Prince George and its consultants (Golder Associates Ltd. and Dayton and Knight Consulting Engineers) were invited by the Lheidli T'enneh First Nation to deliver a presentation to the Lheidli T'enneh Community Treaty Council later that day. A copy of the minutes from the site meeting/ presentation to the Community Treaty Council is provided in Appendix IX of this Application/ Comprehensive Study Report.

Key issues raised by the Lheidli First Nations during the site meeting, and subsequently during the presentation to the Community Tribal Council included the following:

- opportunities for ensuring employment/ economic benefits to members of the Lheidli T'enneh First Nation;

- potential for fisheries impacts associated with construction and operation of the Fishtrap Island Collector Well, and if representatives of MWLAP and/or DFO were represented on the June 11th, tour; and

- First Nations involvement and opportunities to provide input during public and regulatory review period.

As referenced in the meeting minutes, under the terms of the Section 11 Order for this project, the Lheidli T'enneh First Nation will be invited to participate in the Technical Working Group following submission and acceptance of the Application by the Environmental Assessment Office. Richard Krehbiel, Director Treaty and Policy Research for the Lheidli T'enneh First Nation referred to the Memorandum of Understanding on Cooperation and Communication Between the *City of Prince George* and the *Lheidli T'enneh Band*, and the Protocol on Communication Between the *City of Prince George* and the *Lheidli T'enneh Band* (July 16th, 2002). Copies of these documents are available through the City of Prince George's website, at the following addresses and are provided in Appendix X of this Application/ Comprehensive Study Report:

- http://www.city.pg.bc.ca/pages/media2002/protocol1.pdf

- http://www.city.pg.bc.ca/pages/media2002/protocol1.pdf

- http://www.city.pg.bc.ca/pages/media2002/protocol3.pdf

The City of Prince George confirmed that it is committed to meeting its obligations for cooperating and communicating with the Lheidli T'enneh First Nation based on this Memorandum of Understanding and Protocol Agreement during all phases of consultation, public review, and development of the Hart Water Supply Improvement Project on Fishtrap Island.

Prior to the June 11, 2003 onsite meeting and presentation to the Community Treaty Council, Richard Krehbiel was contacted to discuss the Lheidli T'enneh First Nation's Traditional Use Study (TUS), funded through the Ministry of Forests. To the best of his knowledge, Mr. Krehbiel did not know of any recorded TUS sites overlapping the study

area. During the discussion he emphasized that the TUS was not exhaustive, and that a lack of specific information for an area did not necessarily correlate to a lack of use by First Nations.

During these preliminary discussions with Richard Krehbiel, the issue of Lheidli T'enneh First Nation wells was brought up. He indicated that Fort George (Shelley) No. 2 Indian Reserve is approximately 10 km from the study area, and the Clesbaoneecheck No. 3 Indian Reserve is approximately 3.5 km from the study area. The well water at both reserves is not potable; drinking water is brought in from a separate source. Mr. Krehbiel emphasized that he was not a specialist on aquifers, but in his mind there seemed to be little chance of negative impacts to the wells at the above-mentioned reserves. In Golder's opinion, because these wells are well outside the zone of influence illustrated in Figure 9.10, they are not expected to be impacted by operation of the proposed Fishtrap Island Collector Well.

The Nazko First Nation Statement of Intent map for treaty negotiations (available at http://srmwww.gov.bc.ca/dss/initiatives/treaty/Images/PDF/nazko.pdf) appears to show the Nechako River as the northern boundary of Nazko territory. This would place Fishtrap Island very near, if not within, Nazko territory. Several attempts were made to contact the Nazko Band Government by telephone to confirm whether the band has a traditional interest in Fishtrap Island, but no response was received. In addition, the Heritage Inspection Permit application was forwarded to the Nazko Band Government for comment. According to the Archaeological Planning and Assessment office, no comments were received from the Nazko. It is Golder's understanding that the Nazko Band Government has informed the EAO that the Band does not wish to participate in the environmental assessment.

18.0 DISCUSSIONS WITH GOVERNMENT

18.1 Pre-Application Consultation Meeting

Initial discussions with government agencies regarding the City of Prince George's Hart Water Supply Improvement Fishtrap Island Collector Well Project commenced with a pre-application consultation meeting held with the British Columbia Environmental Office (BCEAO), including representatives of various provincial and federal agencies on August 8th, 2002 in Victoria, B.C.

The purpose of this pre-application meeting was for the City of Prince George and its consultants, Golder Associates and Dayton & Knight Engineers, to introduce and provide an overview of the proposed project to the regulatory review agencies. This pre-application meeting also provided an opportunity for the EAO and the Canadian

Environmental Assessment Agency to discuss agency requirements, timelines, and review procedures under the British Columbia Environmental Assessment Act (BCEAA) and the Canadian Environmental Assessment Act (CEAA).

This meeting was attended by the agencies listed in Table 18.1.

Table 18.1 List of Attendees at Pre-Application Meeting 8 August 2002

Name	Agency/ Organization
Marcia Farquhar	Environmental Assessment Office
Jim Spafford	Ministry of Sustainable Resource Management – Archaeological Branch
John Mathers	Canadian Environmental Assessment Agency
Wendy Bertrand-Bolton	Western Economic Diversification Canada (WEDC)
Malcolm Smith	Hemmera Envirochem
Carl Alleyne	Health Canada
Peter Bailey	Ministry of Community Aboriginal and Women's Services
Rick Kreibhel	Lheidli T'enneh Band
Bruce Gaunt	Ministry of Health Services (Northern Health Authority)
David Fishwick	Ministry of Health Services – Victoria
Derek Nishimura	Fisheries and Oceans Canada (DFO – Vancouver)
Jennifer Tenant	Environment Canada (Vancouver)
Dave Buyar	Land and Water BC (Prince George)
John Summers	Fisheries and Oceans Canada (DFO – Prince George)
Bob Osborne	Environmental Assessment Office – Aboriginal Relations Coordinator
Michael Leeson	Environmental Assessment Office
Dave Dyer	City of Prince George
Richard Harper	Dayton & Knight Ltd. Consulting Engineers
Don Gamble	Golder Associates Ltd.
Dave Munday	Golder Associates Ltd.

The following key issues were identified and discussed during the 8 August 2002 pre-application meeting.

- In anticipation of the pending changes to the BCEAA, which were subsequently adopted in the new Act which was proclaimed on 30 December 2002, the EAO recommended that the City of Prince George prepare *Terms of Reference* (TOR) detailing the scope and approach to be undertaken in preparing the environmental assessment (Appendix I).

- The EAO and the Canadian Environmental Assessment Agency requested preparation and submission of a *Project Description* to confirm the scope and components of the project. Mr. John Mathers, formerly of the Canadian Environmental Assessment Agency, recommended that the *Project Description* be prepared according to CEAA's Operational Policy Statement for preparing Project Descriptions: http://www.ceaa-acee.gc.ca/0011/0002/ops_ppd_e.htm.

- To satisfy Comprehensive Study Level requirements under CEAA, John Mathers indicated that the scope of the EA should include some discussion of Alternative Means of Undertaking the Project, Accidents and Malfunctions, and Cumulative Impacts. These components are included in this environmental assessment as Sections 5.0, 12.0, and 13.0, respectively.

- Mr. Rick Krehbiel, who represents the Lheidli T'enneh Band, confirmed that the project is within the traditional territory of the Lheidli T'enneh Band. Mr. Krehbiel also indicated that the Band have an interest in the project from the perspective of treaty and land claim issues, and mentioned that the Lheidli T'enneh Band had completed a Traditional Land Use study for their area.

- Following this Pre-Application Meeting, a telephone conference call was held on 5 September 2002 between members of the project design team (Dayton & Knight and Golder) and Ms. Vicki Carmichael (BCEAO), Mr. Tom Muirhead (Land and Water BC), and Mr. Al Kohut (Land and Water BC) to discuss and provide input into an initial draft *Terms of Reference*.

18.2 Development of the Terms of Reference and Project Description

Additional discussions with government agencies were undertaken throughout the fall of 2002 to review, discuss, and to provide input into draft versions of both the *Terms of Reference* and *Project Description*. Telephone conference calls were convened on 15 October 2002, and on 3 December 2002 to address the following:

- review and discuss the *Terms of Reference* for this *Application for Environmental Assessment Certificate*;

- review and discuss the *Project Description*, including alternative means of undertaking the project; and

- receive site-specific and regional-specific resource information to assist in characterizing the environmental setting and potential environmental effects associated with the project.

18.3 Interviews with Regional Regulatory Agency Representatives

In addition, Golder Associates met with and interviewed the following regional regulatory agency representatives for the purpose of soliciting their concerns and to receive their input:

- Tom Muirhead, Senior Water Allocation Technician, Land and Water BC, Resource Management Omineca-Peace, Planning and Allocation;

- Bill Arthur, Senior Ecosystem Specialist, Omineca Ecosystem Section, MWLAP; and

- John Summers, Habitat Biologist, Habitat and Enhancement Branch, Fisheries and Oceans Canada (DFO).

Tom Muirhead indicated that the proposed collector well and related ancillary facilities would need to be designed for the 1 in 200 year flood event. As indicated in Section 11.1 of this environmental assessment, the collector well and pump house structure will be constructed at an elevation consistent with the 1 in 200 year flood design criteria.

Construction and operation of the City's Hart Water Supply Improvement project is not anticipated to result in a harmful alteration, disruption, or destruction of fish habitat. Based on an on-site meeting (10 October 2002) with Mr. John Summers, DFO expressed no objections or concerns with respect to the proposed construction and operation of the collector well and ancillary facilities, provided that the project did not require any instream works or undertakings within 30 m top of bank of the Nechako River or its tributaries, the water transmission lines follow the path of least resistance out to the BC Hydro right-of-way and along the existing access road to the bridge, and the water transmission line is routed underneath the bridge in the existing block-outs provided.

18.4 Correspondence Submitted to the BC Environmental Assessment Office and Canadian Environmental Assessment Agency

Based on the above discussions and correspondence with federal and provincial agency personnel, the following documents were subsequently issued to the BCEAO and the Canadian Environmental Assessment Agency.

- The study *Terms of Reference*, was issued in final to the BCEAO on 28 November 2002. This document was entitled *Application for Environmental Assessment Certificate and Comprehensive Study Report, City of Prince George Hart Water Supply Improvements, Fishtrap Island Collector Well Project, Prince George B.C.*

- A *Project Description* was issued to the Canadian Environmental Assessment Agency on 1 October 2002, in accordance with the general format and structure outlined in CEAA's Operational Policy Statement for preparing Project Descriptions: http://www.ceaa-acee.gc.ca/0011/0002/ops_ppd_e.htm. This document was titled *Project Description* for the *City of Prince George Hart Water Supply Improvements, Fishtrap Island Collector Well, Prince George, B.C.*

- A letter report was issued to the Canadian Environmental Assessment Agency describing alternative means of installing a 750 mm diameter water transmission main from the proposed Fishtrap Island Collector Well northward across the Nechako River to the Hart Water Distribution Area. This letter correspondence served as a supplemental document to the 1 October 2002 *Project Description* for the *City of Prince George Hart Water Supply Improvements, Fishtrap Island Collector Well.*

- An Executive Summary report was issued to the BCEAO on 6 February 2003 as a basis for providing a more complete and current version of the *Project Description*, itemized above.

- *Draft Application for Environmental Assessment Certificate and Comprehensive Study Report for the City of Prince George Hart Water Supply Improvements Fishtrap Island Collector Well Project, Prince George, B.C.* on March 31st, 2003.

18.5 Agency and First Nations Site Tour and Meeting

Following receipt of agency comments on the draft Application/ Comprehensive Study Report, the City of Prince George and its consultants convened a site meeting with representatives from federal and provincial regulatory review agencies and with members of the Lheidli T'enneh First Nation on June 11th, 2003.

The purpose for this site meeting/ tour was to visit the sites of the proposed project components, including the site of the collector well, access roads, and water transmission mains, and to visit other municipal collector wells (PW601 and PW605) and a

conventional vertical well (PW607). The site visit also included an inspection of municipal well along the north side of the Nechako River near the Hart Highway where there had been a previous spill of hydrocarbons within the capture zone of the well. This site meeting provided an opportunity for regulatory agencies and First Nations who ultimately would be reviewing the Application/ Comprehensive Study Report as part of the Technical Working Group to gain a first-hand understanding and appreciation of site conditions and characteristics. The meeting/ tour also provided an opportunity for the regulatory review agencies and First Nations to provide additional feedback and input prior to the submission of the revised *Application for Environmental Assessment Certificate/ draft Comprehensive Study Report* to the BC Environmental Assessment Office and the Canadian Environmental Assessment Agency.

A copy of the minutes from the June 11th, 2003 site meeting/ tour with the agencies is presented in Appendix IX of this Application/ Comprehensive Study Report. These minutes also include a summary of input and feedback received by the Lheidli T'enneh First Nation who attended the site tour, and subsequently, attended a presentation to the Lheidli T'enneh First Nation Community Treaty Council by the City of Prince George and its consultants.

The June 11, 2003 site meeting/ tour was attended by the agencies and First Nations listed in Table 18.2.

Table 18.2 List of Attendees at Site Tour Meeting 11 June 2003

Name	Agency/ Organization
	Regulatory Agencies
Teresa Morris	Environmental Assessment Office
Kim Cholette	Environmental Assessment Office
Steve McNaughton	Environmental Assessment Office
Linda Sullivan	Canadian Environmental Assessment Agency
Debra Myles	Canadian Environmental Assessment Agency
Wendy Bertrand-Bolton	Western Economic Diversification Canada (WEDC)
Jennifer Tennant	Environment Canada
Peter Bailey	Ministry of Community Aboriginal and Women's Services
Bruce Gaunt	Ministry of Health Services (Northern Health Authority)
Tom Muirhead	Land and Water BC (Prince George)
	Lheidli T'enneh First Nation
Marvin George	Lheidli T'enneh First Nation
David Baker	Lheidli T'enneh First Nation
Jim Stewart	Lheidli T'enneh First Nation

Name	Agency/ Organization
Frank Frederick Sr.	Lheidli T'enneh First Nation
Carl Frederick	Lheidli T'enneh First Nation
Vera Seymour	Lheidli T'enneh First Nation
Edith Frederick	Lheidli T'enneh First Nation
Robert Frederick	Lheidli T'enneh First Nation
Wendy Jael	Lheidli T'enneh First Nation
Michael Bozoki	Lheidli T'enneh First Nation
	Proponent
Dave Dyer	City of Prince George
Marco Fornari	City of Prince George
	Proponent's Consultants
John Boyle	Dayton & Knight Ltd. Consulting Engineers
Don Gamble	Golder Associates Ltd.

As summarized in the minutes from this site meeting/tour, the following key issues were identified and discussed:

- Inclusion of sentinel (observation) wells to be presented in the Application/ Comprehensive Study Report.

- Discussion of potential sources of contamination and risk of accidents resulting in release of hazardous materials to the Lower Nechako River Aquifer associated with operation and maintenance of the CN railway line (e.g., spraying of pesticides, herbicides, hydrocarbon contamination associated with creosote railway ties, MTBE contamination) to be included in the Application/ Comprehensive Study Report.

- Discussion of the City's operational and maintenance protocol for ensuring that quality of groundwater from the collector well will meet drinking water criteria to be included in the Application/ Comprehensive Study Report. For example, frequency and parameters for testing and reporting of water quality parameters to the Northern Regional Health Unit, quality control/ quality assurance regulation of chlorination and fluoridation procedures.

- Discussion of the difference between a "collector well" and a "conventional vertical well". A collector well is much larger, and withdraws greater quantities of water from an aquifer. The proposed collector well would

consist of a concrete caisson approximately 5 m in diameter, 30 m deep into the aquifer, and would include multiple well screens that are projected radially into the aquifer near the base of the caisson. Each well screen would extend approximately 30 m from the caisson.

- Discussion of the proposed tie-in point for the proposed water transmission main leading from Fishtrap Island Collector Well to PW605, and whether it would require work within 30 m from top of bank of the Nechako River. While the actual site of the tie-in point has not yet been determined, it will be located a minimum of 50 m from the top of bank of the Nechako River, and therefore, will not encroach within the riparian area of the Nechako River.

- Discussion of applying for concurrent provincial permits and approvals, at the time the Application for Environmental Assessment Certificate/ draft Comprehensive Study Report is accepted by the EAO and the Canadian Environmental Assessment Agency. It is anticipated that the only provincial permits and approvals required will be a Health Approval from the Northern Regional Health Unit, and either a Water Act (Section 9) Approval from the Ministry of Water Land and Air Protection, or a Notification from Land and Water BC for the water transmission main crossing of the back-channel.

It was subsequently confirmed that issuance of a Water Licence from the Ministry of Water Land and Air Protection for the extraction of groundwater from the collector well would not be applicable, since the water licensing process does not currently apply to groundwater extraction projects (T. Morris, Project Assessment Manager, Environmental Assessment Office, 2003, pers. comm.).

19.0 CONCLUSIONS

This assessment has been made based on withdrawals of groundwater at the design flow capacities of the proposed Fishtrap Island Collector Well and, where appropriate, the City of Prince George's two other collector wells PW601 and PW605. The design flow rates exceed the projected average 20-year flows for the City by a factor approaching three.

The *Hart Water Supply Improvement Project* can be constructed in an environmentally sound manner with minimal environmental impact by following recommendations provided in this document.

Even operating the proposed Fishtrap Island Collector Well at its design flows, the long-term impact of the project is negligible with respect to the Nechako River flows during

both low and high flows. Furthermore, the impact may not be detectable in terms of the accuracy of estimation of river flows.

Potential impacts of withdrawals of groundwater from the proposed Fishtrap Island Collector Well on the Lower Nechako River Aquifer are limited in terms of drawdown. No other users of the Lower Nechako River Aquifer will be affected by operation of the proposed Fishtrap Island Collector Well.

The same comment can be made for operation of the City's three collector wells concurrently at their design flows.

GOLDER ASSOCIATES LTD.

Don B. Gamble, MCIP, R.P.Bio.
Associate/ Environmental Planner

Nancy Elliott, R.P.Bio.
Fisheries Biologist

Aug 22, 2003

Nick Sargent, M.Sc., P.Geo.
Associate/ Senior Hydrogeologist

DBG/NS/NE/ns/ne/wf

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21.0 PERSONAL COMMUNICATIONS

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