INVENTORY AND RATING OF SALMONID HABITATS IN THE VICINITY OF QUESNEL, B.C.
I. Report

Prepared for:

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

Table

LIST OF FIGURES

Figure

LIST OF PHOTOGRAPHS

Photograph

LIST OF APPENDICES

Appendix

1.0 INTRODUCTION

The Fraser River Action Plan (FRAP), an initiative under the Canadian government's Green Plan, aims to establish a management program that will promote sustainable development and ensure that the health and productivity of the Fraser River Basin's ecosystems are restored and enhanced. In order to accomplish this ambitious task, FRAP is working to build partnerships with the various stakeholders within the Fraser River Basin to develop a cooperative management program based on the principles of sustainability. An integral part of such an undertaking is to compile inventory data on existing fish habitats including a rating of their value along with the locations of available habitat rehabilitation and enhancement opportunities. This baseline information could then be used to assess, plan and direct land development activities along the study area streams within the context of environmentally sustainable development.

In 1992, ECL Envirowest Consultants Limited (Envirowest) was retained by the Department of Fisheries and Oceans (DFO) to develop and complete the first baseline inventory project which described, rated and mapped fish habitats along the major watercourses within City of Prince George (Nowotny and Hickey 1993). This information has since been used to assist DFO and the City in directing and controlling development near fish habitats as well as in contributing to the update of the City's Community Plan and Riverfront Trail System.

In 1993, Envirowest was retained by DFO to conduct similar inventories in the vicinity of the cities Kamloops (Envirowest 1994) and Quesnel, B.C. This report and accompanying map series present the inventory information for the City of Quesnel. The specific objectives of the study were to:

1. conduct a biophysical survey of the Fraser and Quesnel rivers as well as Baker Creek within the study area;

2. identify and classify the major salmonid habitat types (rearing and/or spawning) within the study area;

3. rate individual areas along the watercourses as to their value as salmonid rearing and/or spawning habitat;

4. identify locations of point-sources of pollution which may have an effect on water quality; and

5. identify fish habitat enhancement and restoration opportunities within the study area.

Degradation and alteration of fish habitats along watercourses within the study area has occurred from:

- development activities such as dyking, culverting and filling to prevent flooding or erosion;
- activities associated with industrial, commercial, agricultural, residential, and/or recreational upland uses;
- water withdrawals for agriculture or industry; and
- degradation of water quality from effluent discharges, spills of harmful materials, sedimentation from streambank erosion or introduction of contaminants from snow removal and storm runoff.

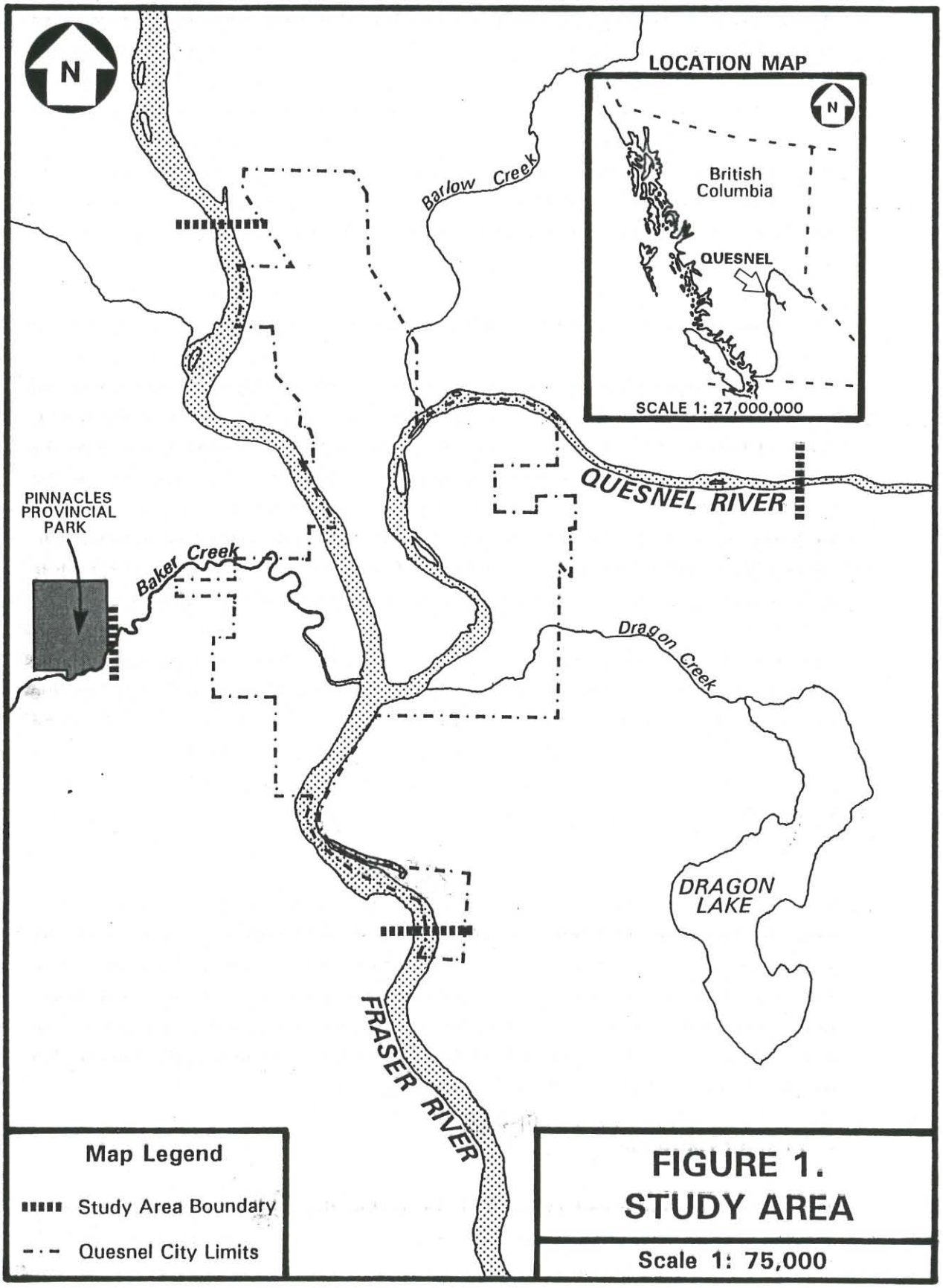
Due to the importance of the study area streams for fish rearing and/or spawning, the instream habitats, riparian zones and adjacent uplands must be managed to minimize the impacts of development. This study takes the first step in protecting these areas by providing an inventory of, and value ratings for, these habitats.

The study findings are presented in two parts, this report and an accompanying map series covering the Fraser and Quesnel rivers, and Baker Creek within the study area. The report outlines the methods employed during the study and provides details on the study results along with conclusions and recommendations. The map sheets provide a summary of the study findings, in particular the habitat value ratings. This cartographic format includes an index map for quick map referencing and a legend defining the symbols used on the map sheets.

2.0 STUDY AREA

2.1 Description

The project study area extended beyond, but encompassed, the city limits of Quesnel, B.C.. The Quesnel area has a population of approximately 23,500 people and is situated at the confluence of the Quesnel and Fraser rivers in the North Cariboo Region of B.C. at an elevation of 475 m. Specifically, the study area encompassed 11.0 km of the Quesnel River from the main B.C. Hydro powerline crossings to the confluence with the Fraser River, 11.5 km of the Fraser River from a point 1.5 km upstream of Bouchie Creek (across from the Quesnel Airport) to the downstream end of the Weldwood mill property (4 km downstream of the Quesnel River confluence) (Fig. 1). In addition, 6.9 km of Baker Creek, a Fraser River tributary, were inventoried. The survey included the shorelines and riparian zones along both banks of the streams.


N
LOCATION MAP
N
British Columbia
QUESNEL
SCALE 1: 27,000,000
Barlow Creek
QUESNEL RIVER
PINNACLES PROVINCIAL PARK
Baker Creek
Dragon Creek
DRAGON LAKE
FRASER RIVER
Map Legend
Study Area Boundary
Quesnel City Limits
FIGURE 1.
STUDY AREA
Scale 1: 75,000

The Quesnel study area lies within the Sub-Boreal Spruce biogeoclimatic zone of B.C. which encompasses the Interior Plateau and the Fraser Basin (Meidinger and Pojar 1991). The zone is characterized by continental climate with extremes in seasonal temperatures, severe, snowy winters, relatively warm, moist and short summers, and moderate annual precipitation. Mean annual temperatures range from 1.7°C to 5°C with the average temperature remaining below 0°C for four to five months and above 10°C for two to five months per year. Mean annual precipitation ranges from 440 to 900 mm, between 25% and 50% of which occurs as snow.

The landscape is dominated by coniferous forests with hybrid white spruce and subalpine fir occurring as the climax tree species. Lodgepole pine is common in mature forests and pioneers extensive seral stands along with trembling aspen and paper birch. Douglas-fir occurs as small but consistent component of the forest. Alluvial forests of black cottonwood, often interspersed with spruce, occur on the active floodplains of the major watercourses. Wetlands are common in the SubBoreal Spruce Zone where poorly drained, post-glacial depressions and river ox-bows are present. Wetland communities include sedge marshes, scrub birch, swamp birch and willow fens, treed fens and swamps with black and hybrid white spruce, and black spruce - *Sphagnum* bogs (Meidinger and Pojar 1991).

Forestry, the mainstay of Quesnel and the surrounding area, is supported by large tracts of moderately productive forest. Agricultural capability is generally low due to adverse climate and topography but the soils present at the lower elevations along the major rivers have the highest capability. The majority of the agriculture in the zone is forage-based, supporting cattle and dairy operations. Some of the more favourable sites support field crops and cereal grain production (Meidinger and Pojar 1991).

The Fraser River at Quesnel drains an area of 97,900 km^2 and has a mean annual total discharge of 34.5 million dam^3 (1 dam^3 = 1,000 m^3) as reported by Environment Canada (1991). The peak monthly mean annual discharge occurs in June with the minimum typically being recorded in February. The Quesnel River, in contrast, drains an area of 11,500 km^2 and has a mean annual total discharge of 7.42 million dam^3. The peak and minimum monthly mean annual discharges also occur in June and February/March, respectively.

2.2 Salmonid Utilization

The mainstem Fraser and Quesnel rivers within the City of Quesnel primarily provide rearing habitat for salmonids and function as migratory routes for both

adult and juvenile fish. The Fraser River within Quesnel is utilized for rearing and migration by chinook salmon (*Oncorhynchus tshawytscha*) stocks from upriver streams including the Cottonwood, Blackwater (Westroad), Nechako and Stuart River systems and Upper Fraser tributaries (Fraser et al. 1982), and as a migration corridor by the Stellako, Nadina, Stuart and Bowron River sockeye salmon (*O. nerka*) stocks (Marshall and Manzon 1980; Farwell et al. 1987). Small populations of pink salmon (*O. gorbuscha*) also migrate past Quesnel to spawn in upstream tributaries including the lower Nechako River (T. Cone, pers. comm.). The Quesnel River system functions as a migratory route for chinook, coho (*O. kisutch*) and sockeye salmon destined for spawning grounds further upstream, outside of the study area. Lewis and Levings (1988) found chinook salmon smolts and under-yearlings rearing in the Quesnel River throughout the study area. A small number of pink salmon spawners have been observed in the Quesnel River on odd years (Fraser River system pink salmon spawn only on odd years) within the city limits (F. Lorenz, pers. comm.). In addition to the mainstem rivers within the study area, chinook spawning in the upper reaches (outside the study area) and pink salmon spawning near the mouth of Baker Creek (within the study area) has been observed (F. Lorenz, pers. comm.). Baker Creek is a tributary to the Fraser River entering from the west within the city limits of Quesnel.

Other salmonid species known to be present within the study area streams are rainbow trout (*O. mykiss*) and Dolly Varden char (*Salvelinus malma*) (Olmsted et al. 1980; Whelen et al. 1980; B. Chapman, pers. comm.).

The rearing habitats present in the mainstem Quesnel and Fraser rivers and their tributaries are particularly important because of the life history of the chinook salmon populations inhabiting this part of the Fraser River watershed. The juveniles produced from these populations are denoted as "stream-type", indicating that they rear for one year in freshwater prior to entering the ocean (Tutty and Yole 1978; Hickey and Lister 1981). This behaviour requires that, following emergence from the gravel, the juvenile fish spend the spring through winter, in freshwater prior to migrating downstream to the Fraser River estuary the next spring. Even though chinook salmon spawning has not been documented within the study area, downstream dispersion of juveniles from upstream tributaries of the Quesnel River (Olmsted et al. 1980; Whelen et al. 1980) and the Fraser River (Lister et al. 1981; Rosberg et al. 1981; Chatwin et al. 1963) has been noted indicating that immigration of chinook salmon juveniles into the study area would be expected.

A fish sampling program conducted in the mainstem Fraser River around Quesnel during August through March captured chinook salmon juveniles throughout the sampling period (Rosberg and Associates 1987). A total of four sampling sites

were located within the Quesnel study area, two along the Weldwood mill, and two in the City of Quesnel downstream of the Moffat Bridge (one site on each bank). The sampling results confirm the use of the area by rearing young-of-the-year and overwintering chinook salmon and attest to the high value of the area's fish habitat.

Stream habitat utilization by juvenile salmonids varies due to several factors including individual fish and population size, season of the year, instream conditions and the habitat types available within the stream. Newly emerged chinook fry initially display a schooling behaviour and a preference for stream margins with low velocities (Lister et al. 1981; Russell et al. 1983). Fry emergence in the Quesnel and Upper Fraser River systems occurs as early as March and can extend into June but occurs predominantly in April and May (Lister et al. 1981; Emmett and Convey 1990; Whelen et al. 1980; Rosberg et al. 1981). As the year progresses and the size and strength of the fish increase, they tend to spread out and utilize deeper, faster flowing water (Lister and Genoe, 1970). Also, downstream movement of juveniles following emergence has been documented but the proportion of the population and factors influencing the movement appear to vary (Lister et al. 1981; Russell et al. 1983; Rosberg et al. 1981). Studies have also identified accessible small tributary creeks (including ephemeral streams) as important rearing habitats for juvenile chinook salmon (Lister et al. 1981; Russell et al. 1983; Rosberg et al. 1981). In addition, juvenile chinook salmon have been found to rear in the seasonally flooded areas along the mainstem rivers from April through to July (Rosberg et al. 1981). As winter approaches and the water temperatures decrease, juvenile chinook salmon seek refuge in areas of slower moving water and in the interstitial spaces between cobbles, boulders, large rip rap and amongst organic debris such as beaver (*Castor canadensis*) lodges and log jams (Emmett and Convey 1990; Emmett 1989; Rosberg and Associates 1987; Swales et al. 1985).

3.0 MATERIALS AND METHODS

3.1 Baseline Data Collection

Prior to initiating the field survey, baseline data (including fish population information), locations of known storm water outfalls, effluent discharges, snow dump sites and sewage outfalls, were compiled from available sources including the City of Quesnel, local industries, BC Environment, and through interviews with DFO personnel and a review of existing Stream Inventory Summary System (SISS) database records and maps. The information was transferred onto the base maps and used for reference during the field survey.

Colour aerial photographs of the study area were acquired from Maps-BC and used to augment field observations of the upper portions of the small mainstem tributary streams and to assist in the description and identification of mainstem habitats, physical features, and upland status.

3.2 Field Survey

A biophysical survey of the Fraser and Quesnel rivers within the city limits of Quesnel was conducted by boat between September 14 and 20, 1993. In addition, Baker Creek was surveyed on foot from the Pinnacles Provincial Park boundary downstream to the confluence with the Fraser River. The small tributaries which enter the mainstems as well as the seasonally-flooded areas were also surveyed inland for a sufficient distance to assess the value of the fish habitat present.

Colour 35 mm photographs were taken during the survey to further document the condition of the vegetation communities and shorelines, point sources and any other pertinent conditions. In addition, a helicopter survey of the Fraser and Quesnel River foreshores was conducted on September 15, 1993. The primary purpose of the flight was to video tape a majority of the study area for future reference, and secondarily, to identify areas of concern that were not evident from the water or roads.

3.2.1 Habitat Variables

Following a review of the scientific literature relating to salmonid stream habitat utilization within upper Fraser River systems and consultation with environmental agency personnel, the following habitat variables were identified as being important in the rating of salmonid habitat values.

Instream Substrates:	fines (clay, mud, sand), gravels, cobbles, boulders, bedrock or others (i.e. rip rap)
Nearshore Flow:	riffle, run, glide, pool, or backeddy
Bank Composition:	fines (clay, mud, sand), gravels (large and small), cobbles, boulders, bedrock or armoured

Bank Stability:	eroding or stable
Submergent Vegetation:	community description
Emergent Vegetation:	community description
Lower Riparian Vegetation:	community description
Upper Riparian Vegetation:	community description
Upslope Vegetation:	community description
Upland Use:	residential, industrial, agricultural, recreational, linear development (roads, railroads, pipelines, transmission lines, etc.), or undeveloped

To facilitate identification and rating of salmonid habitats, linear units, termed "streambank sections", were defined along the mainstem rivers. Because of the inherently smaller wetted width and the homogeneity of the both the riparian zones and channel character, homogeneous stream sections, termed "reaches" were demarcated along Baker Creek. Delineation of these sections was based on a subjective determination of the general homogeneity of a given length of shoreline with respect to the above set of habitat variables. Field data were collected for each streambank section or reach. The data collected during the field survey included descriptions of the present upland status, the relative abundance and species composition of vegetation communities, log debris accumulations, bank composition and condition, nearshore stream flow characteristics, predominant and secondary substrate types of the nearshore and bank, locations of storm water outfalls, effluent discharges, and prominent instream structures such as bridges, docks, power/pipelines, intakes and other man-made structures.

For the purposes of this study, the riparian zone was defined as the vegetated area from the lowest point near the waters edge upslope to the top of the bank including those communities inherently inter-related with the watercourse; i.e. plant communities established on fluvial materials with nutrient, substrate or debris input from slopes adjacent to the watercourse.

3.2.2 Habitat Rating Criteria

Mainstem Fraser and Quesnel Rivers

The fish habitats surveyed along the mainstem rivers within the study area were rated with respect to their salmonid rearing and/or spawning value. Three rating categories were employed: high, medium and low. The following set of criteria (based on the important habitat variables outlined in report section 3.2.1) were developed and applied to the rating of the habitats within the Streambank Sections. It should be noted that all the criteria need not have been met for a particular section to receive a certain rating; often a combination of habitat qualities and quantities were used to rate a stream section.

High:

- overwintering habitat provided by significant quantities of cobble, boulder and large rip rap substrates and/or large organic debris
- significant quantities of high water refuge and rearing habitat within shallow-gradient, low-velocity nearshore areas
- potential for salmonid spawning (gravel substrates and appropriate water velocity/depth)
- stable nearshore and streambanks
- well-developed riparian and emergent vegetation communities which stabilize banks, provide cover (protection) and function as a source of fish food production.

Medium:

- limited areas of overwintering habitat among clusters of large substrates
- limited areas of rearing habitat due to excessive flows and/or inappropriate substrates
- limited area and/or non-contiguous riparian zone
- stable to moderately stable nearshore and streambanks
- mixture of substrate types (i.e. gravels with sand and/or mud and/or scattered cobble/boulder)
- general presence of emergent and riparian vegetation; upland vegetation is present if upper banks are unstable.

Low:

- general lack of rearing habitat
- predominance of sand or mud substrates
- absence or degradation of the riparian vegetation
- unstable, eroding banks
- extreme water flow conditions (i.e. stagnant area or deep, fast-flowing water)
- lack of spawning potential (inappropriate substrates and/or flow velocities)
- over-abundance of submergent vegetation

Baker Creek

A biophysical inventory of Baker Creek was conducted on foot from the eastern boundary of Pinnacles Provincial Park downstream to the confluence with the Fraser River. Biophysical data including stream width, depth, substrates, character, riparian vegetation and its status, bank composition and stability were recorded. In addition, upland use was noted as were observations of salmon spawning, stream degradation and habitat enhancement and/or rehabilitation opportunities. Based on the biophysical information gathered, a value rating was assigned to each reach in relation to salmonid spawning and rearing.

Other Tributary Streams

Tributary streams provide important rearing areas for the local and migrant fish populations. In the case of some tributaries, elevated water temperatures in the slow-flowing rearing areas located off the mainstem may stimulate rearing salmonids to seek the cooler water temperatures in these streams. This behaviour also enables the fish to avoid the typically higher predator densities in the mainstem and off-channel rearing areas. The criteria based on the important habitat variables outlined in report section 3.2.1 were applied to the tributary streams when assigning habitat value ratings. Again, it should be noted that all the criteria need not have been met for a particular stream or area to receive a certain rating and often a combination of habitat qualities and quantities were used to rate a stream.

3.2.3 Vegetation Inventory

The vegetation along the mainstem rivers was inventoried to document the species present and their relative abundance within a given streambank

section. It should be noted that the availability of this information does not eliminate the need for more detailed on-site habitat assessments for any proposed developments. Site-specific detailed species and abundance information should be collected and used as baseline information from which appropriate compensation and/or mitigation measures could be prescribed for impacted areas. Other pertinent site-specific biophysical information such as bank substrate composition should be taken into account in determining the likelihood of achieving the prescribed mitigative measures.

Identification of vegetation species was not meant to be exhaustive. In fact, the intention of the vegetation portion of the survey was to identify general community associations among the aquatic, riparian, and to a lesser degree, the adjacent upland habitats. The survey was also intended to locate significant areas of aquatic and riparian communities along the river systems. Such descriptions would aid developers, environmental agency personnel, and City staff in identifying any need for, or extent of, vegetation replacement in the event that habitat impacts occur as a result of development or as part of habitat enhancement/restoration projects.

Plants were identified to the species level. Many different plant keys were utilized but the nomenclature follows Vascular Plants of the Pacific Northwest (Hitchcock *et al.* 1984) where ever possible (see Section 8.0 - References for a listing of the additional references employed).

Four distinct plant communities were recognized within the Quesnel study area and they are described below.

- **Emergent** - herbaceous wetland species capable of tolerating complete submersion for short periods of time.

- **Lower Riparian** - species found along the lower banks of the watercourse, seasonally inundated sand/gravel bars and low-lying flats within the floodplain. The water table is usually accessible to the root systems. Soils may be skeletal as occurs on exposed gravel bars, or conversely, comprised of recently infilled sediments (largely sands).

- **Upper Riparian** - species found along the upper banks or on elevated floodplain benches, consisting primarily of shrubs and young trees. Inundation by water is often less frequent. Soils are generally well developed and well drained.

- **Upland** - species found on the slopes above the floodplain benches and high water marks. Soils are well developed. Trees and shrubs are the primary community constituents.

Submergent plants were not observed in the study area. High flows, mobile substrates, large water fluctuations, and decreased light penetration due to the turbidity (Fraser River) act to preclude the establishment of submergent species.

Efforts to identify common species were concentrated within the submergent, emergent and lower riparian zones as these communities play a more prominent role in the provision and maintenance of fish habitat.

The accumulated baseline data were used to prepare maps of the Fraser and Quesnel rivers documenting habitat ratings (high, medium or low) for each of the Streambank Sections.

3.3 Mapping

The study area is one of the few regions of the province for which 1:5,000 scale, B.C. Ministry of Environment, topographical mapping is available (MOE 1980). From thirteen of these maps, seven maps were produced to provide coverage for the entire study area. Map production entailed splicing together original maps in order to provide sufficient upland coverage. The new map sheets were then screened by 40% to subdue, yet retain, the topographic map features. The shorelines of the mainstem rivers and their tributaries were then redrawn and enhanced for reference. The geographical referencing points present on the original map sheets were also retained. The aerial photographs of the study area were used as a guide in making pertinent updates to the base maps.

The physical conditions present within each Streambank Section or reach are displayed using coded labels. The labels identify the habitat value, predominant

and secondary substrates composing the nearshore and lower banks, bank stability, and the relative abundances of the four vegetation communities described previously. Lower reaches of mainstem tributary streams were surveyed for a sufficient distance upstream to assess their fish habitat values and these reaches were rated according to the criteria outlined in Report Section 3.2.2 and labelled with the appropriate code (high, medium or low).

Added to each map were; 1) a location map identifying the general location of the area depicted, 2) a legend describing the symbols and codes used, and 3) locations of effluent and storm water outfalls.

A 1:50,000 scale index map covering the entire study area was also produced to enable the reader to easily locate the particular river section of interest. This was accomplished by splicing together four Energy, Mines and Resources Canada (Energy, Mines and Resources 1977) 1:50,000 scale topographic map sheets, screening the new map by 40% to subdue, yet retain, the topographic map features and enhancing the shorelines of the mainstem rivers and their tributaries.

4.0 RESULTS

4.1 Fraser River Biophysical Survey and Habitat Value Ratings

Results of the biophysical survey of the Fraser River are presented in tabular form in Appendix 1 and cartographically on the accompanying 1:5,000 scale map sheets. A dBase IV format computer data file was created of the Fraser River biophysical data for possible future data integration and Geographic Information System (GIS) applications.

Any references made within this report to banks of a particular stream follow the standard convention where "left bank" and "right bank" refer to the sides of the stream while facing downstream.

4.1.1 Physical Description

The portion of the Fraser River flowing through the Quesnel study area is relatively straight and exhibits very little side channel formation. Gravel bars occur at the bends in the river within the upper and lower extent of the study area but not in the developed section through the city where the streambanks have been armoured to prevent erosion. The Fraser River is also turbid due to its bedload. This latter condition combined with the

large annual water level fluctuations preclude the establishment of submergent vegetation and limits bar recolonization by riparian vegetation.

The upland use by Streambank Section length was assigned from field observations and review of 1992 aerial photographs. Half of the total streambank length (both shorelines) was denoted as either residential (6.3 km) or undeveloped (6.2 km). The land use occurring in the remainder of the total length surveyed (both shorelines) included 16% (3.9 km) as agricultural, 16% (3.8 km) as industrial, 9% (2.1 km) as recreational and 8% (2.1 km) as linear development (primarily road and railway).

Nearshore stream flow type was described for each Streambank Section along the Fraser River. Of the total streambank length (both shorelines), nearly half, 48% (11.7 km) was denoted as run. The next most prevalent flow type was glide at 44% (10.6 km) with backeddy at 6% (1.6 km) and riffle at only 2% (0.5 km).

Shoreline substrates were described by Streambank Section. Based on the total streambank length surveyed (both shorelines), the majority (59% or 14.5 km) of the length had cobble as the dominant substrate type. In descending order were boulders at 14% (3.5 km), gravel at 12% (2.9 km), man-made materials (rip rap and metal debris) at 10% (2.3 km), bedrock at 3% (0.7 km) and fines at 2% (0.5 km).

Bank composition and stability were also recorded by Streambank Section. Over half (59% or 14.4 km) of the total length of streambank surveyed (both shorelines) exhibited cobble as the primary bank constituent. Fines (primarily sand) comprised 20% (4.9 km), man-made materials (rip rap and metal debris) 13% (3.1 km), gravels 5% (1.3 km) and boulders 3% (0.7 km). Approximately one-third (31% or 7.2 km) of the total length of streambank surveyed (both shorelines) was classified as eroding with the remaining 72% (17.7 km) denoted as stable. Approximately 18% (3.1 km) of the total length of streambank classified as stable was armoured with man-made materials (rip rap).

4.1.2 Vegetation Communities along the Fraser River

Plant communities along undeveloped sections of the river are relatively uniform and may be described in relation to distinct parameters, i.e. soils, slope, and exposure. The effects of disturbances to lands adjacent to the river are apparent from the plant species that colonize them. The level of

disturbance can be evaluated by examining the degree of contrast in species composition with that of undisturbed communities. The following riparian vegetation descriptions focus on the major community types found in disturbed and undisturbed sites in relation to local topography.

Recommendations for remediation within each of the four defined riparian zones are presented later in this report. A complete listing of plant species encountered appears in Appendix 2.

Emergent Community - Fraser River

The prevalence of the emergent vegetation along the Fraser River is proportional to the amount of suitable habitat present. Preferred conditions for the establishment of emergent species include a low gradient shoreline, backchannel or depositional area where flows are slow to moderate. The substrates along the lower banks of the Fraser River were dominated by cobbles, gravels and boulders with minor sediment infilling. The occurrence of significant deposits of fine sediments upon which emergent plant species could establish was itself, lacking. Widely fluctuating water levels and relatively high flow rates result in the movement of streambed materials and act to preclude the development of extensive emergent plant communities.

The occurrence of this community type was found to be sporadic and fragmented. Representation is characterized by a single species of spike-rush (*Eleocharis palustris*) and scouring-rush (*Equisetum variegatum*).

Lower Riparian Community - Fraser River

The lower riparian plant communities of the Fraser River are seasonally inundated with water during periods of high flow primarily during May, June and July. It is during these periods of high flow where the greatest salmonid habitat values associated with lower riparian plant communities are realized. The outmigration of juvenile salmonids is largely coincident with high water levels, during which time lower riparian plant communities are at the shoreline interface with the aquatic environment. The greater size and rigidity of the shrubs and herbaceous perennials of relatively undisturbed lower riparian plant communities have a greater ability to reduce nearshore water flow velocity than disturbed and grass dominated sites. Submerged woody vegetation also provides refuge areas from the high flow velocities of the main channel and from predators. Insects and

invertebrates washed into the river during high flows are also a primary food source for fish. Additionally, the shrubs of the lower riparian zone are critical in maintaining the integrity and stability of bank materials.

Instream gravel bars and floodplain benches were common physiographic features in the lower riparian zone. Seasonal inundation, frequent disturbance from bedload movement and high water velocity in these areas greatly influences plant community composition which is reflected in the early successional status of existing communities. Vegetation generally occurred where sand and fine sediments infilled the cobble and gravel dominated substrates of bars and benches. The vegetative cover in more stable sites (i.e. the inside bank at bends, protected sites) was dominated by sandbar willow (*Salix exigua*). On disturbed and boulder-strewn sites vegetative cover was often sparse (described as incomplete in Appendix 1) and limited to seedling cottonwoods, grasses and herbaceous species.

Common herbaceous species include asters (*Aster* sp.), goldenrod (*Solidago canadensis*, *S. spathulata*), prairie sage (*Artemisia ludoviciana*) and sweet-clover (*Melilotus occifinalis*, *M. alba*). Less common were Watson's willow-herb (*Epilobium watsonii*), sneezeweed (*Helinium autumale*) and slender rush (*Juncus tenuis*).

Grasses were common to abundant in this zone. Dominant species include spreading bentgrass (*Agrostis alba* var. *stolonifera*), tickle-grass (*A. scabra*) and slender hairgrass (*Deschampsia cespitosa*). Other common grasses include Canadian, Interior and Kentucky bluegrass (*Poa compressa, P. interior, P. pratensis*).

Natural, undisturbed lower riparian species associations occurring on relatively steeply sloped banks were commonly dominated by black cottonwood (*Populus trichocarpa*) and alder (*Alnus tenuifolia*). Secondary species include hybrid white spruce (*Piacea glauca* x *englemanii*), red-osier dogwood (*Cornus stolonifera*), whiplash willow (*Salix lasiandra* var. *caudata*) and black twinberry (*Lonicera involucrata*). This community type was relatively poorly represented along the surveyed sections of the Fraser River due to the greater occurrence of floodplain bench-type landforms and loss of suitable growing sites in rip rap bank sections.

An additional community type was represented by a narrow discontinuous strip of largely shrubby vegetation types along riverbank sections with coarse substrates and relatively steep slopes.

Photograph 1. Lower riparian community - Fraser River

Photograph 1 shows a representative lower riparian community established in sandy soils deposited over a cobble/boulder shoreline adjoining a low floodplain bench. The foreshore is dominated by sandbar willow and the backshore is predominantly young black cottonwood saplings. Such streambank sections have high salmonid habitat values associated with them.

Upper Riparian Community - Fraser River

The significance of the upper riparian plant communities to salmonids is largely based on the values of tree and shrub species in providing stability to bank materials, shading and overhead cover for salmonids using the shoreline habitats and in acting as the primary source of coarse woody debris and litterfall that provides the structure, cover and food base that are primary constituents of stream ecosystems. Native tree and shrub species are generally viewed as having superior fish and wildlife values over most introduced species such as grasses and herbaceous species. The presence and abundance of native tree and shrub species is reflected in the salmonid habitat value ratings for each of the identified streambank sections.

The upper riparian plant communities occurring on wide floodplain benches were dominated by black cottonwood, alder and white spruce and less commonly by birch (*Betula papyrifera*).

The well developed shrub layer of floodplain benches is often represented by a mixed species assemblage including Nootka rose (*Rosa nutkana* var. *hispida*), beaked hazelnut (*Corylus cornuta*), wolf willow (*Eleagnus commutata*), snowberry (*Symphoricarpos albus*), chokecherry (*Prunus virginiana* var. *demissa*), serviceberry (*Amelanchier alnifolia*) and highbush cranberry (*Viburum edule*). Other less common shrubs include buffaloberry (*Sheperdia canadensis*), spreading dogbane (*Apocynum androsaemifolium*) and black hawthorn (*Crateagus douglasii*). The upper riparian plant communities of relatively steeply sloped bank sections were often indistinct or absent, bearing a modest to poorly developed shrub layer including most of the aforementioned species.

The herb layer in the undisturbed floodplain communities was often poorly developed. Common species include goldenrod, scouring rush (*Equisetum hyemale*) and less commonly false Solomon's seal (*Smilacina racemosa*).

Grasses were uncommon in undisturbed upper riparian plant communities but often dominant on disturbed sites. Common grass species include rough fescue (*Festuca scabrella*), bluejoint reedgrass (*Calamagrostis canadensis*), slender wheatgrass (*Agropyron caninum* var. *majus*), nodding wildrye (*Elymus canadensis*) and introduced grasses such as quackgrass (*Agropyron repens*) and crested wheatgrass (*A. cristatum*).

Disturbed communities largely result from a range of land use activities including encroachment by residential, agricultural and industrial developments, powerline and bridge crossings and recreational uses. While some sites show regeneration by native species, most disturbed sites have a significant component of introduced and weedy species. This is true also for many naturally disturbed sites such as naturally eroding cutbanks.

Common herbs of disturbed sites are largely introduced species such as Canada thistle (*Circium vulgare*), field milk-thistle (*Sonchus arvensis*), prickly lettuce (*Lactuca scariola*), alfalfa (*Medicago sativa*), white and yellow sweet-clover (*Melilotus alba, M. officinalis*), Oyster plant (*Tragopagon dubius*), diffuse knapweed (*Centaurea diffusa*), oxeye daisy (*Chrysanthemum leucanthemum*), wormwood (*Artemisia absinthimum*) and dragon sagewort (*A. dranunculus).*

Upper Slopes - Fraser River

The upper slope zone along the Fraser River study area, as defined for the purposes of description include those areas not directly affected by the processes of the river but having the potential to directly affect it. The value of the upper slope zone to salmonids is largely in its capacity to buffer the effects of human activities on downslope riparian communities.

Hybrid white spruce, birch, Douglas-fir and black cottonwood are the dominant tree species of the upper slopes. The variable but generally poorly developed shrub layer contained a few common species including Nootka rose, serviceberry, spreading dogbane and snowberry.

Disturbed sites in the upper slope zone contain all of the weedy species described above for the upper riparian zone.

4.1.3 Salmonid Habitat Value Ratings

A total of 24.4 km of streambank on the Fraser River was surveyed; the total derived from the sum of individual lengths of the streambank sections along both shorelines. Approximately two-thirds (66% or 16.2 km) of this length was rated as having a high value for salmonids. Many of the streambank sections rated as having high salmonid habitat values describe shoreline habitats that provide protection from mainstem flows and contain large substrates as cover for salmonid juveniles during their outmigration. Nearshore habitats such as bedrock outcroppings and large woody debris are likely utilized by rearing chinook or coho through smoltification and were also considered as having high salmonid habitat values. Other high value habitats include small sidechannels and backchannels, gravel bars, islands, and creek mouths. Tributary confluences, such as that of Baker Creek, are especially important features in providing access points for juvenile salmonids to upstream habitats for rearing.

Photograph 2 shows a boulder-strewn shoreline where breaks and eddies in the flow adjacent to deeper water offer protection from mainstem flows, foraging opportunities and cover for juvenile salmonids in the interstices between boulders. Such areas are likely important resting areas for fry, and, where deep enough, would provide adequate overwintering habitat for resident and anadromous species. Adult fish migrating upstream may also favour such an area for resting or simply to take advantage of reduced nearshore flows.

Photograph 2. Coarse substrates and complex current patterns with high salmonid habitat values - Fraser River.

A total of 29% (7.1 km) of the total streambank length (both shorelines) was rated as having medium salmonid habitat values. Streambank sections having medium salmonid habitat values are generally those with limited protection from mainstem flows, smaller substrates (such as sand and mud), or degraded riparian plant communities, the latter often a consequence of steeply sloped or eroding banks. Streambank sections armoured with rip rap materials were often rated medium if the materials used were of large diameter with large interstices, offering juvenile salmonids hiding cover from predators and refuge from the strong mainstem currents. Streambank sections with significant amounts of woody debris or shoreline structure were also often rated medium where hiding cover and refuge from strong currents would exist during the high flows which occur during the springtime outmigration of juvenile salmonids.

The remaining 5% (1.1 km) of the total streambank length surveyed (both shorelines) was rated as low value and often describe steep and eroding banks with poorly developed plant communities such as those occurring in upstream portions of the study area. Other low value sections are often

those with poor nearshore substrates, severely degraded riparian plant communities and those with little protection from strong mainstem flows.

4.2 Quesnel River Biophysical Survey and Habitat Value Ratings

Results of the biophysical survey of the Quesnel River are presented in tabular form in Appendix 3 and cartographically on the accompanying 1:5,000 scale map sheets. A dBase IV format computer data file was created of the Quesnel River biophysical data for possible future data integration and Geographic Information System (GIS) applications.

4.2.1 Physical Description

From the upper study area boundary, the Quesnel River flows in a relatively straight direction until approximately the city limits where it then flows in a more serpentine manner prior to entering the Fraser River. Side channel formation is non existent in the upper portion of the study area with the exception of locations where steep, eroding cutbanks have resulted in the formation of islands and gravel bars such as in Section Q57. Side channel and island formation is, however, prevalent in the lower portion of the river, particularly at inside bends in the main channel. Natural alterations in these channels and islands has been curtailed through the city by the armouring of the streambanks with rip rap to prevent erosion.

The type of upland use was assigned to each Quesnel River Streambank Section based on field observations and review of recent air photos (1992). Based on a percentage of the total length of streambank surveyed, derived from the sum of the lengths of individual streambank sections along both shorelines, nearly half (46% or 11.2 km) of the total streambank length, was classified as undeveloped. In descending order were industrial at 17% (4.2 km), recreational at 14% (3.4 km), linear development at 12% (2.8 km), agricultural at 7% (1.6 km) and residential at 4% (1.2 km).

Nearshore stream flow type was also assigned by Streambank Section and 85% (20.7 km) of the total streambank length surveyed (both shorelines) was denoted as run. In addition, glide comprised 9% (2.2 km), backeddy 1% (0.2 km), riffle 1% (0.3 km), and backchannel waters 4% (0.8 km)

Predominant nearshore substrate types were recorded by Streambank Section. Survey results indicate that nearly three-quarters (17.7 km) of the total streambank length surveyed (both shorelines) had cobbles as the

primary component. The next most common primary substrate type was gravel at 9% (2.2 km) followed in descending order by man-made substrates (rip rap and concrete) at 9% (2.2 km), fines at 5% (1.2 km) and boulders at 4% (0.9 km).

Over half (53% or 12.9 km) of the total length of streambank surveyed (both shorelines) on the Quesnel River had cobble as the main bank constituent. In addition, approximately one-quarter (23% or 5.6 km) of the total length of streambanks (both shorelines) were composed primarily of gravels with the remainder composed of man-made materials (13% or 3.1 km) and fines (11% or 2.6 km). None of the Streambank Sections had boulders as the primary bank constituent. Approximately one-quarter (23% or 5.6 km) of the total length was described as eroding while the other three-quarters were denoted as stable. Of the total length of streambank classified as stable, 16% was armoured with man-made materials.

4.2.2 Vegetation Communities along the Quesnel River

The topography of upstream portions of the Quesnel River within the city limits of Quesnel differs from that of the Fraser River in that the river valley of the Quesnel is generally narrower and floodplain benches are less extensive. Side channels with overhanging trees and shrubs, poorly vegetated gravel bars and vegetated islands were common in the downstream portions within the study area. Plant species assemblages observed were also somewhat different than those of the Fraser River. A complete listing of plant species encountered within the study area appears in Appendix 2.

Emergent Community - Quesnel River

Like the Fraser River, this community type is sporadic and fragmented, limited by the availability of suitable conditions for establishment. Again, relatively high flow rates, scour and bedload movement largely precludes the establishment of this community type.

Representation is characterized by a single species of spike-rush and common scouring-rush.

Lower Riparian Community - Quesnel River

Instream gravel bars and floodplain benches were relatively common in

downstream portions of the Quesnel River. The vegetative cover in more stable sites was largely dominated by sandbar willow. On more frequently disturbed sites such as instream gravel bars and unprotected shorelines the vegetative cover was often sparse and limited to seedling cottonwoods, grasses and herbaceous species. High water velocities, bedload movement, skeletal soils and a high water table limit the growth of vegetation in this zone. Once established, sandbar willow and black cottonwood seedlings act to stabilize the shoreline and provide cover and foraging opportunities for fish during high flows. The shrubs common to lower riparian communities also act as the first line of defence against bank erosion.

Common herbaceous species of low floodplain benches and gravel bars include asters, goldenrod, prairie sage and sweet-clover. Less common were field mint (*Mentha arvensis*), horsetail and slender rush.

Grasses were common to abundant in this zone. Dominant species include spreading bentgrass, tickle-grass and slender hairgrass. Other common grasses include Canadian, Interior and Kentucky bluegrass.

Natural undisturbed species associations occurring on relatively steeply sloped banks were commonly dominated by black cottonwood, alder and white spruce. Secondary species include, red-osier dogwood, whiplash willow, smooth willow (*Salix glauca*), sarsaparilla (*Aralia nudicaulis*) and bearberry (*Arctostaphyllos uva-ursi*).

Upper Riparian Community - Quesnel River

The upper riparian plant communities occurring on wide floodplain benches were dominated by black cottonwood, alder and white spruce, and less commonly by birch. The shrub layer of floodplain benches is often composed of a mixed species assemblage including Nootka rose, beaked hazelnut, wolf willow, snowberry, chokecherry, serviceberry and highbush cranberry. Less common shrubs include buffaloberry, smooth willow, spreading dogbane and black hawthorn. Upper riparian communities with abundant and diverse shrub growth will enhance the value of the adjacent nearshore habitats by stabilizing bank materials, contributing woody debris and insects and providing shade along shoreline habitats. Upper riparian vegetation on floodplain benches would be inundated with water only during the highest flow periods, and at such times would provide refuge and foraging opportunities for salmonids. Significant wildlife values are also associated with a well developed shrub layer.

The upper riparian plant communities of relatively steeply sloped bank sections were often indistinct or absent, bearing a modest to poorly developed shrub layer including most of the aforementioned species.

The herb layer in the undisturbed floodplain communities was relatively poorly developed. Common species include asters, goldenrod and common scouring rush, and less commonly, false Solomon's seal.

Grasses were less abundant in undisturbed upper riparian plant communities but often dominant on disturbed sites. Common grass species include rough fescue, bluejoint reedgrass, slender wheatgrass, nodding wildrye and introduced grasses such as quackgrass and crested wheatgrass.

Disturbed communities largely result from a range of land use activities including encroachment by residential, agricultural and industrial developments, powerline and bridge crossings and recreational uses. While some sites show regeneration by native species, most disturbed sites have a significant component of introduced and weedy species. This is true also for many naturally disturbed sites such as naturally eroding cutbanks.

Common weeds of disturbed sites are largely introduced species such as Canada thistle, field milk-thistle, prickly lettuce, alfalfa, white and yellow sweet-clover, Oyster plant, diffuse knapweed, oxeye daisy and wormwood.

The weedy species found in overgrazed rangeland adjacent to or encroaching within the upper riparian zone include blueweed (*Echium vulgare*), European stickseed (*Lappula echinata*), great mullein (*Verbascum thapsus*) and Canada thistle.

Upper Slopes - Quesnel River

The upper slopes along the Quesnel River as defined for the purposes of description include those areas not directly affected by the processes of the river but having the potential to directly affect it. The primary fisheries values associated with the upper slope zone are as a buffer to protect the integrity of the riparian zones.

Hybrid white spruce, birch, Douglas-fir and black cottonwood are the dominant tree species of the upper slopes. The variable and generally poorly represented shrub layer contained a few common species including Nootka rose, serviceberry, spreading dogbane and snowberry.

Disturbed sites in the upper slope zone include eroding cutbanks and cleared sites that contain all of the weedy species described above for the upper riparian zone.

4.2.3 Salmonid Habitat Value Ratings

A total of 24.2 km of streambank habitat was surveyed on the Quesnel River during this project; derived from the sum of the individual streambank lengths of both shorelines. Seventy-six percent (18.5 km) of the total length (both shorelines) was rated as having high value for salmonids. Streambank sections with high salmonid habitat values associated with them often describe side channels, nearshore habitats with deep water, moderate flows and coarse substrates, and, spawning areas. Active pink salmon spawning was observed at three locations on the Quesnel River. Progressing upstream from the confluence with the Fraser River, the first spawning (approximately eight fish) was observed at Streambank Section Q43, a side channel on the right bank at the downstream end of the city's Two Mile Flat district. The second site was also in a sidechannel on the right bank at Streambank Section Q57 where erosion from a steep cutbank has widened the stream creating a gravel island. An estimate of the number of fish present at this site could not be made due to the poor viewing conditions. The final spawning location was on the left bank at Streambank Section Q78 (see Photograph 3). Again, a widening of the river in this area has occurred from erosion of a cutbank on the right bank. A small sidechannel has been created on the left bank behind a gravel bar and log jam. Approximately 10 pink salmon were observed spawning in the area and three spawned out carcasses were noted.

Of the remaining length, 22% (5.3 km) were rated as having medium salmonid habitat values. A medium rating often corresponded to bank sections with poorly developed, weedy or incomplete (unvegetated portions) riparian plant communities as was often the case where road and/or railway right-of-ways encroach to the top of the bank. Through the activities related to road and railway construction and maintenance including clearing, filling, snow removal, erosion and subsequent armourment of banks, significant impacts to riparian communities have occurred. Where these impacts were not excessively severe and where desireable nearshore salmonid habitat features existed, a medium rating was often afforded. Residential encroachments causing degradation and fragmentation of riparian zone plant communities were often rated as having medium habitat values if desireable nearshore salmonid habitat values existed.

Photograph 3. A side channel protected by a log jam where pink salmon were observed spawning (on right side of photo) - Quesnel River (Streambank Section Q78).

The remaining 2% (0.4 km) of the total streambank length (both shorelines) surveyed along the Quesnel River was rated as having low salmonid habitat values. Streambank sections rated as having low value often describe unvegetated or severely degraded riparian zone plant communities with average or below average instream habitats as often recorded where road and railway right-of-ways encroach to the top of the river banks. Eroding bank sections associated with land clearing operations along agricultural sections where trees and shrubs have been removed were also often rated as having low salmonid habitat values.

4.4 Descriptions of Mainstem Tributaries to the Fraser River

4.4.1 Baker Creek Biophysical Survey and Habitat Value Ratings

Baker Creek, a large tributary to the Fraser River contains significant salmonid habitat values. As such, a comprehensive biophysical survey was conducted to document and describe salmonid habitat values and to identify

habitat restoration and enhancement opportunities. Such biophysical surveys are useful in providing an overview of the value of a watercourse to salmonids and in assessing potential impacts from land development proposals adjacent to the streambanks.

Approximately 6.9 km of Baker Creek, from the southeast corner of the Pinnacles Provincial Park to the confluence with the Fraser River, was surveyed on foot on September 14, 1993. The upper portion of the creek is contained within an often steep-walled canyon. The general character of the creek may be described as a medium sized, meandering, boulder strewn stream influenced by high runoff flows. The section of Baker Creek shown in Photograph 4 exhibits the typical characteristics common to many sections described below. This type of habitat is preferrred by rearing salmonids but offers few spawning opportunities. The high flows result in gravels being flushed from upper stream sections and deposited in the lower gradient portions close to the confluence with the Fraser River.

The surveyed portion of the creek was segregated into three stream reaches based on the type of upland use which was reflected in the level of impacts that were occurring within the stream and riparian zone. The reaches were denoted beginning from the confluence with the Fraser River (Reach 1) upstream to the Pinnacles Provincial Park boundary (Reach 3). Distances along the stream are measured from the Fraser River/Baker Creek confluence. Individual reach descriptions are provided below.

Reach 1 - High Salmonid Habitat Value

This reach is approximately 1.6 km long and extends from the confluence with the Fraser River upstream to Beaubein Avenue. Land use along this section includes medium and high density residential, light industrial, and park. Encroachments within the top of bank, modifications to the streambank and dumping of debris into the channel have occurred within this reach.

The first 500 m of Baker Creek upstream from the confluence with the Fraser River contains relatively high proportions of gravels that have washed downstream during flood events and have accumulated in this lower gradient section. Photograph 5 shows much of this long section in which pink salmon were observed spawning. Note that this section is easily accessed by people and salmon are easily disturbed where water depth and overhead cover is limited. A man-made dam constructed with large

boulders located 320 m upstream of the confluence also acts to trap gravels. Although beavers have built up the southern part of this rock dam with sticks and cobble it does not prevent the passage of fish. A total of eight pink salmon were observed spawning both above and below this dam. Pink salmon spawning occurred in the tail-out areas of shallow pools where the water was generally less than 30 cm deep and the flow was relatively fast. Three main pools located at approximately 100, 300 and 450 m upstream are separated by faster flowing boulder and cobble strewn runs. Four rock weirs were observed in the smaller of two channels split by a gravel bar at 300 m. Concrete slabs and rip rap materials are mixed with natural small boulders and cobble along the banks. Riparian vegetation along the northern bank behind the shopping mall is restricted to a 3 to 4 m wide strip dominated by black cottonwood. The lower 2 m of the bank is armoured with concrete slabs. Vegetation along the southern bank is largely restricted to shrubs between Warden Road and the creek with a patch of black cottonwoods occurring off the end of the road at the top of the bank. The existing vegetation in this section is of high value to fish since it provides overhead cover and shading as well as contributes to bank stability. Salmonid habitat value ratings for this section are high for spawning and ranges between medium and high for rearing.

Between 500 m upstream of the Fraser River confluence and the Marsh Drive bridge crossing at 660 m, the creek is slower flowing and averages 6 m in wetted width and 20 cm in depth with substrates consisting of cobble and boulders. The flow at the bridge is faster over gravel and small cobbles. The average width was 8 m and the average depth 3 cm. The floodplain averages 15 m in width and is bordered by a narrow band of black cottonwood and an incomplete mixed shrub understory of red-osier dogwood, willow, rose, and chokecherry. Concrete slabs armour a section of the southern bank. Instream structure and cover is limiting. The salmonid habitat value rating within this section is low for spawning and medium for rearing.

The creek, from about 20 m upstream of the Marsh Drive bridge to approximately 800 m upstream from the confluence with the Fraser River averages 8 to 10 m in width. The flow over cobbles and boulders is moderate. The average maximum water depth was 20 cm and the boulder-cobble banks are unvegetated up to an incomplete band of black cottonwoods along the top-of-bank. The salmonid habitat value rating for this section is low for spawning and medium for rearing.

Photograph 4. A typical section of Baker Creek at the downstream end of Reach 3.

Photograph 5. Spawning gravels in the lower portion of Baker Creek.

Between 800 and 950 m upstream from the Fraser River, the channel wetted width averages 9 to 10 m narrowing to 7 m in the downstream portion. The flow is moderately fast and the average depth was 8 cm. The substrates consisted of small boulders, cobbles and coarse gravels which provided little instream structure or cover. A bike trail follows the top of the rip rap bank on the west side where most of the natural riparian vegetation has been removed. The eastern bank has a narrow strip of black cottonwoods present along the top of the boulder-cobble bank. The salmonid habitat value rating for this section is low, relative to other sections.

Between 950 and 1,100 m upstream from the Fraser River, the creek is constricted between two roads where the floodplain and banks average only 20 to 40 m across depending upon road undulations. An incomplete strip of black cottonwoods occurs along the top of the banks and the understorey shrub layer was poorly developed. Small and large boulders and cobble were the dominate substrate types although gravel infilling around the larger boulders was common. The average water depth through this moderately flowing section was 20 cm. The salmonid habitat value rating for this section was low for spawning and medium for rearing.

Wilma Hanson Memorial Park is situated along the west side of the creek to a foot-bridge located approximately 1,400 m upstream from the Fraser River. Little riparian cover, apart from an incomplete strip of black cottonwoods, occurs along the top of the bank. The bank shows erosion above the boulder-lined shore to the maintained grass lawn of the park. The establishment of native trees and shrubs should be encouraged along the top of the bank in order to promote bank stability and provide cover for fish. The bike path also continues along the top of the bank through much of this section. The more stable opposite bank has a more complete strip of black cottonwoods and a better developed shrub layer. The 20 cm deep, 7 to 8 m wide boulder strewn run is typical of many of the sections. Salmonid habitat values are low for spawning and medium-high for rearing.

A patch of gravel approximately 25 m^2 in area occurs in front of a house at the top of the bank approximately 1,500 m upstream from the Fraser River. This occurrence of gravels appears to be the result of infilling from eroding bank materials upstream. The flow is moderate and if the gravel layer is deep enough it would be of high value for spawning salmonids. A deteriorating 1.5 m high wooden retaining wall occurs at the base of the slope below the house.

The creek between 1,550 and 1,600 m is slower flowing, 10 to 11 m wide and 20 to 30 cm deep. The substrates are boulders and cobbles with some infilling of gravels around large boulders.

Reach 2 - High Salmonid Habitat Value

Through this reach, between 1,600 and 3,400 m upstream from the confluence with the Fraser River, Baker Creek flows through light residential and rural areas where encroachments to the top of the bank and removal of riparian vegetation have occurred. The banks along the east side of the creek average 5 to 6 m to a gradually sloping high floodplain bench. Higher banks and cutbanks occur on the east side of the creek. Bank erosion is more prominent where trees and shrubs have been removed from the streambanks.

Between 1,600 and 2,100 m upstream from the Fraser River, the creek is relatively fast flowing with a 2:1 run to pool ratio. The boulder strewn run averages 6 to 7 m in width and 10 to 20 cm in depth. Cobbles are the dominant substrate type with coarse gravels and small boulders secondary. The pools are few and relatively long (10 to 20 m) and vary in depth between 30 cm and 1 m. Cobbles and coarse gravels are dominant through these v-notched pools. Infilling with fine gravels, sands and silts occur in the slower parts of the pools. An old road follows the east side of the creek through this section on an elevated bench part of the way up the slope to Baker Drive. The riparian vegetation along this section is contiguous except for a 40 m section at 1,950 m where the land owner has removed most of the cover. The dominant tree species through this section is black cottonwood with lesser amounts of hybrid white spruce, Douglas-fir and paper birch present. Common shrubs include red-osier dogwood, willow, beaked hazelnut and serviceberry. The salmonid habitat value ratings for this section range between low and medium for spawning and medium-high for rearing.

Where a housing development occurs on the west side of the creek, between 2,100 and 2,200 m upstream from the Fraser River, the riparian trees and shrubs have largely been removed. Existing and regenerating trees and shrubs along this section should be allowed to mature and provide increased bank stability and cover for fish. Two car bodies and other metal debris were observed within the top-of-bank on the developed side of the creek. Much of the bank along the east side of the creek has been armoured with medium-sized rip rap which confines the creek within the

12 m wide gap. The wetted width occupies most of the channel but the water depth is shallow (3-10 cm) and the riffle is relatively fast flowing. The lack of relief in the small boulder dominated substrates and the general lack of instream structure contribute to a low salmonid habitat value rating for this section.

A field occupies the land within a sharp U-turn on the east side of the creek between 2,200 and 2,400 m upstream from the Fraser River. A few black cottonwoods remain along the top of the bank on the inside of the bend. A 30 m high slumped cutbank occurs on the west side of the creek opposite the field. The high proportion of gravels and fines in the profile of the cutbank demonstrate the common bank materials in other sections. The bank, partially vegetated with grasses and a few sapling aspen poplars, should eventually stabilize on its own. However, the steep 5 m high toe of the slumped material against the edge of the creek is a large sediment input source and could be stabilized by planting with native shrubs. An old bridge access road deadends at the top of the 2 m bank on the west side of the creek at approximately 2,320 m upstream of the Fraser River. The land on the west side has returned to floodplain level. Concrete slabs armour the bank off the end of the road. Coarse gravels and cobble dominate the substrates in the slower flowing upstream portion of this section, and small boulders and cobbles dominate the faster flowing downstream portion. The average water depth varied from 10 to 25 cm going downstream. The salmonid habitat value ratings range between low and medium for spawning and medium values were assigned for rearing in this section.

Between 2,500 and 2,600 m, two long shallow pools are separated by a fast flowing run. The dominant substrates in these pools are small cobbles and coarse gravels. The average maximum water depth in these relatively slow flowing, 8 to 10 m wide pools is 15 cm. A 40 m section of the creek bank along the east side of the creek is armoured with rip rap materials. The floodplain benches above the creek are dominated by paper birch and black cottonwood with the dominant riparian shrub being red-osier dogwood. The lack of instream structure and cover along with the slow flow contribute to a habitat value rating of low for spawning and low-medium for rearing in this section.

Between 2,600 and 2,720 m, the creek meanders through a 20 m wide floodplain area close to Baker Drive. A 10 m long, 5 m wide, fast flowing, 10 cm deep boulder strewn run at the upstream end gives way to

slower flowing cobble-boulder substrates in the downstream portion. Concrete slabs and two wrecked vehicles occur along the east bank in this section. The salmonid habitat value rating for this section for spawning is low and for rearing is medium.

The upstream end of a slow flowing 70 m long pool occurs at 2,780 m. The dominant floodplain substrate type is cobble but the instream substrates are coarse gravels and cobble. The 1.5 m high east bank is unstable. The 40 cm deep pool gradually becomes shallower towards the downstream end where some smaller gravels occur near the tailout. A housing development at Tingley Drive encroaches toward the creek where riparian trees and shrubs have been removed along portions of the top of the bank. The salmonid habitat value rating for this section ranges between low and medium as spawning habitat and low to medium as rearing habitat.

Between 2,780 and 3,100 m, the creek has a 2:1 pool to run ratio. Healy Drive follows the west bank of the creek where damage to riparian trees and shrubs along the top of the bank has occurred. The pools are relatively long, shallow and slow flowing with substrates of cobbles and coarse gravels. Instream cover and structure in the pools are limited. The relatively fast flowing runs average 5 to 7 m in width and 10 to 15 cm in depth. A 40 m long rip rap section of bank occurs at approximately 3,000 m on the east side of the creek. At 3,080 m, a 450 mm corrugated metal outfall pipe has been torn apart during high flows and should be repaired and the adjacent 5 m high bank is unstable and eroding also. The salmonid habitat value rating for this section is low-medium for spawning and medium for rearing.

Between 3,100 and 3,400 m upstream from the Fraser River, the creek flows through a relatively undisturbed section. The floodplain through this section is relatively narrow averaging 15 to 20 m between the treed edges. Fast flowing runs occur at the upstream and downstream ends of this section that is otherwise mostly deep and relatively slow flowing. Water depth varies from 40 cm to 1 m with bottom substrates dominated by cobbles and small boulders with coarse gravels present as secondary components. Patches of coarse and fine gravels overlain by sediments are occasional. Black cottonwood and alder are the dominant riparian trees. The boulder and cobble lined banks average 1.5 to 2 m in height and the top of the banks are generally stable. A house occurs at the top of a 12 m high eroding cutbank at approximately 3,400 m upstream. A log/debris pile occurs at the base of the cutbank which provides good cover and

structure along a pool. Overhanging alders also provide overhead cover for fish. Two car bodies occur along the banks of this section. The salmonid habitat value rating for this section ranges between low and medium for spawning and includes medium and high value areas for rearing.

The section of creek between 3,400 and 3,650 m upstream of the Fraser River represents the upstream extent of development related impacts on the creek. This section is characterized by pools separated by shallow riffle areas. Coarse gravels and cobbles dominate the substrates with lesser amounts of small gravels and sand occurring in depositional areas. The pools are relatively shallow (20-30 cm) with slow to moderate flow. Riffles are shallow (5-8 cm) and the flow over small cobble and coarse gravels is relatively fast. Baker Drive encroaches to within 15 m of the creek at the upstream end of this section. Much of the vegetation between the road and the creek was previously removed and is now regenerating with sapling alder and black cottonwood. The 5 m high gravel/sand bank is eroding and unstable where vegetation was removed from the top of the bank. Gravel deposits below the eroding bank at the tailout of a shallow pool appear suitable for spawning but with easy human access to the bank, harassment or poaching would be a concern. Riparian trees and shrubs should be allowed to mature in this section to buffer against activities along the road. The salmonid habitat value ratings for this section are medium for both spawning and rearing.

Reach 3 - High Salmonid Habitat Value Rating

This 3,250 m long section between 3,650 and 6,900 m upstream (to Pinnacles Provincial Park) from the confluence with the Fraser River flows through a largely undisturbed meandering valley. The banks along the creek are often steep and unstable and contain a high proportion of gravels, sand and fines. Natural bank erosion occurs where deposits are unconsolidated. Consolidated bank materials appear to have a higher proportion of clays and erode relatively slowly producing similar pinnacle formations to those found within the park.

The unvegetated floodplain areas adjacent to Baker Creek within Reach 3 are generally not extensive and the boulder lined banks are generally stable with riparian trees and shrubs often overhanging the wetted channel. The composition of flow types includes riffles, pools and faster flowing runs. Large boulders and woody debris are frequent and provide good instream

structure and cover for fish. The maximum depth in the pools is approximately 1.3 m and cover associated with pools is common. Small patches of gravels suitable for spawning are occasional giving the reach as a whole a low habitat value rating for spawning with areas of high value within.

The naturally occurring riparian vegetation community is dominated by black cottonwood and paper birch with fewer hybrid white spruce, Douglas-fir and aspen poplar also present (for a more complete listing see Appendix 2). The shrub and herb layers are well developed and provide a high level of stability to the underlying gravel and sand bank materials. The overall salmonid habitat value ratings range between low and high for spawning (due to small areas of gravels suitable for spawning) and between medium and high for rearing.

4.4.2 Bouchie Creek

Bouchie Creek is a small stream which drains Mit, Milburn and Bouchie lakes and enters the Fraser River from the west approximately 5 km upstream of the Fraser/Quesnel River confluence. Both Milburn and Bouchie lakes are stocked with rainbow trout and in addition, Bouchie Lake supports some natural spawning (B. Chapman, pers. comm.). Habitat inventory or fish population data are not available for Bouchie Creek (B. Chapman, pers. comm.). Stream flow was not evident at the mouth of the creek during the survey. However, since the stream flows through forested land upslope from the Fraser River and enters a high water back channel before entering the mainstem Fraser River, as a minimum it would be expected to contribute to water quality and nutrient input and benefit any rearing salmonids which may be utilizing these habitats.

4.5 Descriptions of Mainstem Tributaries to the Quesnel River

4.5.1 Dragon Creek

This 5 km long creek which drains Dragon Lake flows through residential properties prior to being channelized through its lower half. Approximately three million rainbow trout eggs are taken annually for brood stock from Dragon Lake which also supports a natural spawning rainbow trout population as well as being stocked (B. Chapman, pers. comm.). The creek discharges into the Quesnel River through an elevated 1250 mm diameter culvert in the dyke located about 700 m upstream of the

confluence with the Fraser River. Dragon Creek is, therefore, inaccessible to fish from the Quesnel River. Habitat and fish population information is not available for the creek but it is expected that some rainbow trout may enter the downstream portions of the creek from the lake (B. Chapman, pers. comm.).

4.5.2 Barlow Creek

Barlow Creek drains Ten Mile Lake and the surrounding area and flows in a southerly direction for approximately 11 km before entering the Quesnel River about 6 km upstream from the confluence with the Fraser River. Ten Mile Lake is stocked with rainbow trout and supports a small naturally spawning trout population (B. Chapman, pers. comm.). At the mouth of the creek, the road culvert is elevated and blocked with cobbles, boulders and woody debris, precluding fish access from the Quesnel River. The stream habitat upstream of the culvert for approximately 500 m consists of boulder, cobbles and gravel and is suitable for salmonid rearing. Upstream of this section, the stream has been culverted for a considerable distance in order to stabilize the western bank along an industrial property. No additional habitat or fish information is available for Barlow Creek but the potential exists for fish to enter the creek from Ten Mile Lake (B. Chapman, pers. comm.).

4.6 Sources of Water Quality Degradation

4.6.1 Effluent Discharges

Three effluent discharges are present within the study area (D. Krogel, pers. comm.). Their general locations and descriptions are provided on the accompanying map sheets and are described in Table 1. Dirty white foam, typically in clumps was noted along both shorelines but specifically along Streambank Section F1 and in F4. This was presumably from the effluent outfall located downstream of the Moffat Bridge. The presence of effluent in the water column could discourage fish from utilizing the habitats within the effluent plume. However, it was not within the scope of this project to determine or research the various components of the effluent discharges nor assess their potential impacts on fish or their utilization of adjacent habitats.

Table 1. Location and description of effluent discharges into the Fraser River within the Quesnel study area

DISCHARGE CODE ON MAPS	GENERAL LOCATION	STREAM-BANK SECTION	DESCRIPTION
E01	Fraser River at Weldwood Mill approximately 3.5 km downstream of Fraser/Quesnel confluence	F1	Plant effluent and sewage
E02	Fraser River approximately 100 m downstream of Moffat Bridge	F17	Cariboo Pulp and Paper effluent and City of Quesnel sewage
E03	Fraser River approximately 3.5 km upstream of Fraser/Quesnel confluence	F34	Quesnel River Pulp effluent

4.6.2 Storm Water Outfalls

Rainfall in urban areas collects chemicals present in the atmosphere prior to accumulating additional contaminants upon reaching the surface. Stormwater runoff mobilizes these contaminants and transports them as dissolved, suspended or bed loads. Dissolved loads include soluble nutrients, bacteria and chlorides, while suspended loads include fine-grained sediments and their associated hydrophobic contaminants such as metals (Cr, Cu, Fe, Pb, Ni and Zn), toxic organics and hydrocarbons. Bed load would include coarser sediment and associated contaminants. The surface flow carries lighter weight materials such as hydrocarbons and debris. Water quality degradation, therefore, tends to be seasonal and sporadic depending upon the volume and duration of precipitation experienced in the area. Within the study area, storm water outfalls discharge directly into both the Quesnel and Fraser rivers and Baker Creek as well as into a number of their tributaries and adjacent habitats. Outfall locations are denoted on the map sheets which accompany this report.

4.6.3 Snow Dumps

The City of Quesnel presently dumps snow removed from its streets onto

a large gravel lot on the river side of the BC Rail tracks downstream of the Highway 97 Quesnel River bridge. The City indicated that melt water does not directly enter the Quesnel River but dissipates into the ground. The impacts on surface water quality are, therefore, unknown but presumed to be minimal.

4.6.4 Other Sources

Leachate emanating from the log sorting/storage yard and associated operations were noted in the Two Mile Flat district on the Quesnel River (Streambank Section Q40). Black coloured water was observed entering the Quesnel River from a drainage ditch just upstream of actively spawning pink salmon. The volume of leachate would be expected to be greatest during spring snow melt when the volume of runoff water and ground saturation would be at its highest. However, even during the prolonged dry period at the time of this survey, discharge into the river was evident presumably due to surface runoff from the plant operations.

A wood waste landfill is located on the north side of the Quesnel River upslope from Streambank Section Q57. Leachate is reported to seep from this site (F. Lorenz, pers. comm.). Water seeping from the hillside was noted eroding the bear soils and flowing downslope toward the Quesnel River during the survey. These problems would again be most acute during spring snow melt when the volume of runoff water and ground saturation would be at its highest. However, even during the prolonged dry period at the time of this survey, the seepage was evident. Measures should be taken to intercept and treat this runoff and prevent its discharge into the river.

Brown, rusty coloured stain was evident on the cobble beach along a portion the Fraser River shoreline near the downstream end of the Weldwood Mill site. BC Environment, Environmental Protection in Williams Lake is not aware of any concerns associated with the site (D. Krogel, pers. comm.). Its source and composition were not investigated during this survey.

Other sources of water quality degradation are short-term, localized, random discharges of deleterious substances into the local streams, drainage ditches and storm drains. These discharges often occur by accident or are a result of actions by uninformed individuals but they can have a devastating effect on the stream's aquatic life. This type of

discharge can result from activities such as the washing of industrial equipment and allowing the effluent to enter a stream or the emptying of chlorinated swimming pool water into a storm drain. This latter problem was identified as being a potential problem in Baker Creek (DFO 1993).

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Fish Habitat Values and Habitat Restoration

The streambank sections with the highest salmonid habitat values in the Fraser and Quesnel rivers within the limits of the study area are largely those with some protection from mainstem flows and areas of low floodplain benches with well developed plant communities associated with them. At high water levels these benches become inundated and offer refuge and foraging opportunities for juvenile salmonids. During peak flows, upper riparian zone vegetation is also inundated by water in these areas. A significant contribution of woody debris and litter is also introduced into the system from these benches. In general, streambank sections with steeper sloped banks have a lower contribution per unit length, although they are an important source of coarse woody debris. The interface with shoreline plant communities is particularily valuable adjacent to desireable nearshore habitats. Intact and fully vegetated riparian zone vegetation adjacent to nearshore spawning areas provides shading and overhead cover for salmon.

The upland uses identified for streambank sections indicate a significant proportion (54 and 75%) of lands adjacent to the riparian zone have been modified by development. Encroachments into the riparian zone were common and both direct and indirect impacts to riparian zone vegetation were recorded. Where streambank substrates are dominated by unconsolidated cobbles, gravels and fines, any disturbance to riparian zone plant communities acts to destabilize the banks. This is reflected in the proportion of streambank sections classed as eroding (23-27%) and in the proportion of streambank sections armoured with rip rap materials (17-18%). As bank erosion and rip rap armoured banks preclude the development of significant shoreline plant communities, the values associated with the aquatic - terrestrial interface are lost, as reflected by the lower salmonid habitat value ratings assigned to such sections. Coarse rip rap materials do, however, offer some refuge for juvenile salmonids where sand has not filled the interstices of the rocks. In such cases a somewhat higher salmonid value may have been assigned. Logically then, habitat restoration opportunities designed to increase salmonid habitat values should focus on restoring vigourous shoreline plant communities. General recommendations for the restoration of plant communities specific to each of the identified riparian plant communities are presented below:

Emergent Zone

Although direct impacts to riparian zone communities from adjacent land use should not occur under current land development guidelines, indirect impacts mediated by bank erosion instigated by disturbance to upper riparian zone plant communities were common.

The distribution and extent of emergent plant communities within the study area is limited by the lack of suitable growing sites. The restoration of emergent communities should only be attempted where suitable conditions exist to do so. The preferrred conditions for the establishment of emergent species include areas protected from the erosive forces of mainstem flows and from excessive sand deposition. Backchannels, sidechannels and depressions somewhat removed from the main channel are potentially good sites. Preferred substrates contain fine organic sediments, normally deposited where flow velocity is greatly reduced. Emergent species can tolerate inundation for relatively long periods of time but are rarely very drought tolerant, therefore, roots require access to a reasonably stable high water table. The rushes and sedges of the emergent communities are competitive and secure dominance by rapid growth and reproduction, through vegetative reproduction as well as by producing large seed crops. These conditions give the emergent communities some resilience against physical disturbances and invasion by non-native species and also allows for greater potential success in habitat restoration efforts.

Seeding denuded or exposed sites would likely be unsuccessful without some aboveground vegetation to provide shade and substrate stability to encourage germination and promote seedling survival. Whole plant transplants would have a much higher probability of success. As suitable donor sites are limited in the Quesnel area, it is suggested that seed stock be collected from local plant populations and grown under nursery conditions, which would require early planning. It also follows that the larger the plants are and the higher the planting density is, the greater the potential for survival. Some protection from high flows may be necessary to protect freshly planted stock. This may be achieved by the strategic placement of energy dissipators such as coarse rock, snow fence, or chain-link fencing. These protection measures may encourage higher sediment deposition rates and should removed when plants have securely rooted. Suitable species for restoration of emergent communities are identified in Appendix 4.

Lower Riparian Zone

The restoration of impacted communities in the lower riparian zone can be expected

to be difficult. Revegetation attempts at these sites should include seeding with seed stock collected from the naturally occurring lower riparian grass species as described above and planting with sandbar willow and black cottonwood (cuttings and potted plants). Revegetating relatively steep banks will often be impractical due to the erosive forces of high water flows. Preservation and protection of plant communities in this zone should have a high priority to reflect their value in providing stability to otherwise highly erodible banks, and secondarily, for their value as a source of food items and cover for fish. Direct impacts to lower riparian plant communities should not occur under current land development guidelines. Disturbance to this community type is most often caused by eroding sections of bank. With sand and gravels as the major bank substrates, any disturbance to the tree or shrub layer promotes the destabilization of the bank. Grasses do not have extensive root systems capable of stabilizing sand banks and are easily eroded most commonly resulting in steep, unvegetated and unstable banks. In such cases where impacts are unavoidable (i.e. bridge piling footprints), the restoration of these communities can be expected to be difficult due to the sensitivity to distrurbance of the banks and plant species.

Revegetation attempts at these sites should first address bank stability. While large rip rap materials may be the best materials to stabilize eroding banks they often preclude the development of riparian vegetation. Efforts should be made to restrict armouring to the lower portions of the bank. Creating a berm of large rip rap materials at the toe of the slope would act to confine slumping materials and would permit concurrent regrading of banks towards achieving a minimum 2:1 slope to allow planting with shrubs to naturally stabilize the banks. Constructing low benches contained by rip rap materials on the river side and shallowly sloped banks on the upslope side would increase the extent to which lower riparian vegetation could be developed and maximize the interaction with the aquatic environment during high flows. Although this procedure may not always be applicable due to site conditions, it is preferrable where the objective is to restore or enhance riparian vegetation values for fisheries, wildlife and water quality reasons.

Where conditions are such that the application and distribution of rip rap materials must be extensive, it is suggested that efforts are made to incorporate pockets or strips of vegetation, preferably shrubs and trees. Recent bank armourment projects in the Lower Mainland area have successfully incorporated such "ecopockets" into lower riparian zones.

Sloping shorelines are more prone to erosion where floodplain benches tend to be depositional areas. As a result, soil conditions vary in composition, nutrient and moisture availability which is reflected in the community composition for each.

Therefore, species selected for revegetation attempts should be chosen based on shoreline type.

Low gradient shorelines are most frequently dominated by sandbar willow with other species of grasses and herbs, (as described in the relevant descriptions earlier in this report) present in lesser amounts. Sandbar willow, sometimes referred to as coyote willow, is a relatively common nursery species and is the best species choice for shallow gradient shoreline revegetation. Additional recommended species are presented in Appendix 4.

Upper Riparian Zone

The objectives of restoration attempts associated with impacts to the upper riparian zone should reflect the desire to maintain fisheries values associated with riparian vegetation and to maintain the stability of riverbanks prone to erosion. Mitigation or restoration to achieve naturally occurring plant assemblages would involve planting native tree and shrub species commonly occurring in this zone. The species list in Appendix 4 should be used as a guide in selecting native species for restoration projects. Trees and shrubs are of the greatest importance to bank stability and should be retained whenever possible. The size of the tree or shrub and the planting density should vary with the abundance and vigour of competing weedy and herbaceous species. Most trees and shrubs listed in Appendix 4 can be found in nurseries or propagated relatively easily from cuttings. If weed control is deemed necessary to facilitate the establishment of planted species, the use of mechanical methods would be preferred over the use of herbicides.

Most of the impacts to riparian zone plant communities occur in the upper riparian and upslope zones. Current land development guidelines recommend that no disturbances should occur within 15 m of the top of the bank (*Land Development Guidelines for the Protection of Aquatic Habitat* (Chilibeck 1992).

In order to effect a successful planting program, the stability of existing bank conditions must first be evaluated. Bank slopes greater than 2:1 would be difficult to revegetate where the dominant substrate type is sand or fine materials due to topsoil erosion from rainfall and high water levels. As erosion may progress from either the lower or upper bank slopes it is important to address the stability of both. Lower bank slopes may require armouring with large rip rap materials along sections prone to erosion, such as the outside bend in a river. Erosion in upper bank areas may require regrading to decrease slope angle. Where regrading is not an option the bank may be armoured with rip rap materials in such a manner that partitions or sections are created with trenched or bermed rip rap materials. Where

the banks are steep and cannot be regraded it may be necessary to rip rap much of the bank slope. When this is the case it is suggested that leaving open pockets as planters ("ecopockets") for shrubs and trees would maximize the values. Various types of geotextile mats are also used in combination with seeding and planting to stabilize steeper slopes. Such mats are of two general types. One is composed of biodegradable coco-fiber which acts as a suitable substrate for the grass seed embedded in it. Another less biodegradable type is a monofilament type mesh.

Upper Slopes

The upper slope zones suffer the greatest development associated impacts. This zone begins at the top of bank where any significant slope continues away from the river. An intact, fully vegetated upper slope plant community would function to intercept and filter surface water drainage from developed areas and prevent the formation of erosion gullies, buffer against the invasion of exotic and weedy species, maintain shade to protect plants from excessive exposure and water stress, and to maintain the integrity and stability of riverbanks sensitive to erosion. The upper slope zone, being drier, is a harsh environment where disturbance causing the degradation of natural plant communities is often followed by the invasion of exotic and weedy herbaceous species that are well adapted to conditions of poor soil moisture and nutrient deficiences. Natural recovery and succession from disturbance in upper slope areas generally occurs very slowly. The prescription for restoration in this zone follows that for the upper riparian zone. Species selection for planting should reflect the moisture and nutrient conditions at the site.

Revegetating relatively steeply sloped banks will often be impractical due to the erosive forces of high water flows. Preservation and protection of plant communities in this zone should have a high priority to reflect their value in providing stability to otherwise highly erodible banks, and secondarily, for their value as a source of food and cover for fish.

5.1.1 Land Use and the Potential Limitations of Habitat Restoration Efforts

The upland uses identified for streambank sections indicate approximately 75% of total length of properties adjacent to the riparian zone have been modified by development along the Fraser River and 54% along the Quesnel River. Encroachments into the riparian zone were common and direct and indirect impacts to riparian zone vegetation occurred. Bank erosion and rip rapping are the primary causes of degradation in the plant communities of the riparian zones.

As the degree and types of impacts to riparian zone vegetation appear to vary in accordance with the type of adjacent land uses, restoration efforts would need to vary to address the limitations associated with the various land uses. For example, road and railway rights-of-way must be maintained for safety reasons, precluding any long term restoration attempts to restore mature trees. For these reasons, recommendations for restoration efforts are made in the context of the type of adjacent land uses occurring along the Fraser and Quesnel rivers as follows:

Linear Developments

The percentage of streambank which had linear development upland, primarily road and railway rights-of-way, was 9% (2.1 km) along the Fraser River and 11% (2.8 km) along the Quesnel River. Encroachments to the top of the banks were frequent (see Appendices 1 and 3) and disturbances to riparian vegetation and bank stability have resulted from physical removal of vegetation through construction and maintenance activities, rip rap placement to prevent or mitigate against bank erosion and by fill placement to achieve grade specifications (Photograph 6).

The requirements for maintenance and safety standards within rights-of-way precludes the planting of trees. As the root systems of grasses and herbaceous species have a limited capability in stabilizing bank substrates, it is suggested that shrubs be planted along the river-side of rights-of-way where bank stability is in question. An agreement should be sought with City and railway maintenance departments to define acceptable planting standards. Maintenance practices should allow for limited brushing or pruning to ensure survivability of planted shrubs. It is suggested that brushing or pruning frequency might be limited to every second or third year and should be conducted in the fall after leaf-drop to limit stress on the plants. A minimum pruning or brushing height should be established to maximize the survivability of planted species.

Agricultural Lands

Approximately 16% (3.9 km) of the total length of streambank sections along the Fraser River and 7% (1.6 km) along the Quesnel River were denoted as agricultural. The removal of riparian vegetation to the top of the streambank is a common agricultural practise along these rivers with the goal of maximizing the area of operable land. The impacts to lower riparian zone vegetation communities largely results from the removal of

shrubs and trees from the banks which subsequently causes instability due to the fragile nature of bank substrates (Photograph 7). Once destabilized and bank erosion initiates, the slope of the banks general increases, lowering the possibilities for the establishment of native shrub and tree species which would encourage streambank stability.

To achieve restoration of natural riparian plant associations it is necessary to first address bank stability. Where sections of eroding bank are relatively steep it may be necessary to construct a berm of large rip rap materials along the bottom of the bank with concurrent regrading of the bank to achieve a minimum 2:1 slope. Where streambanks are fairly high (> 5m), regrading to a 2:1 slope may involve relatively large dedications of shoreline (> 10 m from the waters edge). While greater benefits would be provided by vegetated riparian zones, it may be difficult to secure large parcels of land. In cases where an agreement with the land owner cannot be reached to secure these dedications, alternatives should be pursued towards reaching a compromise that still affords a reasonable reestablishment of riparian communities. One such compromise could feasibly include creating a low riparian bench with steeper rip rapped banks upslope. This would decrease the overall width of riparian plant re-establishment but in doing so offers a compromise or basis for negotiations with land owners to achieve riparian dedications and bank stabilization. Constructing a series of 2 or more steps, contained by berms of rip rap materials, would also allow limited riparian planting in the different riparian zones and would provide the vertical stratification found between the herbaceous and shrub species of the lower riparian zone and larger shrubs and trees of the upper riparian zone. This would be preferred over more extensive rip rapping to achieve bank stability and would allow for better development of plant communities.

Livestock damage to riparian plant communities was noted where animals were provided access to the river for the purposes of watering and foraging (Appendices 1 and 3). Due to the fragile nature of bank substrates, there is often damage to plant communities from bank erosion mediated by livestock traffic. Revegetation attempts along bank sections degraded by livestock should be effected using the same methods as described above. The further protection of reestablished communities would require limiting livestock access into the riparian zone. This may be accomplished through fencing and granting water licences to allow water for livestock to be pumped from the river to upslope watering troughs.

Photograph 6. Linear development often impacts riparian zones - Quesnel River.

Photograph 7. Removal of riparian shrubs and trees can destabilize banks - Fraser River.

Residential Properties

Residential developments account for approximately 26% (6.3 km) of the total length of streambank along the Fraser River and 4% (1.0 km) along the Quesnel River within the study area. Riparian zone plant communities were often degraded where residential encroachments involved land clearing, landscaping and rip rapping along the banks. The variety of materials and methods used in landscaping efforts and in armouring eroding bank sections necessitates providing general prescriptions for the reestablishment of riparian zone plant communities.

The restoration of natural riparian plant communities along such sections would involve reaching an agreement with the property owners to dedicate a portion of their properties to this purpose. A number of tax incentives have been proposed as possible compensatory measures for land owners. If an agreement cannot be reached with property owners to fully dedicate lands to the complete restoration of riparian zone plant communities, some less formal agreement to encourage partial restoration would be desireable. It is suggested that many landowners would express an interest in improving or enhancing their properties for the benefit of our fish or wildlife resources. Based on this premise, a pilot program could be set up to inform land owners along the riverbanks how this could be achieved with little cost or effort by them. To this end it may be suggested that such a program would focus on restoring pockets or short sections of naturally occurring riparian plants which can be easily established through the use of propagated cuttings for trees and shrubs and limited transplanting of plugs for the rushes and sedges of the emergent zone. The participation of local environmental agencies in providing the direction for such a program would be appropriate.

Recreational Areas

The portion of the total length of streambank denoted as recreational was approximately 9% (2.1 km) along the Fraser and 14% (3.4) along the Quesnel River within the study area limits.

The Riverfront Trail system links several of the City's parks and follows along the banks of the Fraser and Quesnel rivers, and the lower section of Baker Creek. Pedestrian traffic and landscaping activities are the primary sources of disturbance to the riparian communities along the trail. Controlling access points and decommisioning trails in riparian zones

would encourage the restoration of riparian plant communities through natural seed and vegetative propagation from the existing fragmented areas of natural vegetation. Additional plantings of shrubs and trees along sections of the upper banks currently dominated by grasses would promote the stabilization of banks. The width recommended in the current *Land Development Gudelines for the Protection of Aquatic Habitat* (Chilibeck 1992) for riparian zone leave strips is 15 m from the top of bank, or first significant break in bank slope. A strip of this width vegetated with shrubs and trees is recommended as a long term erosion control measure. It is recognized that recreational areas along the river provide opportunities for the public to interact and learn about the aquatic environment, therefore, public access should be maintained. However, limiting access points and controlling pedestrian traffic may be necessary measures to protect spawning areas and sensitive plant communities. Where sections of trails encroach to the top of the bank as seen below (Photograph 8), they could be moved farther away and the bank planted with trees or shrubs in such a manner as to maintain viewpoints. A well identified and maintained trail system could be developed to both encourage public use and minimize the impacts to riparian plant communities.

Photograph 8. Recreational trail encroachment to the top of bank - Quesnel River.

Industrial Properties

Industrial properties adjacent to the Fraser and Quesnel rivers comprise 16% (3.8 km) and 17% (4.2 km) of the total length of streambanks of each river, respectively. The primary sources of disturbance to riparian communities along industrial properties are removal of vegetation during land clearing and by rip rap armouring bank slopes. Long sections of streambank have been armoured with rip rap materials and riparian vegetation is sparse and dominated by grasses and weedy species. As much of the rip rap materials are large and significant in quantity, suitable rooting substrates are largely unavailable to plants. Restoration of natural riparian plant communities along these sites would involve removing rip rap from short sections or pockets to gain access to the underlying substrates. As the substrates under the rip rap are probably coarse fill it would be necessary to import suitable topsoil materials. Enough soil material should supplied to fill to near the average height of rip rap materials. To protect against erosion and the dispersion of soil materials through the rip rap, planted areas should be small in size and any large interstices against the filled area packed with fine gravels.

5.2 Fish Habitat Restoration Opportunities

5.2.1 Fraser River

1. Removal of fill encroachment into river

   An approximately 25 m wide area of fill was noted within Streambank Section F27 which extended a private property further out into the Fraser River. The material has buried the riparian zone and significantly encroaches onto the foreshore. In addition, considerable erosion of the face of the fill was evident. As a minimum, the fill should be removed, the original streambank stabilized, and the bank revegetated with native trees and shrubs.

2. Riparian planting along agricultural fields

   The riparian vegetation has been removed from banks of the Fraser River along the agricultural fields in the upstream portion of the study area (Streambank Sections F32 and F39). The lack of riparian vegetation in this area not only reduces the importance of the Streambank Sections to rearing fish by eliminating the shading, food

input and cover, it dramatically reduces the stability of the streambank leading to erosion and sediment input to the river. The input of fines from the bank can infill the interstices between the rocks and preclude the use of that area by overwintering salmonids. The streambank in these areas should be fenced to prevent intrusions into the riparian zone and the zone should be replanted with native shrubs and trees. This would serve to help stabilize the eroding banks and contribute to the quality of the nearshore fish habitat. A minimum leave strip width of 15 m is recommended.

3. Riparian planting along the riverfront trail/park system

The City of Quesnel's riverfront trail system extends over 2 km along the top of both banks of the Fraser River (Streambank Sections F14-24). On the eastern river bank the trail extends from Ceal Tingley Park northward to about McNaughton Avenue and on the western shore, from Baker Creek north to Fuller Avenue. In order to provide a clear and "scenic" view of the river, a majority of the riparian vegetation has been removed. In addition, alot of the riparian vegetation that does remain or manages to establish itself in the narrow zone between the rip rap bank and the paved walkway is regularly cut down to maintain the view of the river. Appropriately, this latter situation occurs to the greatest extent in front of the park benches located at intervals along the trail.

The value of the riverfront trail system in preventing further impacts on the shoreline from development as well as its role in instilling respect for the local environment in the residents is acknowledged. However, the riparian zone is extremely valuable to the salmonid juveniles that utilize the shoreline for rearing. The extent to which a scenic view of the river is provided and maintained along the river for trail users could be reduced and the riparian zone along with its aesthetics could be enhanced through the prudent establishment of a wide variety of native trees and shrubs. View points at intervals along the trail could be selected and maintained to provide river views while permitting riparian vegetation to be retained in between. Interpretive signs could be installed along the trail explaining the value to the area's fish and wildlife resource that the riparian trees and shrubs provide. Further understanding of the local ecosystems and how they function would further promote a sense of environmental stewardship in the Quesnel residents and visitors.

4) Removal of debris from shoreline

Two locations were noted along the Fraser River shoreline in the upper portion of the study area where car bodies and metal debris have been strewn along the foreshore. The first was the site of an old dump (streambank section F35) where car bodies and other material have been thrown down the steep bank into a gully. This site is quite extensive and has eliminated the riparian vegetation, with the exception of a few deciduous trees which have managed to establish themselves within the debris. The debris also extends out into the river at the base. Rehabilitation of the site would be difficult due to the steepness of the bank at the site, the size of the dump, and the extent to which it has stabilized over the years. Any proposal to rehabilitate the site must include measures to stabilize the entire area and to revegetate it with an appropriate mixture of native trees and shrubs.

The second site (sections F31, F32) was located along the left bank where old car bodies have been placed along the foreshore, presumably to prevent erosion. The car bodies could be removed, and alternate, more environmentally friendly, bank stabilization treatments applied. This should include the placement of rip rap and reestablishment of native riparian vegetation.

5.2.2 Quesnel River

1. Streambank Erosion at Storm Water Outfall

Major bank erosion and slumping is occurring at an improperly constructed and maintained Ministry of Transportation and Highways (MOTH) road culvert located on Tremblay Road along the right bank in the upper portion of the study area (Streambank Section Q81). This storm water outfall should be reconstructed to stabilize the bank and eliminate the erosion and slumping. Due to the large size of the slump, the work could be a major undertaking.

2. Leachate From Log Sorting/Storage Yard

Leachate emanating from the log sorting/storage yard and associated operations were noted at Streambank Section Q40. Such leachate discharges should be eliminated by either containing it and treating it,

or preparing the yard surface in such a manner that the leachate is not generated.

3. Leachate From Wood Waste/Soil Landfill

A wood waste landfill is located on the north side of the Quesnel River upslope from Streambank Sections Q56 and Q57. Leachate is reported to seep from this site and is mixed with sediments eroded from the bear soils downslope prior to entering the Quesnel River. This problem would be most acute during spring snow melt when the volume of runoff water and ground saturation would be at its highest. However, even during the prolonged dry period at the time of this survey, the seepage was evident. Measures should be taken to intercept and treat this runoff and prevent its discharge into the river.

4. Riparian planting along industrial properties

The riparian vegetation has been substantially removed from banks of the Quesnel River along the properties in the Two Mile Flat Industrial Area. The streambank in this area should be fenced to prevent intrusions into the riparian zone and the zone should be replanted with native shrubs and trees. Along some portions of this area, roads are located very close to the top-of-bank which either eliminates or restricts the extent of the riparian zone. In addition, it appeared that road regrading and probably snow removal activities are impacting the riparian vegetation and the altering the streambank composition by forcing materials down the streambank. Consideration should be given to relocating the roads further back from the river to alleviate these impacts. A minimum leave strip width of 15 m is recommended.

5. Riparian planting along the riverfront trail/park system

The City of Quesnel's Riverfront Trail system links several of the City's parks and provides public access to the natural environment and historic sites along the banks of the Fraser and Quesnel rivers, and the lower section of Baker Creek. Part of this system, the North Quesnel Trail, follows approximately 1.5 km of western bank of the Quesnel River from the Fraser River confluence (Ceal Tingley Park) to the Highway 97 bridge (Chuck Beath Memorial Park). It was noted during the field survey that although the trail system along the river provided a buffer from upland developments, it often meant that

riparian vegetation had been removed to some extent. It is recommended that the City provide for the retention or reestablishment of native riparian vegetation along the river to enhance the value of the area's fish and wildlife habitats. View points at intervals along the trail could be selected and maintained to provide river views while permitting riparian vegetation to be retained in between. This would tend to enhance the aesthetics of the trail system and serve to retain more of its natural appearance.

5.2.3 Baker Creek

The 660 m of Baker Creek downstream from the Marsh Drive bridge crossing to the confluence with the Fraser River contains high value salmon spawning gravels. Riparian zone vegetation has been reduced to a minimum along much of this section, primarily along Warden Road and the Westpark Mall property. As this section has a high potential for the harassment of spawning fish, efforts to restore riparian cover as a buffer against disturbance are recommended.

The maintained green space of the Wilma Hanson Memorial Park between approximately 1,100 and 1,400 m upstream from The Fraser River encroaches to the top of the creek bank where maintained lawn and an incomplete strip of cottonwoods comprise the depauperate riparian zone vegetation. The planting of native trees and shrubs along the bank will stabilize the existing eroding banks and provide cover and food for rearing salmonids.

Additional sections where riparian vegetation has been significantly reduced or eliminated by activities associated with private developments include between 1,950 and 1,990 m, 2,100 and 2,400 m and at 2,780 m upstream of the Fraser River. A large slump occurring 2,300 m upstream presents a high sedimentation concern and should be stabilized by planting. The profiles of eroding banks exposing the substrates indicate gravels and sand are the major constituents. To avoid further bank erosion and to preserve the fisheries values associated with riparian vegetation, the restoration of damaged or denuded sections within the riparian zone is recommended.

At 3,080 m upstream from the Fraser River a 450 mm corrugated metal culvert has been torn apart from high flows and should be repaired or replaced to prevent further damage and erosion.

5.3 Fish Habitat Enhancement Opportunities

Fish habitats along the length of the Fraser and Quesnel rivers within the study area have been impacted by activities associated with land use adjacent to streambanks. Protection for remaining undisturbed riparian habitats can be achieved by referring development applications for areas adjacent to streambanks to the relevant fisheries and environment agencies for approval.

Habitat Referral System

During the survey a number of residential or industrial developments were observed to have had impacts on the streambanks and/or riparian zones of the study area streams. These developments had apparently proceeded without any attention paid to preserving or reinstating the streambank habitat or riparian vegetation. As with many other municipalities in British Columbia, the habitat referral system should be utilized to assess potential impacts of development projects which occur in or around watercourses. This would allow the municipal planning and/or engineering departments and the environmental agencies to work together with the developer towards a goal of protecting these valuable habitats.

Riparian Leave Strips

Riparian leave strips encompass the land and vegetated zones adjacent to watercourses as well as the upland habitats which influence the streambank. These areas are to remain in an undisturbed state throughout and following any development. Leave strips serve to protect the riparian zone, which is critical to the maintenance of a healthy aquatic environment and directly influences the value of the adjacent aquatic habitats. Specifically, riparian zones supply fish food items, detritus upon which fish food organisms depend, contribute large organic debris which complexes the aquatic habitat, provide water temperature regulation, a buffer zone from upland runoff, stream cover, and contribute to streambank stability. Under the joint federal and provincial Land Development Guidelines for the Protection of Aquatic Habitat, the suggested minimum leave strip width (measured from the top-of-bank) is 15 m for residential/low density areas and 30 m for commercial/high density areas (Chilibeck 1992). It is recommended that these guidelines be adopted within the City of Quesnel in order to protect the quality and quantity of the remaining aquatic habitats.

5.3.1 Fraser River

1. Off-channel rearing habitat in old log channel at Weldwood Mill

The remnants of an old log loading/sorting channel exist inland from the eastern bank of the Fraser River within the log storage site at the Weldwood Mill (Streambank Section F1). The channel is presently cut off from the Fraser River and due to its ponded state it contains a considerable amount of aquatic vegetation. The riparian zone is virtually non existent as a result of the close proximity of access roads and log storage areas. Recent signs of channel infilling were also evident. However, based on older topographic maps, the channel was open at both ends which permitted river water to flow through it and undoubtedly provided salmonid rearing habitat. It also appears that a fairly large pond, which may have been used for log sorting, was associated with the channel at the downstream end. This pond may have provided additional rearing habitat.

An opportunity exists to reinstate the flow through the old channel and create productive side channel rearing habitat. Instream habitat complexing and possibly overwintering habitat in the form of a pond could created. Native species of riparian vegetation could be reestablished to provide shade, food organisms and cover along the channel banks. Implementing such a project would require a physical survey of the existing channel and detailed habitat design and construction plans. An assessment of the water quality within the channel and the potential for leachate introduction should also be undertaken to ensure that any newly constructed habitat would be as productive as possible. The water which would be enter the channel would be expected to be less turbid than the Fraser River water since the clearer Quesnel River water intrusion extends along that streambank and would enter the new channel opening.

Revegetation of the Fraser River streambank all along the mill site should also be considered. In order to restore and maintain the riparian zone in this area, it is recommended that native trees and shrubs be planted for a minimum of 15 m from the top-of-bank. For a large portion of the shoreline this would mean decommissioning the access road.

Since the works would occur on Weldwood property, their cooperation would be paramount to the success of such a project. It appears that their log handling facilities at this site are limited and any reduction of this area would not be welcome. The possibility of Weldwood expanding their facilities inland to the east and northwest in compensation for lost area around the channel should be investigated.

5.3.2 Quesnel River

1. Dragon Creek

The elevated outfall into the Quesnel River precludes fish access into Dragon Creek. The potential exists to restore fish access, however, a detailed survey of the existing stream habitat and fish utilization as well as a study of the creek's hydrology should be completed first. This information combined with an assessment of the effect on the Quesnel River dyke would then be used to assess the cost-benefit of any enhancement works in Dragon Creek.

2. Groundwater Channel Development

The opportunity exists to excavate a number of existing high water channels to provide additional salmonid rearing habitat for an extended period of time during the year. A dozen or so under-yearling rainbow trout were observed during the survey stranded in isolated pools in the back channel across the river from the Two Mile Flat industrial area (behind Streambank Section Q46). This indicates that salmonids utilize these areas but are also being stranded as the water level recedes. Since previous fish sampling conducted within the study area mainstem habitats (Lewis and Levings, 1988) has verified that significant numbers of chinook salmon smolts and under-yearlings utilize the Quesnel River for rearing and overwintering, an increase in the available habitat and the length of time it is available would be beneficial. Works could include excavating existing channels to form groundwater channels in which flow is maintained for a longer time period. Detailed surveys would be required to determine the feasibility, extent and most appropriate locations for these works.

Potential sites for side channel improvements include the high water channels within or near Streambank Sections Q10, Q17, Q30 and Q46.

5.3.3 Baker Creek

Habitat enhancement opportunities in Baker Creek are limited by the high annual runoff volumes and velocities. Structures designed to provide instream complexing and cover would have to be constructed requiring very large materials which presents transportation, access and feasibility concerns. However, an example of enhancement is found 320 m upstream from the Fraser River where a strip of large boulders has been placed across the creek. These boulders create a pool and act to trap gravels on the upstream side which are being utilized by spawning pink salmon. Locating and constructing additional sites would provide similar benefits toward increasing the productivity of the creek. Fish passage criteria would need to be addressed in the design and the effects of the altered flow and potential erosion would have to be assessed.

In order to protect the integrity of the streambanks in reaches 1 and 2, no further development or disturbance should be permitted within 15 m from the top of the topographical creek bank. Determination of the width of leave strip should be made on a site-by-site basis. Since these reaches have high recreational use and harassment of spawning fish is likely a problem, it is recommended that the existing vegetation be retained and a series of interpretive signs be erected along the walking trail on the north side of the creek. This may increase the level of stewardship among residents and provide a greater level of protection for spawning fish.

The combination of valuable fish habitat, unique geological features, relatively undisturbed and diverse natural vegetation as well as potential for erosion and mass wasting in Reach 3 indicate that future development to the top of the bank in this section will have negative impacts on not only the local area but potentially a much larger area. A more detailed environmental assessment should be done to determine what additional values are inherent within, and upstream of Reach 3 that may warrant preservation of the area as a regionally important natural area.

6.0 SUMMARY

A total of 125 discrete, relatively homogenous streambank sections were recognized comprising a total linear distance of 48.6 km (including both streambanks) along the Fraser and Quesnel rivers in the vicinity of Quesnel. A detailed inventory of pertinent instream and riparian zone characteristics were recorded for each streambank section and summarized in Appendices 1 and 3. Salmonid habitat value ratings were determined for each streambank section based on the overall values and interactions of the identified

habitat characteristics in the context of known salmonid utilization patterns. The dominant riparian zone plant associations were described for each of the identified streambank sections including those of degraded riparian communities. Fish habitat restoration opportunities and potential habitat enhancement opportunities were identified and described. A series of seven 1:5,000 scale maps were produced identifying streambank section locations, providing an overall salmonid habitat value rating for each section and summarizing the major instream and riparian zone characteristics.

The majority of streambank sections identified had some level of disturbance to riparian zone plant communities associated with them. High salmonid habitat value ratings often correspond to streambank sections with well developed riparian zone plant communities and spawning areas. Significant values to many bird and wildlife species are also associated with riparian zone plant communities. For these reasons and in the light of future development proposals affecting the remaining undeveloped lands adjacent to the riparian zones of these rivers, it is recommended that a planned and systematic approach is taken to ensure the protection of remaining intact riparian communities and restore as much streambank as possible to a natural and more productive state.

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APPENDICES

Legend

Substrate Abbreviations:

F - fines (sand, clay, sediments)
G - gravel
C - cobble
B - boulder
BR - bedrock
RR - rip rap materials, metal debris, etc.

Terms:

Bank Stability:
- stable - river banks not immanently prone to significant erosion or mass wasting.
- eroding - river banks showing evidence of significant erosion (i.e. cutbanks) or a high potential for erosion, for example - unvegetated river banks with non-compacted substrates.

Riparian Vegetation:
- incomplete - refers to plant communities with significant discontinuities in vegetative cover. Two common causes are natural and frequent disturbance from river processes and encroachment by development.

Symbols:

* - plants in the species list classified as uncommon or rare.

/ - between species indicates dominance of species on left of symbol.

\- - between species indicates no apparent dominance.

Four distinct plant communities were recognized within the Quesnel study area as described below.

- **Emergent** herbaceous wetland species capable of tolerating complete submersion for short periods of time.

- **Lower Riparian** species found along the lower banks of the watercourse, seasonally inundated sand/gravel bars and low-lying flats within the floodplain. The water table is usually accessible to the root systems. Soils may be skeletal as occurs on exposed gravel bars, or conversely, comprised of recently infilled sediments (largely sands).

- **Upper Riparian** species found along the upper banks or on elevated floodplain benches, consisting primarily of shrubs and young trees. Inundation by water is often less frequent. Soils are generally well developed and well drained.

- **Upland** species found on the slopes above the floodplain benches and high water marks. Soils are well developed. Trees and shrubs are the primary community constituents.

Appendix 1. Biophysical data for the Fraser River within the Quesnel study area.

STREAM BANK SECTION:	F01
LENGTH (m):	2,000.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/B/G
BANK COMPOSITION:	C/B
BANK STABILITY:	Stable
NEARSHORE FLOW:	Glide
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - sandbar willow/cottonwood seedlings - grasses
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood/alder saplings - grasses/weedy species
UPSLOPE VEGETATION :	Incomplete - grasses/weedy species

ENHANCEMENT OPPORTUNITIES :

Open up existing side channel within log storage yard and create additional fish habitat. Riparian planting along side channel.

RESTORATION OPPORTUNITIES:

Riparian planting along the Fraser River shoreline.

COMMENTS :

Bedrock outcroppings present. See report for additional enhancement/restoration opportunities.

STREAM BANK SECTION:	F02
LENGTH (m):	200.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Agricultural
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - cottonwood seedlings - aster
UPPER RIPARIAN VEGETATION :	Complete - regenerating cottonwood/spruce
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :

STREAM BANK SECTION:	F03
LENGTH (m):	325.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	B
BANK COMPOSITION:	B/C
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Agricultural
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Complete - cottonwood saplings - rose - grasses

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:
Plant cottonwoods and shrubs along top of bank.

COMMENTS :
5 m eroding cutbank. Bank swallow nests. No vegetation below top of bank.

STREAM BANK SECTION:	F04
LENGTH (m):	1,100.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/B
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Glide
UPLAND USE :	Agricultural
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - wolf willow - cottonwood saplings - dogwood - hazelnut - grasses
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:
Allow sapling trees to mature and plant additional trees along the top of bank.

COMMENTS :
Clumps of foam on water

STREAM BANK SECTION:	F05
LENGTH (m):	600.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/G/B
BANK STABILITY:	n/a
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Island - gravel bar

STREAM BANK SECTION:	F06
LENGTH (m):	700.00
VALUE RATING:	Low
INSTREAM SUBSTRATES:	BR/B
BANK COMPOSITION:	F/G
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Incomplete - spruce - cottonwood - birch

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Partially vegetated, undulating, naturally eroding cutbank to 12 m.

STREAM BANK SECTION:	F07
LENGTH (m):	450.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/B
BANK COMPOSITION:	C/B
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - aster - oyster plant - evening primrose
UPPER RIPARIAN VEGETATION :	Complete - cottonwood/wolf willow - rose sweet-clover
UPSLOPE VEGETATION :	Complete - cottonwood - birch/ goldenrod - grasses

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Regenerating site disturbed from road construction/fire?

STREAM BANK SECTION:	F08
LENGTH (m):	550.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	B/BR
BANK COMPOSITION:	C
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Residential
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - sandbar willow - cottonwood seedlings
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood/red-osier dogwood
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:
Riparian planting.

COMMENTS :
Rock groins present along the shoreline.

STREAM BANK SECTION:	F09
LENGTH (m):	1,250.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Dev.
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - grasses/scattered cottonwood/goldenrod
UPSLOPE VEGETATION :	Complete - spruce/lodgepole pine - Douglas-fir

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Railroad parallels river.

STREAM BANK SECTION:	F10
LENGTH (m):	150.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/B/G
BANK COMPOSITION:	C/B/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Agricultural
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	Incomplete - spikerush - horsetail - bluegrass
LOWER RIPARIAN VEGETATION :	Complete - sandbar willow/cottonwood seedlings/aster
UPPER RIPARIAN VEGETATION :	Complete willow - dogwood - grass - rose - snowberry - cherry - hawthorn
UPSLOPE VEGETATION :	Complete - grasses/cottonwood/alder/cherry

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Trail along bank.

STREAM BANK SECTION:	F11
LENGTH (m):	875.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/B/G
BANK COMPOSITION:	C/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Residential
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - sandbar willow/spreading bentgrass - aster
UPPER RIPARIAN VEGETATION :	Complete - cottonwood - sandbar willow - birch
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
A narrow strip of riparian vegetation along the top of bank. Tree cover intermittent.

STREAM BANK SECTION:	F12
LENGTH (m):	700.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	G/C/F
BANK COMPOSITION:	C/G/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Residential
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - sandbar willow/cottonwood seedlings/aster
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood/dogwood - rose/cherry - alder/goldenrod
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Road access through upper and lower riparian.

STREAM BANK SECTION:	F13
LENGTH (m):	175.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR/G
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run/riffle
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - cottonwood saplings/willow - clover - horsetail - alfalfa
UPSLOPE VEGETATION :	Complete - cottonwood/birch/spruce

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Railroad and old road parallel river.

STREAM BANK SECTION:	F14
LENGTH (m):	175.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	G/C/F
BANK COMPOSITION:	C/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Glide
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Floodplain bar at the confluence with the Quesnel River.

STREAM BANK SECTION:	F15
LENGTH (m):	75.00
VALUE RATING:	Low
INSTREAM SUBSTRATES:	C/F/G
BANK COMPOSITION:	C/G/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Riffle
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - sandbar willow/bentgrass
UPPER RIPARIAN VEGETATION :	Incomplete - sandbar willow - cottonwood saplings
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Trail system and park

STREAM BANK SECTION:	F16
LENGTH (m):	50.00
VALUE RATING:	Low
INSTREAM SUBSTRATES:	C/F/G
BANK COMPOSITION:	C/G/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Backeddy
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - sandbar willow
UPPER RIPARIAN VEGETATION :	Incomplete - sandbar willow/grasses
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Boat launch

STREAM BANK SECTION:	F17
LENGTH (m):	150.00
VALUE RATING:	Low
INSTREAM SUBSTRATES:	C/F/G
BANK COMPOSITION:	C/B/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Backeddy
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - sandbar willow - grasses - cottonwood seedlings
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood saplings - grasses - weedy species
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Trail system and park

STREAM BANK SECTION:	F18
LENGTH (m):	50.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Trail system and park/Moffat Bridge

STREAM BANK SECTION:	F19
LENGTH (m):	50.00
VALUE RATING:	Low
INSTREAM SUBSTRATES:	RR/F/G
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Backeddy
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Foot Bridge

STREAM BANK SECTION:	F20
LENGTH (m):	800.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/B/G
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - scattered grasses - cottonwood seedlings
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood/cottonwood saplings/alder saplings
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Trail system and park

STREAM BANK SECTION:	F21
LENGTH (m):	75.00
VALUE RATING:	Low
INSTREAM SUBSTRATES:	G/F/B
BANK COMPOSITION:	C/F/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Backeddy
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - grasses/willow
UPPER RIPARIAN VEGETATION :	Incomplete - grasses/cottonwood
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Trail system and park

STREAM BANK SECTION:	F22
LENGTH (m):	50.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Glide
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Moffat Bridge

STREAM BANK SECTION:	F23
LENGTH (m):	100.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	G/F/C
BANK COMPOSITION:	C/G/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Backeddy
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - sandbar willow
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood - grasses
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Trail system and park

STREAM BANK SECTION:	F24
LENGTH (m):	650.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood/willow - grasses
UPSLOPE VEGETATION :	Incomplete - grasses/Douglas-fir - spruce/snowberry/weedy species

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Trail system and park

STREAM BANK SECTION:	F25
LENGTH (m):	1,200.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/B
BANK STABILITY:	Stable
NEARSHORE FLOW:	Glide
UPLAND USE :	Residential
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - willow/cottonwood seedlings
UPSLOPE VEGETATION :	Complete - Douglas-fir/pine-spruce/birch - bearberry - juniper - weedy species

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :

Short sections with no mature trees.

STREAM BANK SECTION:	F26
LENGTH (m):	1,200.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/B/G
BANK COMPOSITION:	C/B
BANK STABILITY:	Stable
NEARSHORE FLOW:	Glide
UPLAND USE :	Residential
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - willow - horsetail - hairgrass/aster/alder - dogwood/grasses
UPPER RIPARIAN VEGETATION :	Complete - cottonwood/birch/willow/maple - hazelnut - serviceberry - cherry
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :

First significant natural community upstream from town center.

STREAM BANK SECTION:	F27
LENGTH (m):	750.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Residential
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - willow - alder - cottonwood seedlings
UPPER RIPARIAN VEGETATION :	Complete - incomplete - cottonwood/willow/alder
UPSLOPE VEGETATION :	Incomplete - cottonwood/spruce/Douglas-fir/aspen

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:
Pull back fill from within top of bank.

COMMENTS :
Debris down bank

STREAM BANK SECTION:	F28
LENGTH (m):	625.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/B
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - willow - cottonwood seedlings/horsetail
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Complete - spruce/cottonwood/Douglas-fir - alder - grasses

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Debris down bank. Bank appears to contain large amounts of fill.

STREAM BANK SECTION:	F29
LENGTH (m):	550.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	G/F/C
BANK COMPOSITION:	C/B/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - sandbar willow/aster - hairgrass - horsetail
UPPER RIPARIAN VEGETATION :	Complete - alder - dogwood - cottonwood/rose - hazelnut - serviceberry
UPSLOPE VEGETATION :	Complete - cottonwood/spruce - solomon seal - twisted-stalk/buffaloberry - cherry

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :

STREAM BANK SECTION:	F30
LENGTH (m):	350.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	B/C
BANK COMPOSITION:	B/C
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Glide
UPLAND USE :	Residential
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - alder/dogwood - cottonwood
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Complete - birch/cottonwood/spruce

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :

6 m naturally eroding cutbank

STREAM BANK SECTION:	F31
LENGTH (m):	650.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	B
BANK COMPOSITION:	F/G
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Residential
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Incomplete - grasses - aspen poplar - spruce (top)

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :

Car bodies along bank. 13 m cutbank of sand, fines, gravel. Partially vegetated. Some human induced erosion.

STREAM BANK SECTION:	F32
LENGTH (m):	475.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	F/G/C
BANK COMPOSITION:	G/F/C
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Backeddy
UPLAND USE :	Agricultural
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - grasses
UPPER RIPARIAN VEGETATION :	Incomplete - grasses/scattered cottonwood
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

Plant top of bank with trees and shrubs. Remove cars.

COMMENTS :

Car bodies along bank

STREAM BANK SECTION:	F33
LENGTH (m):	250.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/B
BANK COMPOSITION:	F/G
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Glide
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Complete - cottonwood/birch (top of bank)

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
25 m naturally eroding cutbank

STREAM BANK SECTION:	F34
LENGTH (m):	850.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	G/C/F
BANK COMPOSITION:	G/C/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Agricultural
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - grasses/aster
UPPER RIPARIAN VEGETATION :	Complete - cottonwood/spruce - aspen
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Trees are an isolated remnant at bottom of field.

STREAM BANK SECTION:	F35
LENGTH (m):	75.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Glide
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Incomplete - birch- aspen/mullen

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:
Removing debris would result in erosion initially. Streambank would have to be restored and stabilized. Access to site is very difficult.

COMMENTS :
Old garbage dump - metal.

STREAM BANK SECTION:	F36
LENGTH (m):	450.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/B
BANK COMPOSITION:	F/G
BANK STABILITY:	Unstable
NEARSHORE FLOW:	Backeddy
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Incomplete - birch/cottonwood/spruce (top of bank)

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
22 m naturally eroding cutbank.

STREAM BANK SECTION:	F37
LENGTH (m):	150.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/B
BANK STABILITY:	Stable
NEARSHORE FLOW:	Backeddy
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - dogwood/horsetail - hairgrass - aster
UPPER RIPARIAN VEGETATION :	Complete - alder/cottonwood/dogwood - hazelnut - twinberry
UPSLOPE VEGETATION :	Complete - aspen/spruce/cottonwood/birch

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :

STREAM BANK SECTION:	F38
LENGTH (m):	450.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	G/C/F
BANK COMPOSITION:	F
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Riffle/pool
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - grasses - horsetail - aster
UPPER RIPARIAN VEGETATION :	Complete - alder/dogwood - grasses - twinberry
UPSLOPE VEGETATION :	Complete - cottonwood - aspen

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :

2 creeks enter - no flow. High utilization by wildlife. Eroding banks are sedimentary deposits from creek.

STREAM BANK SECTION:	F39
LENGTH (m):	800.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C
BANK COMPOSITION:	F/G/C
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Agricultural
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - grasses/weedy species
UPPER RIPARIAN VEGETATION :	Complete - grasses
UPSLOPE VEGETATION :	n/a

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Farmers field to top of bank.

STREAM BANK SECTION:	F40
LENGTH (m):	2,625.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/B/G
BANK COMPOSITION:	C/B/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Glide
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - cottonwood seedlings - aster
UPPER RIPARIAN VEGETATION :	Complete - alder/willow/dogwood
UPSLOPE VEGETATION :	Complete - cottonwood - birch

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :
Streambank section includes backchannel.

STREAM BANK SECTION:	F41
LENGTH (m):	850.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	B/C/G
BANK COMPOSITION:	F/G/C
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Glide
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Incomplete - goldenrod - sage - clover - oyster - yarrow - thistle

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

COMMENTS :

Treed at top. 25 m naturally eroding cutbank. Garbage along base of slope.

STREAM BANK SECTION:	F42
LENGTH (m):	750.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	B/C/G
BANK COMPOSITION:	F/G/C
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Glide
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Incomplete - goldenrod - thistle - clover - oyster plant

ENHANCEMENT OPPORTUNITIES :

RESTORATION OPPORTUNITIES:

Plant trees at top of bank.

COMMENTS :

Garbage thrown from top/slumping. Partially vegetated.

Appendix 2. Listing of plant species found along the Fraser and Quesnel River systems in the vicinity of Quesnel, B.C.

Trees

Douglas maple (N)*	*Acer glabrum* var. *douglasii*
Mountain alder (N)	*Alnus tenuifolia*
Paper birch (N)	*Betula papyrifera*
Hybrid white spruce (N)	*Picea glauca* x *engelmanii*
Lodgepole pine* (N)	*Pinus contorta*
Trembling aspen (N)	*Populus tremuloides*
Black cottonwood (N)	*Populus trichocarpa*
Douglas-fir (N)	*Pseudotsuga menziesii*
Mountain ash (I)*	*Sorbus acuparia*
Western redcedar (N)*	*Thuja plicata*

Shrubs

Serviceberry (N)	*Amelanchier alnifolia*
Spreading dogbane (N)	*Apocynum androsaemifolium*
Bearberry (N)	*Arctostaphylos uva-ursi*
Tall Oregon-grape (N)*	*Berberis aquifolium*
Oregon-grape (N)	*B. nervosa*
Red-osier dogwood (N)	*Cornus stolonifera*
Beaked hazelnut (N)	*Corylus cornuta*
Black hawthorn (N)	*Crateagus douglasii*
Wolf-willow (N)	*Eleagnus commutata*
Dwarf juniper (N)*	*Juniperus communis*
Black twinberry (N)	*Lonicera involucrata*
Devil's club (N)*	*Oplopanax horridus*
Chokecherry (N)	*Prunus virginiana* var. *demissa*
Nootka rose (N)	*Rosa nutkana* var. *hispida*
Red Raspberry (N)*	*Rubus idaeus*
Thimbleberry (N)	*R. parviflorus*
Bebb's willow (N)*	*Salix bebbiana*
Sandbar willow (N)	*S. exigua* var. *interior*

(N) - native (I) - introduced * - uncommon or rare

Appendix 2. Listing of plant species found along the Fraser and Quesnel River systems in the vicinity of Quesnel, B.C., continued.

Shrubs, continued

Smooth willow (N)	*S. glauca*
Whiplash willow (N)	*S. lasiandra* var. *caudata*
Buffalo berry (N)	*Sheperdia canadensis*
Birch-leaved spirea (N)*	*Spiraea betulifolia*
Snowberry (N)	*Symphoricarpos albus*
Highbush cranberry (N)	*Viburnum edule*

Herbs

Yarrow (N)	*Achillea millefolium*
Long headed anemone (N)*	*Anemone cylindrica*
Spreading dogbane (N)	*Apocynum androsaemifolium*
Sarsaparilla (N)	*Aralia nudicaulus*
Wormwood (I)	*Artemisia absinthimum*
Dragon sagewort (I)	*A. dranunculus*
Prairie sage (N)	*A. ludoviciana*
Goatsbeard (N)*	*Aruncus sylvester*
Asparagus (I)	*Asparagus officinalis*
Showy aster (N)	*Aster conspicuous*
Few-flowered aster (N)	*A. modestus*
Douglas aster (N)	*A. subspicatus*
Red columbine (N)*	*Aquilegia formosa*
Canada thistle (I)	*Cirsium vulgare*
Bunchberry (N)	*Cornus canadensis*
Oxeye daisy (I)	*Chrysanthemum leucanthemum*
Mountain avens (I)*	*Dryas drummondii*
Blueweed (I)	*Echium vulgare*
Fireweed (I)	*Epilobium angustifolium*
Watson's willow-herb (N)	*E. watsonii*
Water horsetail (N)*	*Equisetum fluviatile*
Common scouring-rush (N)	*E. hyemale*
Dwarf scouring-rush (N)*	*E. scirpoides*

(N) - native (I) - introduced * - uncommon or rare

Appendix 2. Listing of plant species found along the Fraser and Quesnel River systems in the vicinity of Quesnel, B.C., continued.

Herbs, continued.

Variegated horsetail (N)	*E. variegatum*
Brown-eyed Susan (N)*	*Gaillardia aristata*
Sweet-scented bedstraw (N)	*Galium triflorum*
Northern bedstraw (N)*	*G. boreale*
Oak fern (N)*	*Gymnocarpum dryopteris*
Sneezeweed (N)	*Helinium autumale* var. *montanum*
Mountain mare's tail (N)*	*Hippuris montana*
Toad rush (N)*	*Juncus bufonius*
Slender rush (N)	*J. tenuis*
Prickly lettuce (I)	*Lactuca scariola*
European stickseed (I)	*Lappula echinata*
Northern twinflower (N)*	*Linnaea borealis*
Alfalfa (I)	*Medicago sativa*
White sweet-clover (I)	*Melilotus alba*
Yellow sweet-clover (I)	*M. officinalis*
Field mint (N)	*Mentha arvensis*
Common evening-primrose (N)	*Oenthera strigosa*
One-sided wintergreen (N)*	*Orthilia secunda*
Mountain sweet-cicely (N)*	*Osmorhiza chilensis*
Common plantain (I)	*Plantago major*
Pink wintergreen (N)*	*Pyrola asarifolia*
Sticky cockle (I)*	*Silene noctiflora*
False Solomon's seal (N)	*Smilacina racemosa*
Canadian goldenrod (N)	*Solidagocanadensis*, *S. canadensis* var. *subserratus*
Spikelike goldenrod (N)	*Solidago spathulata*
Field milk-thistle (I)	*Sonchus arvensis*
Clasping twisted-stalk (N)*	*Streptopus amplexifolius*
Common tansy (I)	*Tanacetum vulgare*
Western meadowrue (N)*	*Thalictrum occidentale*
Oyster plant (I)	*Tragopagon dubius*
Great mullein (I)	*Verbascum thapsus*

(N) - native (I) - introduced * - uncommon or rare

Appendix 2. Listing of plant species found along the Fraser and Quesnel River systems in the vicinity of Quesnel, B.C., continued.

Grasses

Slender wheatgrass (N)	*Agropyron caninum* var. *majus*
Crested wheatgrass (I)	*A. cristatum*
Quackgrass (I)	*A. repens*
Spreading bentgrass (I)	*Agrostis alba* var. *stolonifera*
Tickle-grass (N)	*A. scabra*
Bluejoint reedgrass (N)	*Calamagrostis canadensis*
Slender hairgrass (N)	*Deschampsia cespitosa*
Nodding wildrye (N)	*Elymus canadensis*
Rough fescue (N)	*Festuca scabrella*
Timothy (I)*	*Phleum pratense*
Canadian bluegrass (N)	*Poa compressa*
Interior bluegrass (N)	*P. interior*
Kentucky bluegrass (I)	*P. pratensis*
Rabbitfoot polypogon (I)*	*Polypogon monspeliensis*
Bristlegrass (I)*	*Setaria viridis*

Sedges

Retrorse sedge (N)*	*Carex retrorsa*
Crawford's sedge (N)	*C. crawfordii*
Creeping spike-rush (N)*	*Eleocharis palustris*
Small spike-rush (N)*	*E. parvula*
Small-fruited bulrush (N)*	*Scirpus microcarpus*

(N) - native (I) - introduced * - uncommon or rare

Appendix 3. Biophysical data for the Quesnel River within the Quesnel study area.

STREAM BANK SECTION:	Q01
LENGTH (m):	375.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Complete - scattered cottonwoods at top of bank.

RESTORATION OPPORTUNITIES:
Plant trees at top of bank.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
8 m rip rap bank.

STREAM BANK SECTION:	Q02
LENGTH (m):	250.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G
BANK COMPOSITION:	C/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - sandbar willow/aster
UPPER RIPARIAN VEGETATION :	Incomplete - sandbar willow/scattered cottonwood
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
High use recreational area.

STREAM BANK SECTION:	Q03
LENGTH (m):	100.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood saplings - willow
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Bank stabilized by pouring concrete over rip rap materials.

STREAM BANK SECTION:	Q04
LENGTH (m):	525.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G
BANK COMPOSITION:	C/B/RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - sandbar willow - cottonwood seedlings
UPPER RIPARIAN VEGETATION :	Complete - grasses/scattered cottonwood
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q05
LENGTH (m):	100.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - sandbar willow/grasses/weedy species
UPPER RIPARIAN VEGETATION :	Incomplete - pocket of willow/weedy species
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q06
LENGTH (m):	50.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Trail and industrial development at top of bank.

STREAM BANK SECTION:	Q07
LENGTH (m):	175.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run/riffle
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood saplings/rose - weedy species
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Allow trees and shrubs to mature along trail.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Trail at top of bank.

STREAM BANK SECTION:	Q08
LENGTH (m):	325.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Incomplete - scattered cottonwood saplings - grasses - weeds
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Railroad at top of bank.

Appendix 3. Biophysical data for the Quesnel River within the Quesnel study area, continued.

STREAM BANK SECTION:	Q09
LENGTH (m):	675.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/G/B
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - aster - grasses/willow
UPPER RIPARIAN VEGETATION :	Complete - cottonwood/alder/willow/dogwood - cranberry
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q10
LENGTH (m):	275.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	G/C/RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Backchannel
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - cottonwood seedlings/aster
UPPER RIPARIAN VEGETATION :	Complete - cottonwood saplings/sandbar willow
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q11
LENGTH (m):	325.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/B/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - cottonwood seedlings/sandbar willow/aster
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Remove metal debris from west end of section close to trail.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Floodplain bar.

STREAM BANK SECTION:	Q12
LENGTH (m):	300.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/B/G
BANK COMPOSITION:	C/B
BANK STABILITY:	Stable
NEARSHORE FLOW:	Glide
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - cottonwood seedlings - sandbar willow
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood saplings/sandbar willow - sagewort
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Upstream end of floodplain bar.

Appendix 3. Biophysical data for the Quesnel River within the Quesnel study area, continued.

STREAM BANK SECTION:	Q13
LENGTH (m):	200.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Agricultural
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - grasses/cottonwood saplings
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood saplings/willow - grasses
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Field encroaches to top of bank

STREAM BANK SECTION:	Q14
LENGTH (m):	100.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	F/G
BANK COMPOSITION:	F/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Backeddy
UPLAND USE :	Agricultural
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - grasses/cottonwood saplings
UPPER RIPARIAN VEGETATION :	Incomplete - grasses - cottonwood saplings
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Plant trees and shrubs along top of bank.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Field encroachment to top of bank.

STREAM BANK SECTION:	Q15
LENGTH (m):	25.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Agricultural
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - grasses/ few cottonwood saplings
UPPER RIPARIAN VEGETATION :	Complete - grasses
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Plant top of bank with trees and shrubs.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Field encroachment to top of bank.

STREAM BANK SECTION:	Q16
LENGTH (m):	25.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Agricultural
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - grasses/scattered cottonwood saplings
UPPER RIPARIAN VEGETATION :	Complete - grasses
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Plant trees and shrubs along top of bank.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Field encroaches to top of bank.

STREAM BANK SECTION:	Q17
LENGTH (m):	700.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/B/G
BANK COMPOSITION:	C/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - sandbar willow - cottonwood seedlings
UPPER RIPARIAN VEGETATION :	Complete - cottonwood saplings & seedlings - sandbar willow
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Floodplain bar.

STREAM BANK SECTION:	Q18
LENGTH (m):	200.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Agricultural
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - grasses/cottonwood saplings
UPPER RIPARIAN VEGETATION :	Complete - grasses
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Plant trees and shrubs along top of bank.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Field encroaches to top of bank.

STREAM BANK SECTION:	Q19
LENGTH (m):	150.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/B
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Residential
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	Incomplete - spike-rush - horsetail
LOWER RIPARIAN VEGETATION :	Complete - cottonwood saplings - alder saplings - grasses
UPPER RIPARIAN VEGETATION :	Complete - grasses/ cottonwood saplings
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Plant trees and shrubs along top of bank.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Field encroaches to top of bank.

STREAM BANK SECTION:	Q20
LENGTH (m):	200.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G
BANK COMPOSITION:	C/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - cottonwood saplings/alder saplings - willow
UPPER RIPARIAN VEGETATION :	Incomplete - willow/cottonwood saplings - grasses
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Trail at top of bank.

Appendix 3. Biophysical data for the Quesnel River within the Quesnel study area, continued.

STREAM BANK SECTION:	Q21
LENGTH (m):	200.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	F/G
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Glide
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	Incomplete - spike-rush - horsetail
LOWER RIPARIAN VEGETATION :	Incomplete - sandbar willow - cottonwood seedlings
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood saplings/willow/alder saplings/grasses
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Plant trees and shrubs along top of bank.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Field encroaches to top of bank.

STREAM BANK SECTION:	Q22
LENGTH (m):	50.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Incomplete - sandbar willow/weedy species
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Rip rap around bridge piling.

STREAM BANK SECTION:	Q23
LENGTH (m):	300.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	G/C
BANK STABILITY:	Stable
NEARSHORE FLOW:	Glide
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - bentgrass/sweet-clover/sandbar willow/cottonwood seedlings
UPPER RIPARIAN VEGETATION :	Complete - cottonwood/alder - rose - snowberry - serviceberry - hawthorn
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q24
LENGTH (m):	100.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G
BANK COMPOSITION:	G/C
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - cottonwood saplings/wolf willow - serviceberry - dogwood
UPPER RIPARIAN VEGETATION :	Complete - cottonwood/birch/spruce
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q25
LENGTH (m):	50.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - sandbar willow/ cottonwood seedlings/aster
UPPER RIPARIAN VEGETATION :	Complete - cottonwood/rose - serviceberry - cherry
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q26
LENGTH (m):	25.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	G/C
BANK COMPOSITION:	C/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - hairgrass - bentgrass/cottonwood seedlings
UPPER RIPARIAN VEGETATION :	Complete - cottonwood seedlings - grasses
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Plant top of bank with trees and shrubs.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q27
LENGTH (m):	50.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood saplings/dogwood - grasses
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Bridge

STREAM BANK SECTION:	Q28
LENGTH (m):	50.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood saplings
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Bridge

STREAM BANK SECTION:	Q29
LENGTH (m):	50.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/B/G
BANK COMPOSITION:	C
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood saplings/dogwood
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Plant top of bank with trees and shrubs.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Railroad close to top of bank.

STREAM BANK SECTION:	Q30
LENGTH (m):	625.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	F/G
BANK COMPOSITION:	C/G/RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Backchannel
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - cottonwood seedling/alder/bentgrass - willow - clover
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood/wolf willow - dogwood
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Floodplain bar.

STREAM BANK SECTION:	Q31
LENGTH (m):	275.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood saplings/grasses
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Railroad at top of bank.

STREAM BANK SECTION:	Q32
LENGTH (m):	500.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G
BANK COMPOSITION:	C/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run/riffle
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - cottonwood seedlings/sandbar willow/aster
UPPER RIPARIAN VEGETATION :	Complete - cottonwood saplings - willow
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Floodplain bar.

STREAM BANK SECTION:	Q33
LENGTH (m):	100.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Railroad at top of bank.

STREAM BANK SECTION:	Q34
LENGTH (m):	75.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - cottonwood saplings
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood saplings/birch saplings - rose - grass
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Railroad at top of bank.

STREAM BANK SECTION:	Q35
LENGTH (m):	100.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	RR
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Residential
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Incomplete - grasses/cottonwood saplings - wolf willow
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Plant top of bank with trees and shrubs.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Railroad close to top of bank.

STREAM BANK SECTION:	Q36
LENGTH (m):	125.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	G/C
BANK COMPOSITION:	F/G
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Recreational
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - alder/grasses/dogwood/cottonwood saplings
UPSLOPE VEGETATION :	Complete - cottonwood

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Slumped alder along banks.

STREAM BANK SECTION:	Q37
LENGTH (m):	225.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	F
BANK COMPOSITION:	F
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run/riffle
UPLAND USE :	Residential
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - cottonwood - birch - spruce - dogwood - cranberry
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Stabilize bank.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Shrubs and woody debris along shore.

STREAM BANK SECTION:	Q38
LENGTH (m):	150.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	G/C
BANK COMPOSITION:	C/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - cottonwood/willow/dogwood
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Vegetation along edges of side channel.

STREAM BANK SECTION:	Q39
LENGTH (m):	500.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/F
BANK COMPOSITION:	n/a
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - cottonwood seedlings/sweet-clover
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Island

STREAM BANK SECTION:	Q40
LENGTH (m):	550.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Residential/Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - cottonwood/dogwood
UPPER RIPARIAN VEGETATION :	Complete - cottonwood/dogwood/alder - serviceberry - cranberry - willow
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Plant trees and shrubs along the top of bank.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Pink salmon (10) spawning in side channel.

Appendix 3. Biophysical data for the Quesnel River within the Quesnel study area, continued.

STREAM BANK SECTION:	Q41
LENGTH (m):	100.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	G/C
BANK COMPOSITION:	G/C/F
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - alder/cottonwood/dogwood - willow
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q42
LENGTH (m):	150.00
VALUE RATING:	Low
INSTREAM SUBSTRATES:	F/G
BANK COMPOSITION:	G/F
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - alder - cottonwood saplings/Douglas-fir seedlings
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Island - gravel bar

STREAM BANK SECTION:	Q43
LENGTH (m):	600.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G
BANK COMPOSITION:	C/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run/riffle
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - cottonwood seedlings - sandbar willow/sweet-clover
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Upstream end of island. Pink salmon (8) observed spawning in side channel.

STREAM BANK SECTION:	Q44
LENGTH (m):	425.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G
BANK COMPOSITION:	G/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run/riffle
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - cottonwood seedlings/aster
UPPER RIPARIAN VEGETATION :	Complete - alder/cottonwood/dogwood - willow - birch
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Gravel bar/side channel.

Appendix 3. Biophysical data for the Quesnel River within the Quesnel study area, continued.

STREAM BANK SECTION:	Q45
LENGTH (m):	350.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/G/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - grasses
UPPER RIPARIAN VEGETATION :	Incomplete - grasses/scattered cottonwood saplings - willow
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Plant trees and shrubs along top of bank. Move log storage from bank benches.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
High potential for contaminated runoff.

STREAM BANK SECTION:	Q46
LENGTH (m):	150.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/F
BANK COMPOSITION:	G/C
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - dogwood - alder/cranberry - twinberry
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q47
LENGTH (m):	125.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/F
BANK COMPOSITION:	G/C
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - grasses/cottonwood saplings - snowberry - dogwood - goldenrod
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Plant trees along top of bank and allow shrubs to mature.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Vegetation regenerating after fire under powerlines.

STREAM BANK SECTION:	Q48
LENGTH (m):	200.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/F
BANK COMPOSITION:	G/C
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - grasses/cottonwood saplings - wolf willow - serviceberry
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Vegetated, an island at high water.

Appendix 3. Biophysical data for the Quesnel River within the Quesnel study area, continued.

STREAM BANK SECTION:	Q49
LENGTH (m):	500.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	RR/C/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - alder saplings/dogwood - willow - grasses
UPPER RIPARIAN VEGETATION :	Incomplete - grasses/rose - cottonwood saplings
UPSLOPE VEGETATION :	Incomplete - grasses - weedy species

RESTORATION OPPORTUNITIES:
Pull back garbage and debris from top of banks. Plant trees and shrubs along top of bank - may require new road alignment.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Road along top of bank.

STREAM BANK SECTION:	Q50
LENGTH (m):	150.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	G/C/B
BANK COMPOSITION:	C/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run/riffle
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	Incomplete - spike-rush/horsetail
LOWER RIPARIAN VEGETATION :	Complete - grasses/goldenrod - aster
UPPER RIPARIAN VEGETATION :	Complete - serviceberry - alder/spruce
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Side channel.

STREAM BANK SECTION:	Q51
LENGTH (m):	550.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/G
BANK COMPOSITION:	C
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - willow - dogwood/grasses
UPPER RIPARIAN VEGETATION :	Complete - alder/willow - cottonwood - dogwood
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q52
LENGTH (m):	375.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/B/G
BANK COMPOSITION:	G/C
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - grasses/cottonwood saplings
UPPER RIPARIAN VEGETATION :	Complete - grasses/ cottonwood saplings/rose - goldenrod/weedy species
UPSLOPE VEGETATION :	Complete - grasses/cottonwood saplings - rose/goldenrod

RESTORATION OPPORTUNITIES:
Plant bank and top of slope with trees and shrubs.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Refuse along slope of 13 m high bank.

Appendix 3. Biophysical data for the Quesnel River within the Quesnel study area, continued.

STREAM BANK SECTION:	Q53
LENGTH (m):	150.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/B/F
BANK COMPOSITION:	F/B
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - cottonwood saplings - alder - grasses
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood saplings - spruce/birch - Douglas-fir
UPSLOPE VEGETATION :	Incomplete - cottonwood/grasses/birch - rose - spruce seedlings

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Barlow creek access.

STREAM BANK SECTION:	Q54
LENGTH (m):	50.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	F
BANK COMPOSITION:	G/C
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - dogwood - alder
UPSLOPE VEGETATION :	Complete - cottonwood/birch/spruce

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Log jam along bank at downstream end of highwater side channel.

STREAM BANK SECTION:	Q55
LENGTH (m):	300.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	G/C
BANK COMPOSITION:	G/C/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Glide
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - bentgrass - cottonwood seedlings - sandbar willow
UPPER RIPARIAN VEGETATION :	Complete - cottonwood/alder/dogwood - serviceberry - buffaloberry - willow
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Island at highwater.

STREAM BANK SECTION:	Q56
LENGTH (m):	325.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/B/G
BANK COMPOSITION:	G/C/B
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - clumps fromeroding bank - grasses - snowberry
UPPER RIPARIAN VEGETATION :	Complete - rose - serviceberry - snowberry/hawthorn/dogbane - fescue
UPSLOPE VEGETATION :	Incomplete - scattered Douglas-fir - cottonwood - aspen - spruce

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Road upslope follows river.

STREAM BANK SECTION:	Q57
LENGTH (m):	300.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G
BANK COMPOSITION:	G/F/C
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run/riffle
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Incomplete - grasses/ weedy species/cottonwood & birch saplings

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
28 m naturally eroding cutbank. Potential pink salmon spawning in side channel.

STREAM BANK SECTION:	Q58
LENGTH (m):	625.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G
BANK COMPOSITION:	C/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - alder - cottonwood/spruce - birch
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Piles of logs and woody debris along shoreline.

STREAM BANK SECTION:	Q59
LENGTH (m):	375.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/B/G
BANK COMPOSITION:	C/G/B
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - alder/dogwood
UPPER RIPARIAN VEGETATION :	Complete - cottonwood/birch/hazelnut - cherry - cranberry
UPSLOPE VEGETATION :	Complete - spruce/Douglas-fir/ cottonwood - birch

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q60
LENGTH (m):	25.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	F/G
BANK COMPOSITION:	C/G/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Backeddy
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - cottonwood - grasses
UPSLOPE VEGETATION :	Complete - grasses/Douglas-fir - spruce/cottonwood/wolf willow

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q61
LENGTH (m):	50.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	G/F/C
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Riffle
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Incomplete - thistle/weedy species/rose - cottonwood/wolf willow
UPSLOPE VEGETATION :	Incomplete - grasses/yarrow - sweet-clover - aspen & cottonwood seedlings - serviceberry

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Slump in gully.

STREAM BANK SECTION:	Q62
LENGTH (m):	200.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/G
BANK COMPOSITION:	G/F
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Agricultural
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - grasses
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Plant trees and shrubs along top of bank.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Field encroaches to top of bank.

STREAM BANK SECTION:	Q63
LENGTH (m):	250.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	G/C
BANK STABILITY:	Stable
NEARSHORE FLOW:	Riffle
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - cottonwood seedlings/sweet-clover - grasses - alder
UPPER RIPARIAN VEGETATION :	Complete - Douglas-fir - birch - cottonwood - rose - cherry - serviceberry
UPSLOPE VEGETATION :	Complete - Douglas-fir/birch/cottonwood - serviceberry - rose

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q64
LENGTH (m):	50.00
VALUE RATING:	Low
INSTREAM SUBSTRATES:	F
BANK COMPOSITION:	F/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Backeddy
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - alder
UPPER RIPARIAN VEGETATION :	Complete - cottonwood
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q65
LENGTH (m):	50.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/G/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - grasses - aster - alder
UPPER RIPARIAN VEGETATION :	Complete - alder/willow - cottonwood - Douglas-fir - spruce
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q66
LENGTH (m):	475.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	F/G
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - grasses - sweet-clover - alfalfa - goldenrod
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Incomplete - Douglas-fir/birch/cottonwood/aspen - sweet-clover

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

13 - 16 m cutbank with various slopes and degree of vegetation.

STREAM BANK SECTION:	Q67
LENGTH (m):	375.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	F/C/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - grasses/aster - alder
UPPER RIPARIAN VEGETATION :	Complete - alder/dogwood - willow - rose
UPSLOPE VEGETATION :	Complete -cottonwood/birch/Douglas-fir - rose

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q68
LENGTH (m):	225.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - alder
UPPER RIPARIAN VEGETATION :	Complete - cottonwood - alder - spruce
UPSLOPE VEGETATION :	Complete - cottonwood/birch - Douglas-fir

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q69
LENGTH (m):	375.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/F/B
BANK COMPOSITION:	F/C/B
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - alder/cherry - grasses
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Complete - Douglas-fir - spruce

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q70
LENGTH (m):	125.00
VALUE RATING:	Low
INSTREAM SUBSTRATES:	wall
BANK COMPOSITION:	n/a
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Industrial
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Water intake pumpstation.

STREAM BANK SECTION:	Q71
LENGTH (m):	275.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/G/B
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - spruce - Douglas-fir
UPSLOPE VEGETATION :	Complete - Douglas-fir/spruce/cottonwood

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q72
LENGTH (m):	875.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/B/G
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Agricultural
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - aster - grasses
UPPER RIPARIAN VEGETATION :	Complete - grasses/blueweed - stickseed/rose - wolf willow - snowberry
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:
Restrict level of cattle grazing. Plant trees and shrubs along top of bank.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Overgrazed field encroaches to top of bank.

Appendix 3. Biophysical data for the Quesnel River within the Quesnel study area, continued.

STREAM BANK SECTION:	Q73
LENGTH (m):	125.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/B/G
BANK COMPOSITION:	RR
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Complete - horsetail - grasses/ fireweed - buffaloberry - rose - raspberry

RESTORATION OPPORTUNITIES:
Plant trees and shrubs on slope under pipeline.

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Sparse woody vegetation under pipeline right-of-way.

STREAM BANK SECTION:	Q74
LENGTH (m):	300.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/B
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - grasses - aster - dogwood - willow
UPPER RIPARIAN VEGETATION :	Complete - alder - birch/cottonwood - spruce
UPSLOPE VEGETATION :	Complete -cottonwood - spruce/birch

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q75
LENGTH (m):	1,425.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	C/G/F
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - alder - dogwood/aster - snowberry - cherry
UPPER RIPARIAN VEGETATION :	Complete - Spruce - birch/cottonwood/rose - snowberry
UPSLOPE VEGETATION :	Complete - spruce - cottonwood/aspen - douglas-fir

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q76
LENGTH (m):	1,050.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	C/F/B
BANK COMPOSITION:	C/F/B
BANK STABILITY:	Stable
NEARSHORE FLOW:	Glide
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - alder/cottonwood saplings - rose
UPPER RIPARIAN VEGETATION :	Incomplete - cottonwood/spruce - Douglas-fir
UPSLOPE VEGETATION :	Complete - spruce/cottonwood

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

Cattle trails, trampling and foraging damage to understory plants along river.

STREAM BANK SECTION:	Q77
LENGTH (m):	475.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/B/G
BANK COMPOSITION:	F/G/C
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Incomplete - grasses/weedy species
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Incomplete - grasses/weedy species/scattered cottonwood & Douglas-fir

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Top of 10 - 16 m naturally eroding cutbank treed with spruce/birch - aspen

STREAM BANK SECTION:	Q78
LENGTH (m):	350.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	G/C/B
BANK COMPOSITION:	C/G/B
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run/riffle
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - alder - dogwood/cherry - spruce/cedar/aster - goldenrod
UPPER RIPARIAN VEGETATION :	Complete - birch - cottonwood/hazelnut - cranberry - sarsaparilla - twinberry
UPSLOPE VEGETATION :	Complete - cottonwood - spruce

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Pink spawning (10). High natural plant diversity.

STREAM BANK SECTION:	Q79
LENGTH (m):	875.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	G
BANK COMPOSITION:	G/F
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - Douglas-fir/sweet-clover - aster/cottonwood
UPPER RIPARIAN VEGETATION :	n/a
UPSLOPE VEGETATION :	Incomplete - Douglas-fir/spruce/birch

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
15 m relatively steep bank with some surface erosion.

STREAM BANK SECTION:	Q80
LENGTH (m):	875.00
VALUE RATING:	High
INSTREAM SUBSTRATES:	B/C/G
BANK COMPOSITION:	G/F
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Undeveloped
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Complete - alder - cottonwood/serviceberry
UPSLOPE VEGETATION :	Complete - spruce/cottonwood - birch

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

STREAM BANK SECTION:	Q81
LENGTH (m):	175.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	G/F/C
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Incomplete - thistle - rose/goldenrod - dogbane/hazelnut
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
n/a

STREAM BANK SECTION:	Q82
LENGTH (m):	175.00
VALUE RATING:	Medium
INSTREAM SUBSTRATES:	G/C/B
BANK COMPOSITION:	C/G/B
BANK STABILITY:	Stable
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	Complete - alder/cottonwood
UPPER RIPARIAN VEGETATION :	Complete - cottonwood/birch
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :
Railroad parallels river. Riparian zone narrow.

STREAM BANK SECTION:	Q83
LENGTH (m):	30.00
VALUE RATING:	Low
INSTREAM SUBSTRATES:	C/G/B
BANK COMPOSITION:	G/F/C
BANK STABILITY:	Eroding
NEARSHORE FLOW:	Run
UPLAND USE :	Linear Development
SUBMERGENT VEGETATION :	n/a
EMERGENT VEGETATION :	n/a
LOWER RIPARIAN VEGETATION :	n/a
UPPER RIPARIAN VEGETATION :	Incomplete - thistle - rose/goldenrod - dogbane/hazelnut
UPSLOPE VEGETATION :	n/a

RESTORATION OPPORTUNITIES:

ENHANCEMENT OPPORTUNITIES :

COMMENTS :

APPENDIX 4. Recommended native plant species for habitat restoration and enhancement efforts in the vicinity of Quesnel, B.C.

Emergent Zone:

Water horsetail	*E. fluviatile*
Torrey's rush	*J. torreyi*
Slender rush	*J. tenuis*
Mackeral-mint	*M. spicata*
Small-flowered forget-me-not	*Myosotis laxa*
Slender hairgrass	*Deschampsia cespitosa*
Slender beaked sedge	*Carex athrostachya*
Wide-fruited sedge	*C. eurycarpa*
Retrorse sedge	*C. retrorsa*
Crawford's sedge	*C. crawfordii*
Creeping spike-rush	*Eleocharis palustris*
Wool-grass	*Scirpus cyperinus*

Lower Riparian Zone:

Showy aster	*Aster conspicuous*
Few-flowered aster	*A. modestus*
Douglas aster	*A. subspicatus*
Sandbar willow	*Salix exigua* var. *interior*
Smooth willow	*S. glauca*
Whiplash willow	*S. lasiandra* var. *caudata*
Mackenzie willow	*S. rigida* var. *mackenzieana*
Red-osier dogwood	*Cornus stolonifera*
Highbush cranberry	*Viburnum edule*
Black twinberry	*Lonicera involucrata*
Chokecherry	*Prunus virginiana* var. *demissa*
Sarsaparilla	*Aralia nudicaulus*
Canadian goldenrod	*Solidago canadensis*
Spikelike goldenrod	*S. Spathulata*
Star-flowered Solomon's seal	*Smilacina stellata*
Interior bluegrass	*Poa interior*
Tickle-grass	*A. scabra*

Upper Riparian Zone:

Trees

Mountain alder	*Alnus tenuifolia*
Paper birch	*Betula papyrifera*

APPENDIX 4. Recommended native plant species for habitat restoration and enhancement efforts in the vicinity of Quesnel, B.C. (continued)

Upper Riparian Zone: continued

Water birch	*B. occidentalis*
Hybrid white spruce	*Picea glauca* x *engelmanii*
Lodgepole pine	*Pinus contorta*
Trembling aspen	*Populus tremuloides*
Black cottonwood	*Populus trichocarpa*
Douglas-fir	*Pseudotsuga menziesii*

Shrubs

Serviceberry	*Amelanchier alnifolia*
Big sage	*Artemisia tridentata*
Bearberry	*Arctostaphyllos uva-ursi*
Tall Oregon-grape	*Berberis aquifolium*
Red-osier dogwood	*Cornus stolonifera*
Beaked hazelnut	*Corylus cornuta*
Black hawthorn	*Crateagus douglas*
Wolf-willow	*Eleagnus commutata*
Dwarf juniper	*Juniperus communis*
Black twinberry	*Lonicera involucrata*
Chokecherry	*Prunus virginiana* var. *demissa*
Nootka rose	*Rosa nutkana* var. *hispida*
Red raspberry	*Rubus idaeus*
Bebb's willow	*Salix bebbiana*
Sandbar willow	*S. exigua* var. *interior*
Smooth willow	*S. glauca*
Whiplash willow	*S. lasiandra* var. *caudata*
Buffalo berry	*Sheperdia canadensis*
Birch-leaved spirea	*Spiraea betulifolia*
Snowberry	*Symphoricarpos albus*
Highbush cranberry	*Viburnum edule*

Herbs

Yarrow	*Achillea millefolium*
Long headed anemone	*Anemone cylindrica*
Spreading dogbane	*Apocynum androsaemifolium*
Prairie sage	*A. ludoviciana*
Showy aster	*Aster conspicuous*
Douglas aster	*A. subspicatus*

APPENDIX 4. **Recommended native plant species for habitat restoration and enhancement efforts in the vicinity of Quesnel, B.C.** (continued)

Upper Riparian Zone: contd

Watson's willow-herb	*E. watsonii*
Common scouring-rush	*E. hyemale*
False Solomon's seal	*Smilacina racemosa*
Canadian goldenrod	*Solidagocanadensis*
Spikelike goldenrod	*Solidago spathulata*

Grasses

Slender wheatgrass	*Agropyron caninum* var. *majus*
Tickle-grass	*A. scabra*
Bluejoint reedgrass	*Calamagrostis canadensis*
Slender hairgrass	*Deschampsia cespitosa*
Nodding wildrye	*Elymus canadensis*
Rough fescue	*Festuca scabrella*
Canadian bluegrass	*Poa compressa*
Interior bluegrass	*P. interior*