Highway #16 Fish Passage Assessment in Middle Skeena Watershed

Prepared for:
Department of Fisheries and Oceans
&
Pacific Salmon Commission

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INTRODUCTION

The purpose of this report is to present results and background information for the Middle Skeena Watershed fish passage assessment along Highway #16. In July 2004 the Skeena Fisheries Commission was retained by the Department of Fisheries and Oceans, Habitat and Enhancement Branch to conduct a Fish Passage and Culvert Inspection (FPCI) on all non-bridged stream crossings along Highway #16 between Terrace and Hazelton, BC. This Middle Skeena Watershed FPCI is part of a larger regional effort to identify, prioritize, and restore fish passage limited by highways and secondary roads throughout northwest British Columbia.

Maintenance of healthy fish populations requires that upstream components of streams crossed by roads permit the free migration of spawning adult fish and rearing juveniles. The purpose of this project is to serve as an early phase of a program to restore fish passage to diverse fish habitats that have been disconnected in the past by Highway #16 culvert installations.

Many kilometres of critical habitat that used to support salmonids are thought to be inaccessible due to improperly designed and installed fish passage structures along Highway #16 which parallels the Skeena River. These stream crossings were assessed to determine the feasibility and extent of restoration. Deliverables from this project include this narrative report, an updated database of all culverts and bridges crossing Highway #16, a map showing the highway, streams, fish resources, topography, and culvert locations, and a prioritized problem stream crossings list.

BACKGROUND

Highway #16 essentially parallels the Skeena River between Terrace and Hazelton in west central British Columbia for approximately 140 km, passing along the left bank or southeast side. The Skeena River cuts through the Hazelton Mountains, separating the Nass Ranges to the west and north, from the Bulkley Ranges to the south and east. The landscape is composed of a diverse assemblage of rugged mountains and short, steep valleys, with snow, glaciers, glacial cirques, and large areas of alpine slopes.

Within the study area, the highest peaks are the Seven Sisters, Mount Sir Robert, and Mount Quinlan, all possessing glaciers. Although in retreat, the glaciers and snowfields are still massive. Both the Nass and Bulkley Ranges were the source of large, coalescing ice sheets that covered the entire watershed during the Fraser Glaciation, which ended approximately 10,000 years ago.

Middle Skeena tributary watersheds are for the most part mountainous with high relief. Elevation ranges from 2,756 m in the Seven Sisters Range to 60 m on the Skeena River at Terrace. Skeena River peak discharges occur in May and June due to spring snowmelt throughout the upper Skeena Watershed. The peak spring freshets are in almost all years, the largest floods. Water levels in the main river channels and back channels fluctuate seasonally; typically they are high from May to early July, drop for the summer months, rise to intermediate levels in the fall, and reach their annual low levels late in the winter season. Monthly mean discharge for the Skeena River at Usk, Station 08EF001, is 160m^3/s in March and 2,830 m^3/s in June.

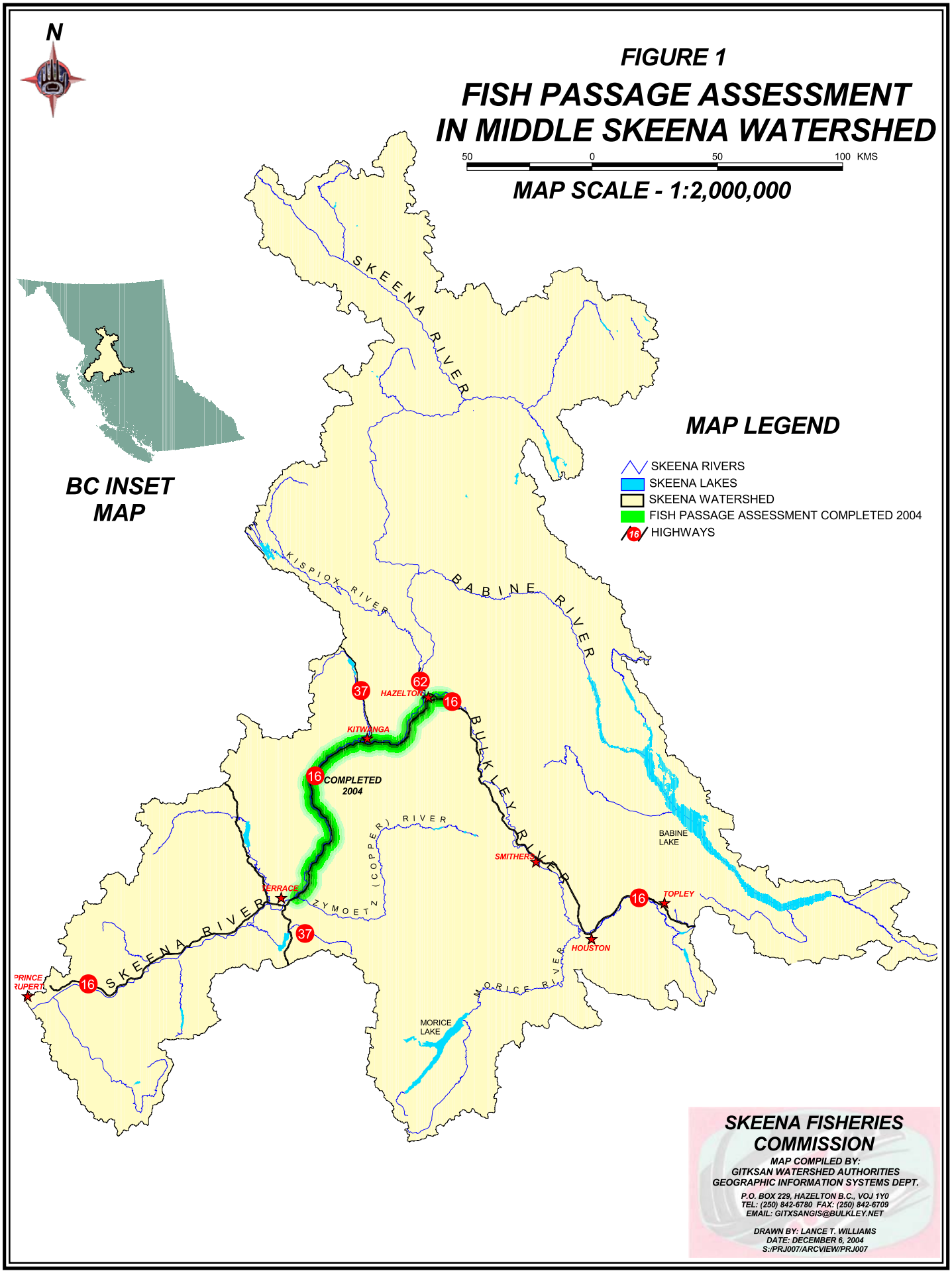
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FIGURE 1
FISH PASSAGE ASSESSMENT IN MIDDLE SKEENA WATERSHED
50 0 50 100 KMS
MAP SCALE - 1:2,000,000
BC INSET MAP
MAP LEGEND
SKEENA RIVERS
SKEENA LAKES
SKEENA WATERSHED
FISH PASSAGE ASSESSMENT COMPLETED 2004
HIGHWAYS
SKEENA RIVER
KISPIOX RIVER
BABINE RIVER
BULKLEY RIVER
COPPER (ZYMOETZ) RIVER
MORICE RIVER
SKEENA RIVER
HAZELTON
KITWANGA
COMPLETED 2004
SMITHERS
TERRACE
HOUSTON
TOPLEY
PRINCE RUPERT
BABINE LAKE
MORICE LAKE
62
37
16
SKEENA FISHERIES COMMISSION
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S:/PRJ007/ARCVIEW/PRJ007

Valley bottom deposits are largely the product of rapid deposition of glacial derived material (fluvio-glacial) during the melting of the last ice sheet about 10,000 years ago. This abundant coarse sediment filled most of the valley to at least several hundred metres. Wide benches (terraces) were cut as the Skeena River cut its way down to the present position, which it reached at least 5,000 years ago. Highway #16 is often located on these terraces. Thin soils, colluvium, and rock outcrops characterize the mountainsides sloping up from the Skeena River and tributaries. On many middle slope positions, a morainal veneer is found while upper areas are dominated by rock and colluvium.

The Skeena River between Terrace and the Bulkley River confluence is characterized as Reach 3 (Resource Analysis Branch 1976). Overall, the Skeena River in this section is a single-thread, slightly sinuous channel, incised into the valley bottom, with a moderately narrow valley floor. From Gitwangak to Cedarvale, the river channel is for the most part comparatively wide. Downstream of Cedarvale, the river carves a generally confined and stable channel to Kitselas Canyon. From Kitselas Canyon downstream to Kitsumkalum River, there are multiple channels and moderate bar development. The average gradient of the river within Reach 3 is 0.001 % with no obstructions to anadromous fish.

Stream channel change on the Skeena mainstem has been relatively slight since the end of the Little Ice Age, approximately 1850, though the Skeena River bed has probably degraded slightly in this time period. There have been minor channel changes from meander movement and bank disturbances from high water events. Channel modifications may also have come about to a minor degree due to rock removal facilitating upriver passage of sternwheel riverboats and log driving activities.

From the south and east, major tributaries draining into this reach of the Skeena River are as follows: Zymoetz (Copper) River, Kleanza Creek, Chimdemash Creek, Legate Creek, Little Oliver Creek, Oliver Creek, Flint Creek, Coyote Creek, Boulder Creek, Price Creek, Shandilla Creek, and Kitseguecla River. With the exception of Copper and Kitseguecla Rivers, most tributaries within the study area are relatively short and steep.

The peak discharges of the major tributaries are typically in May and June due to spring snowmelt. The Skeena tributaries of this portion of the river have much of their watersheds at high elevation and therefore have snow melt peak flows relatively late in the spring. Discharges then decrease until September when fall rains and early snowmelt increase stream flows through October. High stream flows and floods can occur due to rainstorms in the fall (late September to early November). These high stream flows are typically of short duration.

Stream flows decrease through November and December when precipitation most often falls as snow. Discharge continues to decrease until late in the winter, with the annual minimum flow generally occurring from January through March. Summer low flows are typically 4 to 8 times greater than winter stream flows and are sustained principally by high elevation snowmelt, while winter low flows are derived from groundwater, lakes, and unfrozen wetlands. The surrounding glaciated mountains help to maintain moderate summer stream flows. Originating from glaciers, these streams produce moderate amounts of natural sediment that contribute to the wash load eventually deposited in the Skeena Estuary.

Over the years, major storms, floods, and torrents have caused significant changes to tributary streambeds. Every few decades, spring or fall floods cut new channel sections or mobilize sediment wedges and channel bedload, causing significant erosional and depositional features. The spring floods in 1936, 1948, 1972, and the fall flood in 1978 produced some of these effects (Septer and Schwab 1995). For example, following the 1978 flood, fish passage was restricted into many of the tributary streams including Chimdemash Creek, Legate Creek, Oliver Creek,

Coyote Creek and Price Creek, due to the steep-faced gravel fans that occurred at their mouths on the Skeena River.

The tributaries flowing into the Skeena River are for the most part short, high-energy, and steep-gradient streams that level out only in the last kilometre or less, before entering the Skeena. Most of the streams possess stable channels throughout much of their length. However, occasional debris torrents during rainstorm floods may move hundreds of thousands of cubic metres of gravel onto their alluvial fans and into the Skeena River.

Alluvial fan deposits are laid down by creeks and rivers where confined valleys become unconfined and often where smaller steep streams enter wide valleys with a low gradient. The decrease in gradient causes a decrease in stream power, which allows sediment to be deposited, forming an alluvial fan. At any one time, only a small portion of the fan is actively being built up by sedimentation. As sedimentation continues and the height of the channel increases, it becomes unstable since lower areas are located on other parts of the fan. At some point, often during a flood, the channel location will switch to a steeper gradient position and the old channel will be abandoned. This frequent change in channel location and inherent instability is a typical feature of alluvial fans (Gilchrist 1998).

This geomorphologic process is clearly observed at the Highway #16 crossing of Whiskey Creek, which is now trained by rip-rap groins. Highway #16 climbs up the fan to cross Whiskey Creek, then goes downhill to continue along a low river terrace. Similar features are present at or below the highway crossings of Chimdemash, St. Croix, Little Oliver, Oliver, Coyote, Boulder, and Price Creeks. One or more of the Highway #16 alignments constructed since 1952 has negatively affected many of these streams. The trend since the 1970s to place bridges, rather than culverts, over the streams, has facilitated coarse sediment passage and reduced the impacts of the crossings.

FISHERIES RESOURCES

The Middle Skeena Watershed area has high fish values with chinook, pink, sockeye, coho, and chum salmon, and steelhead trout being present to spawn, rear, or migrate. As well, rainbow and cutthroat trout, Dolly Varden, bull trout, kokanee, mountain whitefish, slimy and prickly sculpins, largescale sucker, threespine stickleback, redside shiner, and peamouth chub are also present in the drainage system (DFO 1991b, 1991c). The known sites where sockeye spawn in the Middle Skeena area include the upper reaches of Copper and Kitseguecla Rivers. Kokanee are resident in Kleanza Lake.

Overall, the area has high fish values. Fish distribution, habitat use, and populations are only partly known and documented. In general, the most widely dispersed salmon species is coho, while Dolly Varden, rainbow trout, cutthroat trout, and mountain whitefish are found in most fish bearing waters. Compared to other portions of the Skeena such as the Babine and Kispiox Valleys the Middle Skeena is a relatively moderate producer of salmon.

The fish assemblage of the area provides strong cultural, economic and symbolic linkages, as well as supporting aboriginal, recreational, and commercial fisheries. The presence of salmon is a strong part of cultural and community values and identity within the drainage.

Fish Passage

The movement of fish through culverts can be restricted by many factors including culvert length and gradient, stream levels and velocities, and inlet and outlet configurations. Improper culvert design and installation can block fish passage to spawning and rearing areas such as small streams, lakes, and wetlands.

When adult salmon enter freshwater, the maturing fish stop feeding and rely on energy reserves stored in body fat and protein to carry them through migration and spawning. The rate of sexual maturity is established by heredity and most often cannot adjust to delay (Powers and Orsborn 1985). Barriers that cause excessive delay and/or abnormal energy expenditures can result in pre-spawning mortality.

The direction and length of migration varies with the fish species and life stage, consequently, the necessary timing, frequency, and duration for unimpeded access to required habitats also varies. On a finer scale, juvenile salmonids and resident freshwater species need to freely disperse to find optimal rearing conditions; areas with reduced competition, high quality and low velocity refuge habitat, and fewer predators to ensure their survival.

Restoring fish passage increases the amount of available habitat within a stream system. If habitat abundance is the limiting factor, fish populations will rise in response to increased access to additional habitat. However, the population response to habitat gain is also frequently dependent on numerous other factors, which may include the quality and quantity of new habitat, the nature and abundance of predators, and the presence of competitors.

When impassable culverts are replaced, restoring fish passage may change the transport of sediments, woody debris, and other materials to downstream reaches. This could change the slope or elevations of upstream or downstream channel reaches, as elevation differences are reconciled. These changes, which can lead to both relative positive and negative effects, can affect the aquatic environment by altering habitat preferences and characteristics affecting fish use and behavior.

Consideration of potential changes, especially by flood stage stream flows and sediment transport events, is necessary in the Middle Skeena Watershed due to the topographical and climatic conditions. If fishways are selected as restoration options, routine inspections and maintenance must be recognized as essential parts of the project in order to have success in passing fish over moderate to long time spans.

METHODS

Pre-field Planning

In order to generate a list of structures/streams to assess in the field portion of the project, an office-based overview was compiled and reviewed to identify all non-bridged stream crossings. Data used included highway inventory data, GIS analysis of Terrain Resource Inventory Maps (TRIM), and a compilation of the existing fisheries information using the Fish Information Summary System (FISS). Traditional fisheries knowledge, other fisheries references, and anecdotal material regarding important fish streams in this section of Highway #16 were also rolled into the review. A GIS-based map of Middle Skeena tributaries crossed by Highway #16 between Terrace and Hazelton was created.

Fieldwork

The fish passage culvert inspection methodology is based on the BC Government fish passage protocol outlined in Fish Passage – Culvert Inspection Procedures, (FPCI) (Parker 2000). Essentially, the FPCI fieldwork data collection includes: administrative categories such as stream name, location coordinates, and watershed code; measuring stream and culvert characteristics; noting the fish bearing qualities and quantities; evaluating barriers; and taking upstream and downstream photographs from the culvert inlet and outlet. Stream measurements were taken at distances of 25 m and 50 m so as to avoid the influence of the culvert on stream characteristics.

The following field gear was used to collect stream and culvert characteristic data:

- Culvert length was measured with a Bushnell Yardage Pro laser range finder.
- Culvert and stream widths and depths were measured with a meter stick or tape.
- Stream velocities were measured with a Swoffer 2100 Current Meter.
- Stream and culvert gradients were measured with a Suunto clinometer.
- Location coordinates were recorded with a Garmin 12XL or a Garmin eTrex Summit.
- Photographs were taken with a HP Photosmart R707, 5.1 MP digital camera.
- Stream lengths were measured with a hip chain.

Post-Field

Following completion of the fieldwork, calculations were prepared for each barrier culvert site evaluating the type and degree of obstruction, stream length upstream of the barrier as well as overall length, and the Q100. These calculations were then scored using the criteria in the FPCI (Parker 2000) followed by the prioritization of assessed culverts. Three primary report sections were prepared to describe all stream crossings in text format, in a database, and on 1:50,000 scale maps.

Fish bearing streams receiving the fish passage culvert inspection were prioritized using the FPCI scoring matrix (Parker 2000). The matrix considers fish species present, fish habitat values, barrier type, length of habitat upstream, proportion of stream habitat barred, and the presence of further upstream barriers. In short, prioritization is based on maximizing fish access to habitat segregated by a barrier culvert on Highway #16. The priorities do not take into account sediment movement or maintenance issues. The FPCI scoring matrix can be used to prioritize and to base restoration or rehabilitation efforts on funding availability or other considerations.

Fish species		Habitat value		Barrier		Length of new habitat		Stream barred %		Limiting to upstream barrier	
Multiple or significant	10	H	10	Full	10	≥1 km	10	>70%	10	Yes	5
Single	6	M	6	Partial	6	<1 km	6	51–70%	6	No	0
Other	3	L	3	Underter	3	<500 m	3	<50%	3		

Table 1: FPCI scoring matrix.

Fish species are classed as single, or multiple, or significant, to note the degree of restorative benefits. Information in regard to fisheries values was generated through professional judgement by subjective analysis that included:

- Fish populations and habitat known to be conservation risks or concerns.
- Fish species of Provincial significance; these include species that have been identified provincially as being particularly sensitive to forest harvesting activities (Haas 1998). In the Middle Skeena Watershed, this mostly refers to bull trout (BT), Dolly Varden (DV), and/or cutthroat trout (CT).
- Fish populations and habitat identified by First Nations as being traditionally or contemporarily important.

Habitat value is a subjective rating based on the known value of the stream habitat to be gained and is based on complexity, productivity, and limiting habitats. Different values for different habitat types are based on species preference and known distributions.

The barrier factor is used to give higher priority for sites with more severe obstructions to fish. Barriers are based on outfall drop, culvert water velocity, culvert gradient, and culvert length.

Length of new habitat is the length of potentially restored stream, measured on the 1:20,000 scale map, to the next known barrier using gradient classes to differentiate the fisheries values of different habitat types. Stream barred percent is the length of new habitat divided by the total fish bearing stream length. Limiting to upstream barrier is scored if there is another culvert upstream of the site that has been assessed as a full, partial, or undetermined barrier (Parker 2000).

The relative numerical scores associated with each category are then summed. The ranking of high, moderate, or low is given based on the scoring classes listed below.

- High ranking score 39–55
- Moderate ranking score 26–38
- Low ranking score 15–25

Additionally, a secondary provincial scoring matrix was used in conjunction with the above method. This modified scoring matrix has been previously applied to Highway #37N culvert assessments. Methodology and results are presented in Appendix 5

RESULTS

A total of 256 drainage structures, including 11 bridges, were recorded on Highway #16 between Terrace (commencing at the Highway #16 and Highway #37S junction) and New Hazelton. The fish passage surveys were carried out in September 2004.Twenty-one fish bearing stream reaches crossed by Highway #16 are culverted. Of these twenty-one stream reaches, eleven do not have fish passage issues. Ten culverts are characterized as having fish passage issues, consisting of various types and degrees of barriers along with abundance and value of upstream fish habitat. Of these ten streams, five are rated as high priority. The other five streams are prioritized as low due to a lack of fish distribution and fish habitat information.

Due to past surveys, third order and larger streams at the 1:50,000 scale in the Middle Skeena area have a relatively complete inventory of fish species presence and general habitat values. Information for first and second order creeks is limited and marginal in nature. There are numerous instances of gazetted stream names being applied as local names to other nearby creeks for escapement and surveys efforts. Many first order unnamed tributary streams to Skeena River that are crossed by Highway #16 are not mapped at the 1:20,00 scale.

Previous culvert assessments for sections of Highway #16, Terrace to Hazelton, have been completed by Kontic (1998), Seefried (1998), and Allan (1974). These assessments were not geo-referenced, but utilized driven distance from known landmarks such as roads or major stream crossings; therefore, many of the culverts previously noted were difficult to find.

Map Culvert No.	Stream Name	Comment	Fish Species	Fish Passage Issue	Restoration Site Priority
251	Station Cr, alias Mission Cr	Left bank failure slide into Cr 7m downstream of outlet. Highest priority in the Middle Skeena area to restore.	CO, CM, PK, DV, CT, ST, RB	Yes. Outfall, culvert gradient, and velocity barriers at all flows.	High
26	Singlehurst Creek	Log stream works deteriorating, needs maintenance. Adult coho and pinks observed below culvert.	CO, CT, DV, RB, ST	Yes, if log stream works are not maintained	High
131	Flint Creek	Baffles installed every 4m in culvert.	PK, RB, DV	Yes. Outfall and velocity barriers.	High
180	Shandilla Creek	Juvenile trout observed upstream of culvert. Velocity and outfall drop barriers. Outlet 30 m upstream from Skeena R is backwatered in high flows.	PK, ST, CO, CT, DV	Yes. Outfall and velocity barriers	High
193	Andimaul Cr	Full barrier culvert with 1.25 m outfall drop.	CT, DV, RB, ST	Yes. Outfall barrier at all flows, velocity barrier at high flows.	High
69	Unnamed Stream	0.65m outfall drop, no pool. Recommend fish and fish habitat sampling.	Unknown	Yes	Low
22	Vahalla Cr	Also known locally as Gossen Cr. Water intake adjacent to outlet.	CT and CO suspected	Outfall barrier at all flows	Low.
23	Noble Five Creek	Also known locally as Gossen Cr.	CO suspected	Outfall barrier at all flows, velocity barrier at high flows	Low
28	Unnamed Stream	Culvert inlet is blocked by stumps, sediment and LWD. Backwater is high quality rearing habitat. Culvert is backwatered by Skeena R high flows.	CH, CO, CT, DV	Yes	Low
76	Unnamed Stream	Outfall drop 1.7m, no pool. Old pipe in creek downstream causing bank erosion. Recommend fish and fish habitat sampling.	CO, CAS	Yes, Outfall barrier at all flows.	Low

Table 2: Highway #16 culverts with fish passage issues.

High Priority Fish Passage Sites

Station Creek

Station Creek culvert has been impassable to fish since its installation in 1965, as noted by Bustard (1986) and Pendray (1990). This third order watershed is approximately 12.5 km in length, draining 26.5 km^2 of mountainous and wetlands ground on the northern slope of Hagwilget Peak. Waterfall Creek, the major tributary, is approximately 7 km in length and drains two wetlands to the southeast of New Hazelton. Station Creek drains into Bulkley River 1.5 km upstream of the Skeena River confluence. Water Survey of Canada maintains stream gauge 08EE028 in upper Station Creek.

Station and Waterfall Creeks contain pink salmon (*O. gorbuscha*), coho salmon (*O. kisutch*), steelhead (*O. mykiss*), cutthroat trout (*O. clarkii*), and Dolly Varden char (*Salvelinus malma*) Mitchell (1998). The principal fisheries values in the system are currently located below the highway crossing in Station Creek, but Woloshyn (2004) notes that historically, coho spawners were reported as far upstream as the mid-reaches of Station and Waterfall Creeks in New Hazelton. There are much higher densities of cutthroat trout and Dolly Varden char in the upper sections of Waterfall Creek (Bustard 1986). Bustard indicated that this is due to the highly productive habitat (riffle, pool, cover, etc.) and stable flow regime in this system.

There are three principal barriers to fish access in the system: a rock chute at 0.5 km upstream of Bulkley River that prevents pink salmon movement above it; the highway culvert blocking coho and steelhead movement upstream; and a 20m waterfall on upper Waterfall Creek (Mitchell 1998).

The Station Creek system has been impacted by municipal and industrial concerns and is subject to various diversions of flow. A minimum flow requirement of 0.03m^3/s for Waterfall Creek ensures: sufficient flow for fish passage through culverts; dilution for the secondarily treated sewage effluent discharge; and flows for the fish species known to be present (Mitchell 1998). Waterfall Creek has been channelized alongside the CNR tracks, riparian vegetation has been removed through developed sections of New Hazelton, and there are point and non-point sources of contaminated surface run-off from municipal streets, parking lots, chipper mill, etc. (Mitchell 1998).

Gitxsan Watershed Authorities (2004a) report that Xsan Xsagiibil was a fishing site located at the mouth of Station Creek (Xsi Gwin Sagiiblax). This site was directed to a spring steelhead and fall coho fisheries. Gitxsan Watershed Authorities strongly support fish passage restoration on this system.

Fishery stewardship groups attach significant importance to the fish and fish habitat values of Station Creek system. Since the early 1990s, a consensus-based stewardship program, involving local communities, interest groups, and the Department of Fisheries and Oceans, has operated a hatchery, enumerated returning adult salmon, and operated an adult coho trap that allows removal of brood stock, as well as the capture and transport of live adults to the creek upstream of the impassable Highway #16 culvert. It should be noted that the trap, truck, and enumeration operation is a paid contract by BC Ministry of Transportation to meet fish passage requirements.

Station Creek is the highest priority culvert to rehabilitate on Highway #16 within the Middle Skeena Watershed. As well, it is arguably the highest priority for fish passage in the entire Skeena River drainage. This culvert issue has been noted by DFO as a serious hindrance to fish passage since at least 1975. The culvert is undersized according to Ministry of Transportation guidelines. In the event of an extreme flood, washout of the culvert and/or the adjacent CN Rail line would severely damage fish habitat downstream from the highway. DFO and Ministry of Transportation managers are encouraged to commence serious discussions that are solution orientated in an appropriate timeframe.

Table 3. Station Creek FPCI data

Date	Sept 15 04, Nov 22 04	Stream Name	Station Creek
Road Name	Highway #16	Watershed Code	460-007300
UTM/GPS Location	09 586630 6122416	Recorders Name	LW/KR
1:20 000 Map Sheet	93M.022 .023		
Site Number	251		

Culvert Characteristics	
Culvert Diameter (mm)	1500 mm
Culvert Length (m)	99 m
Culvert Slope (%)	1.8%
Culvert Material	Riveted Multi-Plate
Culvert Water Velocity	Average 3.93 m/s
Culvert Shape	Round
Culvert Wetted Width	120 cm
High Water Mark	150cm
Culvert Water Depth	33 cm
Culvert Outfall Drop	96 cm
Culvert Maintenance	No
Comment	

Stream Characteristics		
Pool Depth at Outfall	120 cm	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	3.95 m	5.7m
Bankfull Width avg	8.9 m	6.8 m
Water Depth avg	27.5 cm	30.5 cm
Bankfull Depth (cm)	43 cm	72.5 cm
Stream Velocity avg	0.58 m/s	0.80 m/s
Stream Gradient (%)	2.5 %	2.5 %
Substrate	Sand/cobble	Gravel/cobble
Fish Habitat Quality	High	High
Beaver Activity/Type	None observed	None observed
Barrier Evaluation:	Full	
Barrier Type	Outfall drop and velocity	
Prescription	Open bottom structure, backwater if necessary	
Comment	Culvert overdue for rehab	

Q100 Estimate	8.93 m/s
Stream Length Above Barrier	9000 m
% Stream Barred	80 %

Fish species		**Habitat value**		**Barrier**		**Length of new habitat**		**Stream barred %**		**Score**
Multiple and Significant	10	H	10	Full	10	≥1 km	10	>70%	10	**50**

Station Creek: inlet downstream

Station Creek: inlet upstream

Station Creek: outlet upstream

Station Creek: outlet downstream

Station Creek: November 22, 2004, view across creek 7 m downstream of outlet.

Station Creek slide initiated by ditchline drainage from Highway #16.

Singlehurst Creek

Singlehurst Creek is one of the most productive coho streams in the Middle Skeena Watershed (Culp 2000). From 1965, when Highway #16 was rerouted, until 1978, the Highway #16 culvert across Singlehurst Creek had a 1.7 m outlet drop that prevented fish migration. DFO installed two timber weirs that created pools and effectively backwatered the culvert (Southgate 1978, Hancock *et al,* 1983). These log and timber stream works need to be renewed (Kontic 1998), as they are deteriorating, and the healthy pink and coho adult migration needs to be ensured of passage.

Singlehurst Creek mainstem is 5.6 km in length, of which, 2.6 km is low gradient, high quality fish habitat. The mainstem is headed by two lakes that ensure a stable flow regime. The watershed is approximately 13 km^2, draining the west slope of Bornite Mountain.

Singlehurst Creek contains chum salmon in the lower reach, coho salmon, even and odd year pink salmon, cutthroat trout, steelhead, rainbow trout, and Dolly Varden char. Taylor (1995) reports a good mix of riffle, pool, and run habitat with an average thalweg depth of 24 cm and a mean gradient of 1.7%. While the culvert does not present any obstruction to adult fish, there is a velocity barrier to juvenile salmon. Because of the highly productive fisheries values in this system, the precautionary approach applies, and rehabilitative stream works are strongly recommended.

Table 4. Singlehurst Creek FPCI data

Date	Sept 14 04	Stream Name	Singlehurst Creek
Road Name	Highway #16		
UTM/GPS Location	09 538510 6050830	Watershed Code	400-232100
1:20 000 Map Sheet	103I.068 .069	Recorders Name	LW/FJ
Site Number	26		

Culvert Characteristics	
Culvert Diameter	2000 mm
Culvert Length	37 m
Culvert Slope	1.8 %
Culvert Material	Riveted Multi Plate
Culvert Velocity avg	1.6 m/s
Culvert Shape	Round
Culvert Wetted Width	120 cm
High Water Mark	79 cm
Culvert Water Depth	41cm
Culvert Outfall Drop	10 cm
Culvert Maintenance	No
Comment	

Stream Characteristics		
Pool Depth at Outfall	77 cm	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	4.2 m	4.1 m
Bankfull Width	8.8 m	4.6 m
Water Depth avg	61.5 cm	22.8 cm
Bankfull Depth	62 cm	21.5 cm
Stream Velocity avg	0.45 m/sec	0.94 m/s
Stream Gradient avg	2.5 %	2.0 %
Substrate	Gravel/cobble	Cobble/gravel

Fish Habitat Quality	High	
Beaver Activity/Type	None Observed	
Barrier Evaluation:	Full if previous rehab works fail	
Barrier Type	Outfall drop	
Prescription	Log stream works need renewal; install rock to backup and strengthen logworks.	
Comment		

Q100 Estimate	7.5 m/s
Stream Length Above Barrier	2400 m
% Stream Barred	80 %

Potential FPCI score if no rehabilitative stream works conducted

Fish species		Habitat value		Barrier		Length of new habitat		Stream barred %		Potential Score
Multiple & significant	10	H	10	Full	10	≥1 km	10	>80%	10	**50**

Singlehurst Creek: Inlet downstream

Singlehurst Creek: Inlet upstream

Singlehurst Creek: Outlet upstream

Singlehurst Creek: Outlet downstream

Singlehurst Creek: Log stream works backwatering culvert.

Singlehurst Creek pink salmon

Singlehurst Creek coho salmon

Shandilla Creek

Shandilla Creek is a fourth order stream at the 1:20,00 scale which drains the northwest slope of Kitseguecla Mountain and portions of unnamed peaks to the west. The drainage is approximately 44.3 km^2 with an elevation range from 205 to 1880 m. Shandilla Creek culvert has been largely impassable to fish since the late 1960s when the present culvert was installed (Allen 1974, Andersen 1979). SKR Consultants (2003) conducted a FPCI procedure and thoroughly reported on the fish passage situation. Anecdotal reports from local old time residents note that the stream supported a fair run of fish in the past. Gitxsan Watershed Authorities (2004b) report that Xsa Andilgan was a fishing and camp site located at the mouth of Shandilla Creek. This site was directed to spring steelhead and fall coho fisheries.

SKR (2003) reports that Shandilla Creek supports pink salmon, coho salmon, chinook salmon, rainbow trout/steelhead, cutthroat trout, and Dolly Varden. There is a total of 520 m of moderate to high quality habitat between the Skeena River and the falls on both East Shandilla and Shandilla Creeks. Of this habitat, the 260 m section in Shandilla Creek between the culvert and the East Shandilla confluence is the most valuable (SKR 2003). At high flows, the Skeena River backwaters the culvert (Williams 2004).

The Highway #16 crossing of Shandilla Creek received a prioritization score of 32, which falls within the moderate ranking score category (SKR 2003). This FPCI process scores the Shandilla crossing as falling into the high priority category due to the weight of traditional fisheries information, as well as current cultural concerns around the pink, coho, and steelhead spawning that could be re-established at Shandilla Creek.

Replacement of the Shandilla Creek culvert with an open bottom structure is recommended in the near term to ensure fish passage. DFO, Ministry of Transportation, and Gitwangak Watershed managers are encouraged to meet and discuss solutions to this outstanding problem.

Table 5: Shandilla Creek FPCI data

Date	Sept 16 04	Stream Name	Shandilla Creek
Road Name	Highway 16		
UTM/GPS Location	9 562494 6105037	Watershed Code	400-372400
1:20 000 Map Sheet	103P.010 93M.001	Recorders Name	LW/GS
Site Number	180		

Culvert Characteristics	
Culvert Diameter	2600 x 4500 mm
Culvert Length	27.4 m
Culvert Slope	4 %
Culvert Material	Multi Plate
Culvert Velocity avg	1.41 m/s
Culvert Shape	Elliptical
Culvert Wetted Width	410 cm
High Water Mark	42 cm
Culvert Water Depth avg	28.6 cm
Culvert Outfall Drop	260 cm
Culvert Maintenance	Low
Comment	Outfall and velocity barrier

Stream Characteristics		
Pool Depth at Outfall	140 cm	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	4.3 m	3.15 m
Bankfull Width avg	4.75 m	6.1 m
Water Depth avg	25 cm	25.2 m
Bankfull Depth avg	60.5 cm	85 cm
Stream Velocity	0.53 m/sec	0.68 m/sec
Stream Gradient	7 %	7 %
Substrate	Boulder/cobble	Boulder/cobble
Fish Habitat Quality	High	Moderate
Beaver Activity/Type	None	None
Barrier Evaluation:	Full	
Barrier Type	Outfall drop and velocity	
Prescription		
Comment		

Q100 Estimate	34.3 m/s
Stream Length Above Barrier	520 m
% Stream Barred	9%

Fish species		**Habitat value**		**Barrier**		**Length of new habitat**		**Stream barred %**		**Gitxsan concerns**		**Score**
Multiple and Significant	10	M	6	Full	10	<500 m	3	<50%	3	High	10	**42**

Shandilla Creek: Inlet upstream

Shandilla Creek: Inlet downstream

Shandilla Creek: Outlet upstream

Shandilla Creek: Outlet downstream

Andimaul Creek

Andimaul Creek is a third order stream at the 1:20,00 scale which drains the northern slope of Kitseguecla Mountain. The drainage is approximately 15.5 km^2 with an elevation range from 206 to 1820 m. Andimaul Creek culvert is a full barrier that has prevented fish passage since the late 1960s when the present culvert was installed. Allen (1974) and Seefried (1998) previously noted the impassable culvert that has an outfall drop of 1.2 m. SKR Consultants (2003) conducted a FPCI procedure and thoroughly reported on the fish passage situation. Gilchrist *et al* (1996) conducted a reconnaissance level inventory of Andimaul Creek fisheries values.

SKR (2003) reports that Andimaul Creek supports rainbow trout/steelhead, cutthroat trout, and Dolly Varden. Allen (1974) reported that "it is believed that steelhead and residents are present." The lower reach of Andimaul Creek is approximately 4.2 km in length with an average gradient of 13%. Upstream of the highway crossing for 900 m, the moderate average gradient is less than 10% with suitable spawning and rearing habitat.

The Highway #16 crossing of Andimaul Creek received a prioritization score of 46, which falls within the highest ranking score category (SKR 2003). Replacement of the Andimaul Creek culvert with an open bottom structure is recommended in the near term to ensure fish passage.

Table 6: Andimaul Creek FPCI data

Date	Sept 16 04	Stream Name	Andimaul Creek
Road Name	Highway 16		
UTM/GPS Location	9 569104 6105799	Watershed Code	400-386100
1:20 000 Map Sheet	93M.001	Recorders Name	LW/GS
Site Number	193		

Culvert Characteristics	
Culvert Diameter	1500 mm
Culvert Length	27 m
Culvert Slope	3 %
Culvert Material	Multi-plate
Culvert Velocity avg	2.6 m/s
Culvert Shape	Round
Culvert Wetted Width	95 cm
High Water Mark	80 cm
Culvert Water Depth	21 cm
Culvert Outfall Drop	125 cm
Culvert Maintenance	None
Comment	

Stream Characteristics		
Pool Depth at Outfall	38 cm	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	3.5 m	3.15 m
Bankfull Width avg	4.75 m	6.1 m
Water Depth avg	24.5 cm	23 cm
Bankfull Depth avg	60.5 cm	85 cm
Stream Velocity avg	0.97 m/s	0.85 m/s
Stream Gradient avg	3.5 %	3.25 %
Substrate	Gravel/cobble	Gravel/cobble
Fish Habitat Quality	High	High
Beaver Activity/Type	None Observed	None Observed
Barrier Evaluation:	Full	Full
Barrier Type	Outfall drop and velocity	
Prescription	Install open bottom structure	
Comment	Culvert rehab overdue to mitigate fish passage	

Q100 Estimate	8.25 m/s
Stream Length Above Barrier	3380 m
% Stream Barred	84 %

Fish species		Habitat value		Barrier		Length of new habitat		Stream barred %		Score
Multiple and Significant	10	M	6	Full	10	≥1 km	10	>70%	10	**46**

Andimaul Creek: Inlet upstream

Andimaul Creek: Inlet downstream

Andimaul Creek: Outlet upstream

Andimaul Creek: Outlet downstream

Flint Creek

Flint Creek is a third order stream at the 1:20,00 scale which drains the western slope of Weeskinshiht Peak southerly ridge. The drainage is approximately 21.2 km^2 with an elevation range from 160 to 2220 m. Allen (1975) noted fish were observed below the impassable falls at 1.5 km and local people are known to catch rainbow trout. The results of the Resource Analysis Branch (1976a) point sample adjacent to Highway 16 showed rainbow trout and an unidentified species electro-shocked. Drewes (2004) reported pink skeletons below the culvert. Resource Analysis Branch (1976b) noted that Dolly Varden are probable up to the impassable waterfall.

Depending on stream stage, the Highway #16 culvert that passes Flint Creek ranges from a partial to full barrier that has prevented fish passage since the present culvert was installed. Flint Creek culvert obstruction includes a velocity barrier for juveniles and at some stages for adults. The outlet drop ranges from 0.3 m to 1.35 m, creating a barrier for both juveniles and adults at various discharge stages. The baffles spaced every 4 m appear to work well, visibly reducing the velocity within the pipe.

The Skeena River is located 180 m downstream of Highway #16 with the average gradient on Flint Creek of 2.5 %. Upstream of Highway #16, Flint Creek is channelized for approximately 50 m, while downstream; the positioned riprap appears to have been displaced. Upstream of the highway, habitat values are considered moderate for approximately 1.3 km until a 16 m waterfall obstructs fish passage.

Gitxsan Watershed Authorities (2004) report that Xsi Ansa Gantxw is a fishing, processing, and camp site located on the left bank terrace at the mouth of Flint Creek. This fishing site is directed to chinook, sockeye, steelhead, coho, and trout fisheries that utilize the adjacent, large back eddy.

The Highway #16 crossing of Flint Creek received a prioritization score of 46, which falls within the highest ranking score category. Replacement of the Flint Creek culvert with an open bottom structure or backwatering the outlet with weirs is recommended in the near term to ensure fish passage.

Table 7: Flint Creek FPCI data

Date	Sept 15 04	Stream Name	Flint Creek
Road Name	Highway 16		
UTM/GPS Location	9 538597 6089971	Watershed Code	400-316300
1:20 000 Map Sheet	103I.099	Recorders Name	LW/GS
Site Number	131		

Culvert Characteristics	
Culvert Diameter	5000 mm
Culvert Length	37 m
Culvert Slope	3 %
Culvert Material	Multi-plate
Culvert Velocity avg	1.1 m/s
Culvert Shape	Round
Culvert Wetted Width	3.74 m
High Water Mark	4.1 m
Culvert Water Depth	38 cm
Culvert Outfall Drop	35 cm
Culvert Maintenance	None
Comment	

Stream Characteristics		
Pool Depth at Outfall	38 cm	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	13.5 m	4.5 m
Bankfull Width avg	15.9 m	9.2 m
Water Depth avg	23.5 cm	42 cm
Bankfull Depth avg	111 cm	121 cm
Stream Velocity avg	0.65 m/s	0.74 m/s
Stream Gradient avg	2.5 %	2 %
Substrate	C/B	C/B
Fish Habitat Quality	High	High
Beaver Activity/Type	None Observed	None Observed
Barrier Evaluation:	Full	Full
Barrier Type	Outfall drop and velocity	
Prescription	Install open bottom structure/establish backwater weirs	
Comment	Culvert rehab overdue to mitigate fish passage	

Q100 Estimate	36.38 m/s
Stream Length Above Barrier	1500 m
% Stream Barred	89 %

Fish species		**Habitat value**		**Barrier**		**Length of new habitat**		**Stream barred %**		**Score**
Multiple and Significant	10	M	6	Full	10	≥1 km	10	>70%	10	**46**

Flint Creek: Inlet upstream

Flint Creek: Inlet downstream

Flint Creek: Outlet upstream

Flint Creek: Outlet downstream

Low Priority Fish Passage Sites

The following five sites are rated as low priority.

Noble Five Creek

Noble Five Creek is a second order stream at the 1:20,00 scale which drains the northwestern slope of Kleanza Mountain. The drainage is approximately 3.1 km^2 with an elevation range from 95 to 1200 m. Culvert map site number is 23. Kontic (1998) noted cutthroat trout were observed upstream of the highway culvert and anecdotal information points to coho spawners in the lower reach. There is an outfall barrier at all flows. Upstream of the Highway #16 impassable culvert, approximately 800 m is considered low-gradient, suitable habitat. A fish and fish habitat assessment is recommended for Nobel Five Creek to record fish and distribution, seasonal flows, and habitat values.

Table 8: Noble Five Creek FPCI data

Date	Sept 15 04	Stream Name	Noble Five Creek
Road Name	Highway 16		
UTM/GPS Location	9 538194 6048835	Watershed Code	400-230200
1:20 000 Map Sheet	103I.099	Recorders Name	LW/FJ
Site Number	23		

Culvert Characteristics	
Culvert Diameter	1200 mm
Culvert Length	34 m
Culvert Slope	1 %
Culvert Material	CMP
Culvert Velocity avg	N/O m/s
Culvert Shape	Round
Culvert Wetted Width	0.99 m
High Water Mark	0.86 m
Culvert Water Depth	65 cm
Culvert Outfall Drop	111 cm
Culvert Maintenance	Mod
Comment	

Stream Characteristics		
Pool Depth at Outfall	94 cm	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	2.45 m	2.18 m
Bankfull Width avg	3.72 m	3.0 m
Water Depth avg	29.5 cm	30 cm
Bankfull Depth avg	28 cm	31 cm
Stream Velocity avg	0.96 m/s	0.87 m/s
Stream Gradient avg	2 %	2.5 %
Substrate	G	G/C
Fish Habitat Quality	High	High
Beaver Activity/Type	None Observed	None Observed
Barrier Evaluation:	Full	Full
Barrier Type	Outfall drop	
Prescription	Install open bottom structure/establish backwater weirs	
Comment	Culvert rehab overdue to mitigate fish passage	

Fish species		Habitat value		Barrier		Length of new habitat		Stream barred %		Score
Significant - CT	10	?	?	Full	10	Unknown		Unknown		**Unknown**

Noble Five Creek: Inlet downstream

Noble Five Creek: Inlet upstream

Noble Five Creek: Outlet downstream

Noble Five Creek: Outlet upstream

Valhalla Creek

Valhalla Creek, also locally known as Gossen Creek, is a second order stream at the 1:20,00 scale which drains the northwestern slope of Kleanza Mountain. The drainage is approximately 2.6 km^2 with an elevation range from 95 to 1200 m. Culvert map site number is 22. Kontic (1998) noted that cutthroat trout were observed downstream of the highway culvert. Anecdotal reports mention coho in the lower reach upstream to Highway #16.There is an outfall barrier at all flows. It is suspected that 530 m of low gradient, suitable habitat exists upstream of Highway #16. A fish and fish habitat assessment is recommended for Valhalla Creek to enable fish usage knowledge, seasonal flows, and habitat values to be clearly stated.

Table 9: Valhalla Creek FPCI data

Date	Sept 15 04	Stream Name	Valhalla Creek
Road Name	Highway 16		
UTM/GPS Location	9 537929 6048488	Watershed Code	400-229444
1:20 000 Map Sheet	103I.058	Recorders Name	LW/FJ
Site Number	23		

Culvert Characteristics	
Culvert Diameter	1000 mm
Culvert Length	48 m
Culvert Slope	1 %
Culvert Material	CMP
Culvert Velocity avg	1.2 m/s
Culvert Shape	Round
Culvert Wetted Width	0.67 m
High Water Mark	0.34 m
Culvert Water Depth	10 cm
Culvert Outfall Drop	125 cm
Culvert Maintenance	N/O
Comment	

Stream Characteristics		
Pool Depth at Outfall	22 cm	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	272 m	1.57 m
Bankfull Width avg	5.75 m	2.85 m
Water Depth avg	8.5 cm	17.5 cm
Bankfull Depth avg	29 cm	55 cm
Stream Velocity avg	0.60 m/s	0.65 m/s
Stream Gradient avg	2 %	2.5 %
Substrate	G/C	G/C
Fish Habitat Quality	High	High
Beaver Activity/Type	None Observed	None Observed
Barrier Evaluation:	Full	Full
Barrier Type	Outfall drop	
Prescription	Install open bottom structure/establish backwater weirs	
Comment	Culvert rehab overdue to mitigate fish passage	

Fish species		**Habitat value**		**Barrier**		**Length of new habitat**		**Stream barred %**		**Score**
Significant - CT	10	?	?	Full	10	Unknown		Unknown		**Unknown**

Valhalla Creek: Inlet upstream

Valhalla Creek: Inlet downstream

Valhalla Creek: Outlet downstream

Valhalla Creek: Outlet upstream

Unnamed Stream–Map Site No. 28

This unnamed stream, alias Skovens Brook, is a relatively small third order stream at the 1:20,00 scale which drains the western slope of Bornite Mountain. The drainage area is approximately 3.9 km^2. Culvert map site number is 28. Kontic (1998) noted chinook and coho juveniles, as well as cutthroat trout upstream of the highway culvert. There is an outfall barrier at all flows, though at Skeena River high to flood stage flows, the river backwaters the culvert. The pool created upstream of and by Highway #16 is excellent habitat. Rehabilitation is not recommended for this fish passage situation. Stream characteristics for above and below the culvert were not recorded due to the configuration of the Skeena River and pond in relation to the culvert.

Unnamed Stream # 28: Inlet downstream

Unnamed Stream # 28: Inlet upstream

Unnamed Stream # 28: Outlet downstream

Unnamed Stream–Map Site No. 69

This unnamed stream is a first order stream at the 1:20,00 scale which drains the western slope of an unnamed mountain. The drainage area is approximately 2.1 km^2. Culvert map site number is 69. Kontic (1998) noted cutthroat trout downstream of the highway culvert. There is an outfall barrier at all flows. Suspected new habitat is estimated at 600 m. A fish and fish habitat assessment for this unnamed creek is recommended to outline fish distribution, seasonal flows, and habitat values.

Table 10: Unnamed Stream–Map Site No. 69

Date	Sept 28 04	Stream Name	Unnamed Creek
Road Name	Highway 16		
UTM/GPS Location	9 547761 6068457	Watershed Code	400-2734
1:20 000 Map Sheet	103I.079	Recorders Name	LW/GS
Map Site Number	69		

Culvert Characteristics	
Culvert Diameter	1500 mm
Culvert Length	38 m
Culvert Slope	1.5 %
Culvert Material	Multi-plate
Culvert Velocity avg	0.49 m/s
Culvert Shape	Round
Culvert Wetted Width	0.34 m
High Water Mark	0.67 m
Culvert Water Depth	9 cm
Culvert Outfall Drop	65 cm
Culvert Maintenance	M
Comment	

Stream Characteristics		
Pool Depth at Outfall	59 cm	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	2.10 m	1.95 m
Bankfull Width avg	2.75 m	2.8 m
Water Depth avg	16 cm	16.5 cm
Bankfull Depth avg	25 cm	29 cm
Stream Velocity avg	0.29 m/s	0.25 m/s
Stream Gradient avg	2 %	3 %
Substrate	G/S	G/S
Fish Habitat Quality	High	High
Beaver Activity/Type	None Observed	None Observed
Barrier Evaluation:	Full	Full
Barrier Type	Outfall drop	
Prescription	Install backwater weirs or open bottom structure	
Comment	Culvert rehab overdue to mitigate fish passage	

Fish species		Habitat value		Barrier		Length of suspected new habitat		Suspected Stream barred %		Score
Significant -CT	10	?	?	Full	10	600 m	6	>70%	10	**Unknown**

Unnamed Stream # 69: Inlet downstream

Unnamed Stream # 69: Inlet upstream

Unnamed Stream #69: Outlet downstream

Unnamed Stream #69: Outlet upstream

Unnamed Stream–Map Site No. 76

This unnamed stream is a small third order stream at the 1:20,00 scale which drains the western slope of an unnamed mountain. The drainage area is approximately 10.6 km^2. Culvert map site number is 76. The creek forks immediately upstream of the highway culvert, with the north fork flowing through four small lakes lying adjacent to the highway. Kontic (1998) noted coho juveniles and sculpins, as well as cutthroat trout downstream of the highway culvert. Suspected high quality suitable habitat, including the four lakes, is approximately 2 km as viewed on the map.

There is an outfall barrier at all flows with a 1.7 m drop. An old culvert lying perpendicular to the channel approximately 9 m downstream of the outlet has caused moderate erosion to the right bank; this situation needs to be remedied. A fish and fish habitat assessment is recommended for this unnamed creek to enable fish use, seasonal flows, and habitat values to be clearly stated.

Table 11: Unnamed Stream–Map Site No. 76

Date	Sept 28 04	Stream Name	Unnamed Creek
Road Name	Highway 16		
UTM/GPS Location	9 547619 6069770	Watershed Code	400-2754
1:20 000 Map Sheet	103I.079	Recorders Name	LW/GS
Site Number	76		

Culvert Characteristics	
Culvert Diameter	1500 mm
Culvert Length	38 m
Culvert Slope	1.5 %
Culvert Material	Multi-plate
Culvert Velocity avg	1.2 m/s
Culvert Shape	Round
Culvert Wetted Width	0.58 m
High Water Mark	0.85 m
Culvert Water Depth	10 cm
Culvert Outfall Drop	170 cm
Culvert Maintenance	M
Comment	

Stream Characteristics		
Pool Depth at Outfall	16 cm	
Measure	Below Culvert Average	Above Culvert Average
Wetted Width avg	2.75 m	1.66 m
Bankfull Width avg	7.0 m	3.0 m
Water Depth avg	7 cm	6 cm
Bankfull Depth avg	33 cm	36 cm
Stream Velocity avg	0.7 m/s	0.49 m/s
Stream Gradient avg	2.5 %	2 %
Substrate	G/C	G/C
Fish Habitat Quality	High	High
Beaver Activity/Type	None Observed	None Observed
Barrier Evaluation:	Full	Full
Barrier Type	Outfall drop	
Prescription	Install backwater weirs	
Comment	Culvert rehab overdue to mitigate fish passage	

Fish species		**Habitat value**		**Barrier**		**Length of new habitat**		**Stream barred %**		**Score**
Multiple – CO, CAS	10	?	?	Full	10	?	?	?	?	**Unknown**

Unnamed Stream # 76: Inlet downstream

Unnamed Stream # 76: Inlet upstream

Unnamed Stream # 76: Outlet downstream

Unnamed Stream # 76: upstream

Recommended Fish and Fish Habitat Assessments

Table 12: Streams Recommended for Fish and Fish Habitat Assessments.

Cul Map No.	Stream Name	Easting	Northing	Fish Habitat Quality Above	Fish Habitat Quality Below	Beaver Active Above Hwy	Beaver Active Below Hwy	Fish Species Presence Recorded	Fish Passage Issue	Restoration Site Priority	Comments
17	Unnamed Stream	536065	6046138	M	H	Yes	N/O	(CO, CT)	No		Juvenile salmon downstream of culvert to Skeena River. Culvert bottom rusting through at inlet. Fish sampling recommended.
18	Fall Creek	536448	6046446	H	M	N/O	N/O	Unknown	Yes		Fish sampling recommended.
21	Unnamed Stream	537822	6048291	N/A	H	Yes	N/O	Unknown	Yes		Fry spotted 30 m below culvert, culvert has 5m beaver guard at upstream inlet. Domestic water supply line 30 m downstream of outlet. Outfall barrier at low flows.
22	Vahalla Cr, local alias Gossen Cr	537929	6048488	H	H	N/O	N/O	CT	Yes	Low	Outfall barrier at all flows.
23	Noble Five Creek	538194	6048835	N/A	H	N/O	N/O	CT	Yes	Low	Outfall barrier at all flows, velocity barrier at high flows.
24	Unnamed Stream	538270	6049019	H	H	N/O	N/O	Unknown	No		
28	Unnamed Stream, alias Skovens Brook	538687	6054571	N/A	N/A	N/O	N/O	CH, CO, CT, DV	Yes	Low	Culvert inlet is blocked by debris. Pool is high quality habitat. Culvert backwatered by Skeena R high flows.
61	Unnamed Stream	547261	6066040	N/A	N/A	Yes	Yes	CT, DV	No		Culvert inlet and outlet submerged, active beavers
68	Unnamed Stream	547782	6068068	N/A	N/A	N/O	N/O	N/A	Unknown		
69	Unnamed Stream	547761	6068457	H	H	N/O	N/O	CT	Yes	Low	Beaver grate blocked by debris. Outfall drop 0.65 m, outfall pool 0.60 m. Recommend fish and fish habitat sampling. Outfall barrier at all flows.
70	Unnamed Stream	547755	6068462	N/A	N/A	N/O	N/O	Unknown	Yes		Outfall drop 0.65 m, no pool. Recommend fish and fish habitat sampling.

Cul Map No.	Stream Name	Easting	Northing	Fish Habitat Quality Above	Fish Habitat Quality Below	Beaver Active Above Hwy	Beaver Active Below Hwy	Fish Species Presence Recorded	Fish Passage Issue	Restoration Site Priority	Comments
76	Unnamed Stream	547619	6069770	H	H	N/O	N/O	Co, Cas	Yes	Low	Outfall drop 1.7 m, negligible pool. Old pipe in creek downstream causing bank erosion. Recommend fish and fish habitat sampling. Out fall barrier at all flows.
87	Unnamed Stream	545396	6075557	N/A	N/A	N/O	N/O	N/A	Yes		High quality habitat upstream of culvert. Recommend fish sampling.
112	Unnamed Stream alias Hells Bells Creek	539724	6083269	M	M	N/O	N/O	N/A	No		LWD trash rack 24m upstream, 30m and 35 m are cascades, downstream outlet is rusting and needs to be replaced. Tailwater control working well. Fish sampling recommended.
160	Unnamed Creek, alias Whiskey Creek	547002	6100116	M	M	N/O	N/O	N/A	Yes		Fish sampling recommended. Partial barrier at some flows.
243	Gershwin Cr	581463	6115799	N/A	H	YES	YES	DV, CT	No		Old beaver guard needs to be removed. Fish sampling recommended.

DISCUSSION

This report presents fish passage issues on Highway #16 that needs to be addressed with restorative action. It is assumed that agency planners and managers involved with transportation and fish share a concern for the well being of the environment.

Our findings indicate the need for restoration or rehabilitation on five streams crossed by Highway #16. The assessment also found five streams with fish passage issues that require fish and fish habitat assessments in order to acquire information that will support valid decision-making. The task of restoring fish habitat at stream crossings involves establishing priorities based on measurable benefits. With limited resources, a focused approach that provides the greatest short and long term benefits to our fish and fish habitat resources is required. For these compelling reasons, Gitxsan Watershed Authorities strongly recommends Station Creek as the highest priority candidate.

The Station Creek fish passage situation has dragged on with no meaningful management actions for many years. In the course of this project, Gitxsan Watershed Authorities heard from various different sectors: public, conservation, and environmental organizations, First Nations leaders, and Government agency staff – that Station Creek fish passage restoration was the prime concern from their perspectives. Gitxsan Watershed Authorities recognizes that considerable investment will be required to modify the existing road and possibly the railway infrastructure, but restoring fish passage will provide long-term benefits to the aboriginal, recreational, and commercial fisheries, as well to the BC Ministry of Transportation.

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Appendix 1 Summary Highway #16 FPCI Information

Cul Map No.	Stream Name	Easting	Northing	Cul Shape	Cul Material	Cul Height (MM)	Cul Width (MM)	Cul Length (M)	Fish Habitat Quality Above	Fish Habitat Quality Below	Beaver Active Above Hwy	Beaver Active Below Hwy	Watershed Code	Fish Species Presence Recorded	Fish Passage Issue	Restoration Site Priority	Comments
1	Drainage	528665	6040558	R	CMP	600	N/A	37	N/A	N/A	NONE	NONE		N/A	N/A		
2	Drainage	528911	6040575	R	CMP	800	N/A	37	N/A	N/A	NONE	NONE		N/A	N/A		
3	Drainage	529239	6040585	R	CMP	900	N/A	37	N/A	N/A	NONE	NONE		N/A	N/A		
4	Drainage	529249	6040558	R	CMP	600	N/A	28	N/A	N/A	NONE	NONE		N/A	N/A		
5	Drainage	529815	6041024	R	CMP	600	N/A	25	N/A	N/A	NONE	NONE		N/A	N/A		
6	Drainage	530186	6041688	R	CMP	600	N/A	25	N/A	N/A	NONE	NONE		N/A	N/A		
7	Drainage	530862	6042660	R	CMP	600	N/A	25	N/A	N/A	NONE	NONE		N/A	N/A		
8	Drainage	531558	6043021	R	CMP	500	N/A	25	N/A	N/A	NONE	NONE		N/A	N/A		
9	Drainage	532585	6043608	R	CMP	900	N/A	25	N/A	N/A	NONE	NONE		N/A	N/A		
10	Drainage	532790	6043649	R	CMP	500	N/A	25	N/A	N/A	NONE	NONE		N/A	N/A		
11	Drainage	532886	6043664	R	CMP	1200	N/A	25	N/A	N/A	NONE	NONE		N/A	N/A		
12	Copper R	533844	6044009	N/A	N/A	N/A	N/A	N/A	H	H	N/A	N/A	440-00000	CO, CH, SK, CM, PK, ST, DV, CT, RB, MW	N/A		Bridged
13	Drainage	534511	6045365	R	CMP	1000	N/A	22	N/A	N/A	NONE	NONE		N/A	N/A		
14	Skeena Backwater	534909	6045541	N/A	N/A		N/A	0	N/A	N/A	NONE	NONE		CT, RB	N/A		Skeena River backwater, no pipe
15	Skeena Backwater	535254	6045728	R	N/A		N/A	0	N/A	N/A	NONE	NONE		N/A	N/A		East end of backwater
16	Drainage	535778	6045967	R	CMP	800	N/A	15	N/A	N/A	NONE	NONE		N/A	N/A		
17	Unnamed Stream	536065	6046138	R	CMP	1200	N/A	34	M	H	YES	NONE		(CO, CT)	NO		Juvenile salmon downstream of culvert to Skeena River. Culvert bottom rusting through at inlet. Fish sampling recommended.
18	Fall Creek	536448	6046446	R	MP	2400	N/A	25	H	M	NONE	NONE	400-225000	UNKNOWN	YES		Fish sampling recommended. Outfall barrier.
19	Drainage	537013	6047014	R	CMP	1200	N/A	72	N/A	N/A	NONE	NONE		N/A	N/A		
20	Drainage	537352	6047531	R	CMP	600	N/A	13	N/A	N/A	NONE	NONE		N/A	N/A		Culvert rim dented 15% and rusting badly
21	Unnamed Stream	537822	6048291	R	CMP	1200	N/A	32	Unknown	H	YES	N/O		N/A	Out fall barrier at low flows		Culvert has 5m beaver guard at upstream inlet.

																	Domestic water supply line 30 m downstream of outlet.
22	Vahalla Cr, local alias Gossan Cr	537929	6048488	R	CMP	1200	N/A	48	H	H	N/O	N/O	400-229444	CT	Outfall barrier at all flows	Low	Domestic water intake 9 m downstream of outlet. Slight bend in culvert.
23	Noble Five Creek	538194	6048835	R	CMP	1200	N/A	34	Unknown	H	N/O	N/O	400-230200	CT,	Outfall barrier at all flows, velocity barrier at high flows	Low	
24	Unnamed Stream	538270	6049019	R	CMP	900	N/A	34	Unknown	H	N/O	N/O		UNKNOWN	NO		
25	Kleanza Creek	538999	60450219	N/A	N/A	N/A	N/A	N/A	H	H	N/O	N/O	400-231800	CH, CO, PK, ST, DV, RB, CT, MW	NO		Bridged. Run of river hydro proposed.
26	Singlehurst Creek, alias Swede Creek	538510	6050830	R	MP	2000	N/A	37	H	H	N/O	N/O	400-232100	CO, CT, DV, (RB, ST)	Yes, if log stream works are not maintained	High	Log works deteriorating, need maintenance. 20 pinks and 3 coho spotted 25 m below culvert, 22 pinks counted from 35m to 25m below culvert
27	Unnamed Stream	538399	6054076	R	MP	900	N/A	45	Unknown	Unknown	N/O	N/O		N/A	N/A		Culvert is beneath highway and usk frontage road
28	Unnamed Stream, alias Skovens Brook	538687	6054571	R	MP	1400	N/A	39	H	N/A	N/O	N/O	400-242300	CH, CO, CT, DV	YES	Low	Culvert inlet is blocked by debris. Pool is high quality habitat. Culvert backwatered by skeena r high flows.
29	Drainage	539647	6056834	R	CMP	600	N/A	19	N/A	N/A	N/O	N/O		N/A	N/A		
30	Chimdemash Cr	540352	6057492	N/A	N/A	N/A	N/A	N/A	H	H	N/O	N/O	400-248400	CO, CT, DV, PK	NO		
31	Drainage	540552	6057586	R	CMP	750	N/A	22	N/A	N/A	N/O	N/O		N/A	N/A		
32	Unnamed Stream	541102	6057818	R	CMP	750	N/A	27	M-H	M-H	N/O	N/O		UNKNOWN	NO		
33	Unnamed Stream	541461	6058031	R	CMP	800	N/A	23	N/A	N/A	N/O	N/O		N/A	N/A		Skeena River is 10 m below

																	culvert, rock bluff/waterfall 2m above culvert
34	Unnamed Stream	541521	6058069	R	CMP	1200		34	N/A	N/A	N/O	N/O			N/A		
35	Drainage	542250	6059816	R	CMP	750	N/A	37	N/A	N/A	N/O	N/O		N/A	N/A		None
36	Mannix Cr	542884	6060589	R	MP	1800	N/A	27	N/A	N/A	N/O	N/O	400-256700	CT, DV, RB	NO		Stream gradient is 35% blow culvert and 75% above culvert
37	Unnamed Stream	543209	6060780	R	MP	1200	N/A	34	N/A	N/A	N/O	N/O			N/A		
38	Unnamed Stream	543400	6060907	R	CMP	750	N/A	27	N/A	N/A	N/O	N/O		N/A	N/A		Creek ends at 25m upstream from culvert and is seepage from a draw.
39	Tumbling Cr	543560	6061146	R	MP	1600	N/A	19	N/A	N/A	NONE	NONE	400-257800	N/A	NO		2m cascades 4m upstream from culvert, 6 m cascades 8m upstream from culvert
40	Ste. Croix Cr	543861	6061522	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NONE	NONE	400-258700	CO, PK, DV	NO		Bridged
41	Unnamed Stream	543944	6061870	R	CMP	1000	N/A	56	N/A	N/A	NONE	NONE			N/A		
42	Drainage	544317	6062863	R	CMP				N/A	N/A	NONE	NONE			N/A		Culvert submerged, no measures.
43	Unnamed Stream	544412	6063587	R	CMP	1600	N/A	25	N/A	N/A	NONE	NONE	400-262000		N/A		
44	Unnamed Stream	544362	6064391	R	CMP	1200	N/A	34	N/A	N/A	NONE	NONE			N/A		
45	Drainage	544479	6064617	R	CMP	600	N/A	27	N/A	N/A	NONE	NONE			N/A		
46	Drainage	544877	6064974	R	CMP	750	N/A	27	N/A	N/A	NONE	NONE		N/A	N/A		
47	Drainage	545061	6065118	R	CMP	650	N/A	25	N/A	N/A	NONE	NONE		N/A	N/A		
48	Drainage	545452	6065327	R	CMP	1250	N/A	43	N/A	N/A	NONE	NONE		N/A	N/A		
49	Drainage	545763	6065363	R	CMP	600	N/A	16	N/A	N/A	NONE	NONE		N/A	N/A		
50	Drainage	545993	6065348	R	CMP	650	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
51	Drainage	546146	6065307	R	CMP	750	N/A	27	N/A	N/A	NONE	NONE		N/A	N/A		
52	Unnamed Stream	546218	6065315	R	CMP	1200	N/A	27	N/A	N/A	NONE	NONE	400-267700	N/A	N/A		
53	Drainage	546307	6065340	R	CMP	700	N/A	34	N/A	N/A	NONE	NONE		N/A	N/A		
54	Unnamed Stream	546444	6065397	R	CMP	750	N/A	27	N/A	N/A	NONE	NONE	400-267900	N/A	N/A		
55	Drainage	546614	6065476	R	CMP	600	N/A	23	N/A	N/A	NONE	NONE		N/A	N/A		
56	Drainage	546721	6065602	R	CMP	800	N/A	18	N/A	N/A	NONE	NONE		N/A	N/A		
57	Unnamed Stream	546787	6065737	R	CMP	1000	N/A	22	N/A	N/A	NONE	NONE	400-268500	N/A	N/A		

58	Unnamed Stream	546924	6065893	R	CMP	??	N/A	??	N/A	N/A	NONE	NONE			N/A		Culvert under Mt. O'Brien debris flow
59	Drainage	547011	6065906	R	CMP	700	N/A	25	N/A	N/A	NONE	NONE		N/A	N/A		
60	Drainage	547170	6065987	R	CMP	200	N/A	22	N/A	N/A	NONE	NONE		N/A	N/A		Submerged
61	Unnamed Stream	547261	6066040	R	CMP	700	N/A	22	Unknown	Unknown	YES	YES	400-269900	CT, DV	NO		Culvert inlet and outlet submerged, active beavers
62	Unnamed Stream	547399	6066194	R	CMP	700	N/A	22	N/A	N/A	NONE	NONE		N/A	N/A		
63	Drainage	547452	6066267	R	CMP	650	N/A	19	N/A	N/A	NONE	NONE		N/A	N/A		
64	Drainage	547463	6066321	R	CMP	600	N/A	18	N/A	N/A	NONE	NONE		N/A	N/A		Submerged
65	Drainage	547548	6066567	R	CMP	600	N/A	22	N/A	N/A	NONE	NONE		N/A	N/A		
66	Drainage	547552	6066574	R	CMP	750	N/A	22	N/A	N/A	NONE	NONE		N/A	N/A		
67	Legate Cr	547728	6067128	N/A	N/A	N/A	N/A	N/A	H	H			400-271000	PK, CO, MW, RB, DV, CAS	NO		Bridged
68	Unnamed Stream	547782	6068068	R	CMP	950	N/A	18	Unknown	Unknown	NONE	NONE		N/A	N/A		None
69	Unnamed Stream	547761	6068457	R	CMP	1100	N/A	27	Unknown	Unknown	NONE	NONE	400-273400	CT	Yes outfall barrier at all flows.	Low	Beaver grate blocked by debris. Outfall drop 0.65 m, outfall pool 0.60 m. Recommend fish and fish habitat sampling.
70	Unnamed Stream	547755	6068462	R	CMP	900	N/A	22	Unknown	Unknown	NONE	NONE	400-273400	UNKNOWN	NO		Outfall drop 0.65 m, no pool. Recommend fish and fish habitat sampling.
71	Drainage	547702	6068631	R	CMP	650	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		Inlet silt and debris causing 60% blockage.
72	Drainage	547605	6068984	R	CMP	650	N/A	22	N/A	N/A	NONE	NONE		N/A	N/A		
73	Drainage	547596	6069243	R	CMP	900	N/A	27	N/A	N/A	NONE	NONE		N/A	N/A		
74	Unnamed Stream	547645	6069582	R	CMP	900	N/A	22	N/A	N/A	NONE	NONE		N/A	N/A		27% gradient to Skeena R with impassable falls.
75	Unnamed Stream	547635	6069625	R	MP	750	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
76	Unnamed Stream	547619	6069770	R	MP	1500	N/A	38	Unknown	Unknown	NONE	NONE	400-275400	CO, CAS	Yes, Outfall barrier at all flows.	Low	Outfall drop 1.7 m, negligible pool. Old pipe in creek downstream causing bank erosion. Recommend fish

																	and fish habitat sampling.
77	Drainage	547514	6070376	R	CMP	600	N/A	18	N/A	N/A	NONE	NONE		N/A	N/A		
78	Drainage	547435	6070674	R	CMP		N/A	9	N/A	N/A	NONE	NONE		N/A	N/A		Submerged
79	Drainage	547401	6070859	R	CMP	1000	N/A	23	N/A	N/A	NONE	NONE		N/A	N/A		
80	Drainage	547279	6071295	R	CMP	550	N/A	20	N/A	N/A	NONE	NONE		N/A	N/A		
81	Drainage	546851	6072145	R	CMP	850	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
82	Little Oliver Cr	546490	6073026	N/A	N/A	N/A	N/A	N/A	H	H			400-281100	CH, CO, DV, RB	NO		Bridged
83	Drainage	546380	6073466	R	CMP	550	N/A	27	N/A	N/A	NONE	NONE		N/A	N/A		
84	Drainage	546337	6073606	R	CMP	650	N/A	37	N/A	N/A	NONE	NONE		N/A	N/A		
85	Oliver Cr	546027	6074452	N/A	N/A	N/A	N/A	N/A	M	H			400-283000	DV, RB	NO		Bridged
86	Drainage	545518	6074844	R	CMP	650	N/A	22	N/A	N/A	NONE	NONE		N/A	N/A		
86A	Unnamed Stream	545288	6075643	R	CMP	1200	N/A	27	N/A	N/A	NONE	NONE		N/A	N/A		
87	Unnamed Stream	545396	6075557	R	CMP	1500		27	Unknown	Unknown	NONE	NONE		N/A	N/A		Potential high quality habitat upstream of culvert. Recommend fish sampling.
88	Drainage	544603	6076003	R	CMP	650	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
89	Drainage	544330	6076159	R	CMP	600	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
90	Drainage	544167	6076299	R	CMP	650	N/A	24	N/A	N/A	NONE	NONE		N/A	N/A		
91	Drainage	543669	6076791	R	CMP	600	N/A	23	N/A	N/A	NONE	NONE		N/A	N/A		
92	Drainage	543391	6077065	R	CMP	700	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
93	Drainage	543077	6077596	R	CMP	600	N/A	19	N/A	N/A	NONE	NONE		N/A	N/A		
94	Unnamed Stream	542901	6078305	R	CMP	1700	N/A	22	N/A	N/A	NONE	NONE	400-293000	N/A	N/A		
95	Drainage	542834	6078382	R	CMP	750	N/A	31	N/A	N/A	NONE	NONE		N/A	N/A		
96	Drainage	542693	6078552	R	CMP	500	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
97	Unnamed Stream	542481	6078817	R	CMP	1500	N/A	34	N/A	N/A	NONE	NONE			N/A		
98	Drainage	542398	6078899	R	CMP	600	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
99	Drainage	542157	6079026	R	CMP	650	N/A	32	N/A	N/A	NONE	NONE		N/A	N/A		
100	Unnamed Stream	541882	6079230	R	CMP	1200	N/A	23	N/A	N/A	NONE	NONE		N/A	N/A		
101	Drainage	541758	6079324	R	CMP	650	N/A	30	N/A	N/A	NONE	NONE		N/A	N/A		
102	Unnamed Stream	541228	6079724	R	CMP	1100	N/A	37	N/A	N/A	NONE	NONE	400-296000	N/A	N/A		
103	Drainage	540468	6080246	R	CMP	550	N/A	25	N/A	N/A	NONE	NONE		N/A	N/A		
104	Drainage	540296	6080553	R	CMP	600	N/A	27	N/A	N/A	NONE	NONE		N/A	N/A		
105	Drainage	540211	6080688	R	CMP	600	N/A	27	N/A	N/A	NONE	NONE		N/A	N/A		
106	Unnamed Stream	540017	6081023	R	CMP	1200	N/A	27	N/A	N/A	NONE	NONE	400-302100	N/A	N/A		
107	Drainage	539904	6081212	R	CMP	600	N/A	27	N/A	N/A	NONE	NONE		N/A	N/A		

108	Drainage	539825	6081620	R	CMP	900	N/A	23	N/A	N/A	NONE	NONE		N/A	N/A		
109	Unnamed Stream	539811	6081920	R	CMP	600	N/A	18	N/A	N/A	NONE	NONE		N/A	N/A		
110	Drainage	539810	6082021	R	CMP	850	N/A	26	N/A	N/A	NONE	NONE		N/A	N/A		
111	Drainage	539793	6082842	R	CMP	800	N/A	18	N/A	N/A	NONE	NONE		N/A	N/A		
112	Hells Bells Creek	539724	6083269	R	MP	3600	N/A	36	M	M	NONE	NONE	400-304500	N/A	NO		LWD trash rack 24m upstream, outlet is rusting needs to be replaced. Tailwater working well. Fish sampling recommended.
113	Drainage	539575	6083826	R	CMP	600	N/A	29	N/A	N/A	NONE	NONE		N/A	N/A		
114	Drainage	539560	6084313	R	CMP	750	N/A	20	N/A	N/A	NONE	NONE		N/A	N/A		
115	Drainage	539632	6084554	R	CMP	650	N/A	28	N/A	N/A	NONE	NONE		N/A	N/A		
116	Drainage	539701	6084688	R	CMP	550	N/A	17	N/A	N/A	NONE	NONE		N/A	N/A		
117	Drainage	539776	6084839	R	CMP	600	N/A	20	N/A	N/A	NONE	NONE		N/A	N/A		
118	Drainage	539839	6085062	R	CMP	800	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
119	Drainage	539863	6085392	R	CMP	600	N/A	19	N/A	N/A	NONE	NONE		N/A	N/A		
120	Drainage	539845	6085534	R	CMP	650	N/A	20	N/A	N/A	NONE	NONE		N/A	N/A		
121	Drainage	539830	6085635	R	CMP	600	N/A	18	N/A	N/A	NONE	NONE		N/A	N/A		
122	Drainage	539812	6085714	R	CMP	600	N/A	18	N/A	N/A	NONE	NONE		N/A	N/A		
123	Drainage	539792	6085801	R	CMP	600	N/A	19	N/A	N/A	NONE	NONE		N/A	N/A		
124	Drainage	539757	6086095	R	CMP	600	N/A	18	N/A	N/A	NONE	NONE		N/A	N/A		
125	Drainage	539746	6086317	R	CMP	550	N/A	20	N/A	N/A	NONE	NONE		N/A	N/A		
126	Drainage	539725	6086426	R	CMP	650	N/A	18	N/A	N/A	NONE	NONE		N/A	N/A		
127	Drainage	539660	6086692	R	CMP	1300	N/A	61	N/A	N/A	NONE	NONE		N/A	N/A		
128	Drainage	539408	6087743	R	CMP	950	N/A	24	N/A	N/A	NONE	NONE		N/A	N/A		
129	Unnamed Stream	539121	6088612	R	CMP	800	N/A	48	N/A	N/A	NONE	NONE		N/A	N/A		
130	Drainage	538996	6088926	R	CMP	550	N/A	27	N/A	N/A	NONE	NONE		N/A	N/A		
131	Flint Creek	538957	6089971	R	MP	5000	N/A	37	M	H	NONE	NONE	400-316300	PK, RB, DV	Yes. Outfall and velocity barriers.	High	Baffles installed every 4 meters inside of culvert.
132	Unnamed Stream	540102	6091446	R	CMP	1000	N/A	39	N/A	N/A	NONE	NONE		N/A	N/A		
133	Unnamed Stream	540767	6091846	R	CMP	650	N/A	20	N/A	N/A	NONE	NONE		N/A	N/A		
134	Drainage	540820	6091925	R	CMP	950	N/A	29	N/A	N/A	NONE	NONE		N/A	N/A		
135	Drainage	541265	6092742	R	CMP	900	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
136	Drainage	541454	6093096	R	CMP	650	N/A	22	N/A	N/A	NONE	NONE		N/A	N/A		
137	Drainage	541568	6093259	R	CMP	650	N/A	32	N/A	N/A	NONE	NONE		N/A	N/A		
138	Drainage	541916	6093673	R	CMP	900	N/A	32	N/A	N/A	NONE	NONE		N/A	N/A		
139	Drainage	541995	6094081	R	CMP	850	N/A	22	N/A	N/A	NONE	NONE		N/A	N/A		
140	Coyote Cr	542333	6094984	N/A	N/A	N/A	N/A	N/A	M-H	M-H	NONE	NONE	400-327900	CM, DV, RB	NO		Bridged
141	Drainage	542723	6095311	R	CMP	600	N/A	24	N/A	N/A	NONE	NONE		N/A	N/A		

142	Drainage	542848	6095469	R	CMP	600	N/A	23	N/A	N/A	NONE	NONE		N/A	N/A		
143	Drainage	542887	6095586	R	CMP	650	N/A	27	N/A	N/A	NONE	NONE		N/A	N/A		
144	Drainage	543059	6096059	R	CMP	550	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
145	Unnamed Stream, alias Pine Cr	543591	6096700	R	CMP	1250	N/A	33	N/A	N/A	NONE	NONE		N/A	N/A		
146	Drainage	543797	6096917	R	CMP	600	N/A	26	N/A	N/A	NONE	NONE		N/A	N/A		
147	Drainage	543949	6097097	R	CMP	850	N/A	26	N/A	N/A	NONE	NONE		N/A	N/A		
148	Drainage	544057	6097215	R	CMP	600	N/A	18	N/A	N/A	NONE	NONE		N/A	N/A		
149	Unnamed Stream, alias Cedarvale Cr	544437	6097504	E	MP	1850	N/A	18	N/A	N/A	NONE	NONE		CT	NO		
150	Drainage	544598	6097612	R	CMP	750	N/A	32	N/A	N/A	NONE	NONE		N/A	N/A		
151	Drainage	545209	6098114	R	CMP	650	N/A	31	N/A	N/A	NONE	NONE		N/A	N/A		
152	Drainage	545350	6098223	R	CMP	500	N/A	25	N/A	N/A	NONE	NONE		N/A	N/A		
153	Drainage	545479	6098313	R	CMP	600	N/A	22	N/A	N/A	NONE	NONE		N/A	N/A		
154	Drainage	545548	6098365	R	CMP	600	N/A	36	N/A	N/A	NONE	NONE		N/A	N/A		
155	Drainage	545609	6098445	R	CMP	550	N/A	32	N/A	N/A	NONE	NONE		N/A	N/A		
156	Drainage	545624	6098472	R	CMP	600	N/A	26	N/A	N/A	NONE	NONE		N/A	N/A		
157	Gull Creek	545819	6098719	R	CMP	1000	N/A	76	N/A	N/A	NONE	NONE		N/A	N/A		
158	Gull Creek	545830	6098718	R	CMP	1200	N/A	76	N/A	N/A	NONE	NONE		N/A	N/A		
159	Drainage	546441	6099920	R	CMP	750	N/A	31	N/A	N/A	NONE	NONE		N/A	N/A		
160	Unnamed Creek, alias Whiskey Creek	547002	6100116	E	MP	5000	3000	27	M	M	NONE	NONE	400-340100	N/A	YES		Fish sampling recommended.
161	Drainage	548422	6101059	R	CMP	600	N/A	17	N/A	N/A	NONE	NONE		N/A	N/A		
162	Unnamed Stream	548648	6101176	R	CMP	900	N/A	17	N/A	N/A	NONE	NONE		N/A	N/A		
163	Drainage	548990	6101359	R	CMP	500	N/A	17	N/A	N/A	NONE	NONE		N/A	N/A		
164	Drainage	549182	6101498	R	CMP	600	N/A	17	N/A	N/A	NONE	NONE		N/A	N/A		
165	Drainage	549302	6101561	R	CMP	650	N/A	20	N/A	N/A	NONE	NONE		N/A	N/A		
166	Drainage	549403	6101610	R	CMP	600	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
167	Drainage	549657	6101784	R	CMP	600	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
168	Drainage	549766	6101873	R	CMP	550	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
169	Drainage	549884	6102023	R	CMP	550	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
170	Drainage	549884	6102023	R	CMP	500	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
171	Drainage	550703	6102896	R	CMP	600	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
171	Unnamed Stream, alias Boulder West Cr	551552	6103384	N/A	N/A	N/A	N/A	N/A	H	H	NONE	NONE	400-351000	CH, DV, RB	NO		Bridged
172	Drainage	552497	6103454	R	CMP	650	N/A	22	N/A	N/A	NONE	NONE		N/A			
173	Unnamed Stream, alias Price Cr	555560	6104755	N/A	N/A	N/A	N/A	N/A	H	H			400-358700	DV, RB, PK	NO		Bridged
174	Drainage	556162	6104683	R	CMP	600	N/A	33	N/A	N/A	NONE	NONE		N/A	N/A		
175	Unnamed Stream	556646	6104902	R	CMP	700	N/A	32	N/A	N/A	NONE	NONE	400-359300	N/A	N/A		

176	Drainage	557829	6105626	R	CMP	1550	N/A	58	N/A	N/A	NONE	NONE		N/A	N/A		
177	Drainage	559153	6105819	R	CMP	650	N/A	32	N/A	N/A	NONE	NONE		N/A	N/A		
178	Drainage	561223	6105190	R	CMP	800	N/A	18	N/A	N/A	NONE	NONE		N/A	N/A		
179	Drainage	561962	6105029	R	CMP	600	N/A	18	N/A	N/A	NONE	NONE		N/A	N/A		
180	Shandilla Creek	562494	6105037	E	MP	2600	4500	30	H	H	NONE	NONE	400-372400	PK, ST, CO, CT, DV	Yes. Outfall and velocity barriers	High	Skeena River 30 m below culvert
181	Drainage	565707	6105744	R	CMP	900	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
182	Drainage	565955	6105763	R	CMP	650	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
183	Drainage	566505	6105753	R	CMP	900	N/A	19	N/A	N/A	NONE	NONE		N/A	N/A		
184	Drainage	567066	6105698	R	CMP	650	N/A	19	N/A	N/A	NONE	NONE		N/A	N/A		Blocked
185	Drainage	567162	6105678	R	CMP	650	N/A	18	N/A	N/A	NONE	NONE		N/A	N/A		
186	Drainage	567371	6105696	R	CMP	600	N/A	18	N/A	N/A	NONE	NONE		N/A	N/A		
187	Drainage	567469	6105718	R	CMP	1000	N/A	20	N/A	N/A	NONE	NONE		N/A	N/A		
188	Drainage	568057	6105739	R	CMP	850	N/A	16	N/A	N/A	NONE	NONE		N/A	N/A		
189	Drainage	568173	6105725	R	CMP	800	N/A	20	N/A	N/A	NONE	NONE		N/A	N/A		
190	Drainage	568454	6105771	R	CMP	1200	N/A	20	N/A	N/A	NONE	NONE		N/A	N/A		
191	Drainage	568580	6105789	R	CMP	650	N/A	20	N/A	N/A	NONE	NONE		N/A	N/A		
192	Drainage	568728	6105796	R	CMP	1000	N/A	20	N/A	N/A	NONE	NONE		N/A			
193	Andimaul Cr	569104	6105799	R	MP	1500	N/A	27	H	H	NONE	NONE	400-383900	CT, DV	Yes. Outfall barrier at all flows	High	
194	Unnamed Stream	570383	6105763	R	CMP	800	N/A	30	N/A	N/A	NONE	NONE	400-386100	N/A	N/A		
195	Unnamed Stream	570873	6105215	R	CMP	1000	N/A	44	H	N/A	YES	N/O	400-388900	N/A	N/A		Beaver dam 7 m upstream of inlet
196	Unnamed Stream	571192	6104933	R	CMP	1500	N/A	48	N/A	N/A	NONE	NONE	400-389200	N/A	N/A		
197	Unnamed Stream	571413	6104831	R	CMP	600	N/A	35	N/A	N/A	NONE	NONE		N/A	N/A		
198	Drainage	571412	6104816	R	CMP	1200	N/A	35	N/A	N/A	NONE	NONE		N/A	N/A		
199	Drainage	571698	6104795	R	CMP	600	N/A	34	N/A	N/A	NONE	NONE		N/A	N/A		
200	Unnamed Stream	572084	6104761	R	CMP	1200	N/A	46	N/A	N/A	NONE	NONE	400-389900	N/A	N/A		
201	Unnamed Stream	572221	6104745	R	CMP	600	N/A	20	N/A	N/A	NONE	NONE		N/A	N/A		
202	Drainage	572419	6104747	R	CMP	600	N/A	18	N/A	N/A	NONE	NONE		N/A	N/A		
203	Drainage	572419	6104750	R	CMP	650	N/A	28	N/A	N/A	NONE	NONE		N/A	N/A		Blocked
204	Drainage	572587	6104778	R	CMP	650	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
205	Unnamed Stream	572665	6104791	R	CMP	1200	N/A	27	N/A	N/A	NONE	NONE	400-391500	N/A	N/A		
206	Drainage	572783	6104811	R	CMP	600	N/A	24	N/A	N/A	NONE	NONE		N/A	N/A		
207	Drainage	573441	6104856	R	CMP	650	N/A	18	N/A	N/A	NONE	NONE		N/A	N/A		
208	Drainage	573533	6104789	R	CMP	600	N/A	26	N/A	N/A	NONE	NONE		N/A	N/A		
209	Unnamed Stream	573792	6104695	R	CMP	600	N/A	26	N/A	N/A	NONE	NONE	400-393300	N/A	N/A		Blocked
210	Drainage	573773	6104694	R	CMP	650	N/A	26	N/A	N/A	NONE	NONE		N/A	N/A		Blocked
211	Drainage	574272	6104871	R	CMP	650	N/A	28	N/A	N/A	NONE	NONE		N/A	N/A		
212	Unnamed	574486	6104996	R	CMP	1200	N/A	32	N/A	N/A	NONE	NONE		N/A	N/A		

	Stream																
213	Unnamed Stream, alias Kits Cr	574891	6105238	R	CMP	1200	N/A	55	N/A	N/A	NONE	NONE		N/A	N/A		
214	Kitseguecla River	575064	6105511	N/A	N/A	N/A	N/A	N/A	H	H			450-000000	CH, CO, CM, SK, PK, ST, DV, MW, RB, CT	NO		Bridged
215	Drainage	575261	6105687	R	CMP	600	N/A	20	N/A	N/A	NONE	NONE		N/A	N/A		
216	Drainage	575439	6105768	R	CMP	650	N/A	31	N/A	N/A	NONE	NONE		N/A	N/A		
217	Drainage	575732	6105906	R	CMP	600	N/A	37	N/A	N/A	NONE	NONE		N/A	N/A		
218	Drainage	576247	6106225	R	CMP	600	N/A	23	N/A	N/A	NONE	NONE		N/A	N/A		
219	Drainage	576377	6106352	R	CMP	600	N/A	27	N/A	N/A	NONE	NONE		N/A	N/A		
220	Drainage	576623	6106609	R	CMP	550	N/A	26	N/A	N/A	NONE	NONE		N/A	N/A		
221	Drainage	577022	6107028	R	CMP	650	N/A	35	N/A	N/A	NONE	NONE		N/A	N/A		
222	Drainage	577149	6107160	R	CMP	600	N/A	33	N/A	N/A	NONE	NONE		N/A	N/A		
223	Drainage	577587	6107620	R	CMP	350	N/A	29	N/A	N/A	NONE	NONE		N/A	N/A		
224	Drainage	577720	6107765	R	CMP	650	N/A	24	N/A	N/A	NONE	NONE		N/A	N/A		
225	Drainage	577825	6107873	R	CMP	650	N/A	32	N/A	N/A	NONE	NONE		N/A	N/A		
226	Drainage	577923	6107972	R	CMP	600	N/A	32	N/A	N/A	NONE	NONE		N/A	N/A		
227	Drainage	578178	6108490	R	CMP	650	N/A	32	N/A	N/A	NONE	NONE		N/A	N/A		
228	Unnamed Stream	578200	6108635	R	CMP	650	N/A	38	N/A	N/A	NONE	NONE		N/A	N/A		
229	Drainage	578199	6109097	R	CMP	650	N/A	26	N/A	N/A	NONE	NONE		N/A	N/A		
230	Drainage	578211	6109357	R	CMP	600	N/A	31	N/A	N/A	NONE	NONE		N/A	N/A		
231	Drainage	578382	6109778	R	CMP	950	N/A	79	N/A	N/A	NONE	NONE		N/A	N/A		
232	Drainage	578490	6110144	R	CMP	650	N/A	31	N/A	N/A	NONE	NONE		N/A	N/A		
233	Unnamed Stream	578575	6110563	R	CMP	900	N/A	31	N/A	N/A	NONE	NONE	400-404800	N/A	N/A		
234	Drainage	578576	6111565	R	CMP	650	N/A	27	N/A	N/A	NONE	NONE		N/A	N/A		
235	Drainage	578567	6111729	R	CMP	650	N/A	27	N/A	N/A	NONE	NONE		N/A	N/A		
236	Drainage	578575	6112248	R	CMP	900	N/A	31	N/A	N/A	NONE	NONE	400-407700	N/A	N/A		
237	Drainage	578588	6112553	R	CMP	650	N/A	31	N/A	N/A	NONE	NONE		N/A	N/A		
238	Drainage	578610	6112715	R	CMP	650	N/A	21	N/A	N/A	NONE	NONE		N/A	N/A		
239	Unnamed Stream	578746	6113154	R	CMP	900	N/A	91	N/A	N/A	NONE	NONE	400-409100	N/A	N/A		
240	Drainage	580050	6114743	R	CMP	650	N/A	24	N/A	N/A	NONE	NONE		N/A	N/A		
241	Drainage	580150	6114839	R	CMP	600	N/A	19	N/A	N/A	NONE	NONE		N/A	N/A		
242	Comeau Cr, aka Carnaby Cr	581262	6115657	R	MP	1600	N/A	38	H	H	NONE	NONE		CO, PK, CM, CH, DV, CT	NO		
243	Gershwin Cr	581463	6115799	R	MP	1600	N/A	27	H	H	YES	YES	400-415300	DV, CT	NO		Old beaver guard needs to be removed. Fish sampling recommended.
244	Unnamed	581915	6116184	R	CMP	600	N/A	20	N/A	N/A	NONE	NONE		N/A	N/A		

	Stream																
245	Drainage	582855	6117332	R	CMP	400	N/A	20	N/A	N/A	NONE	NONE		N/A	N/A		
246	Drainage	584484	6118483	R	CMP	400	N/A	20	N/A	N/A	NONE	NONE		N/A	N/A		
247	Unnamed Stream, alias Seeley Cr	584976	6119005	R	MP	1800	N/A	30	H	H	YES	NONE	400-425900-26200	RB, CT, DV	NO		Creek ends and lake begins at 15m above culvert, trout spotted 12m above culvert, debris gate at upstream inlet of culvert
248	Chicago Creek	585140	6119119	R	MP	1600	N/A	23	H	H	NONE	NONE	400-425900	CM, CO, PK, CT, DV, RB	NO		
249	Unnamed Stream, alias West Cr	585635	6120103	R	CMP	1200	N/A	49	Unknown	Unknown	NONE	NONE	400-427800	N/A	N/A		
250	Unnamed Stream	585587	6121572	R	CMP	450	N/A	22	N/A	N/A	NONE	NONE		(CT, DV)	NO		Blocked
251	Station Cr, alias Mission Cr	586630	6122416	R	MP	1500		99	H	H		NONE	460-007300	CO, CM, PK, DV, CT, ST, RB	Yes. Outfall, culvert gradient, and velocity barriers at all flows	High	Left bank failure slide in creek 7 m downstream of outlet.
252	Drainage	587729	6122646	R	CMP	400	N/A	19	N/A	N/A	NONE	NONE		N/A	N/A		
253	Waterfall Cr	589486	6123137	R	CMP	1100 X 2	N/A	73	H	H	YES	NONE	460-007300-394700	CO, CT, DV, RB, ST	Yes. Waterfall Cr is an trib upstream of the hwy 16 barrier on station cr.	Fish passage will be restored when Station Cr fish passage is ensured.	These two culverts are identical in diameter and length
254	Waterfall Cr	590239	6123160	R	MP	1500	N/A	26	H	H	NONE	NONE	460-007300-394700	CO, CT, DV, RB, ST	Yes. Waterfall Cr is an trib upstream of the Hwy 16 barrier on Station Cr.	Fish passage will be restored when Station Cr fish passage is ensured.	

Appendix 2 Maps

1:50,000 maps submitted under separate cover.

Appendix 3 Culvert Inspection Data Form

CULVERT INSPECTION DATA ENTRY FORM

Date (mm/dd/yy)	/ /	Site Number:	
Assessed by:		Work Unit	
Stream Name		GPS Location	UTM Lat-Long

CULVERT CHARACTERISTICS

Culvert Shape:	Round	Arch	Elliptical	Box	Culvert Material	CMP	Multi-plate	Concrete	Wood
Culvert Size (mm):	Dia./Rise/Height	x	----/Span/Width		Culvert Length (m):				
Culvert embedded	yes / no	%			Culvert Slope	Us	Ds	%	
Culvert Wetted Width (cm):					High Water Mark (cm):				
Culvert Water Depth (cm):					Outfall Drop (cm):				
Culvert Water Velocity (m/s):					Fill Slope Depth (m):				
Culvert Maintenance req'd:	Hi / Mod / Lo / No	Comment:							
Comments									
Site Photo Numbers: Inlet Upstream _____ Outlet Downstream _____ Additional:									

STREAM CHARACTERISTICS

Pool Depth at Outfall (cm):		Sediment Source: Hi / Mod / Lo / No			Comment				
Measure	Below Culvert			Average	Above Culvert			Average	Sketch of Channel
Wetted Width (cm):									Upstream
Water Depth (cm):									
Water Velocity (m/s):									
Bankfull Width (cm):									Downstream
Bankfull Depth (cm):									
Stream Gradient:	Us	Ds	Dist (m)	%	Us	Ds	Dist (m)	%	
Substrate:	Sand / Gravel / Cobble / Boulder			Size (mm)	Sand / Gravel / Cobble / Boulder			Size (mm)	
Fish Habitat Quality:	Hi / Mod / Lo / None				Hi / Mod / Lo / None				
Beaver Activity									
Comments									

Appendix 4 Photographs and Data Tables

Photographs and Data Tables submitted under separate cover.

Appendix 5 Secondary Provincial scoring matrix.

The following text and tables describing this secondary Provincial scoring matrix is from Johnston and Saimoto (2003).

Barrier Severity		Barrier Type (B1 or B2)		Fish Presence Type		Habitat Unit		Species Status	
B1	3	Gradient	Y/N	FP(hist)	3	Species	Sk,Co...	Prov - Red	1.5
B2	1	Velocity	Y/N	SFP1	2	Stream Order	3+, 2, 1	Prov - Blue	1.5
B3	0	Vertical drop	Y/N	SFP2	0.5	Good			
		Drop-Pool	Y/N	FA	0	Moderate		FPC	1.5
		Length	Y/N			Limited		Other	

Appendix 4. Summary of default settings for criteria and priority scoring factors used to ranking sites for their potentially impact on fish and fish habitat.

Appendix 4a. Scoring Factors based on the Severity of Barriers
Appendix 4b. Barrier Criteria used for identifying significant obstructions to fish passage (i.e. "B1" Severity)
Appendix 4c. Barrier criteria used for identifying partial obstructions to fish passage (i.e. "B2" Severity)
Appendix 4d. Scoring Factors for the potentially for fish use upstream of culverts impeding fish passage
Appendix 4e. Habitat Units used to evaluate the quality of fish habitat upstream of culverts based on map interpretation
Appendix 4f. Scoring Factors used to calculate the value of habitat upstream of the culvert dependent on specific species that are either present or suspected present.
Appendix 4g. Scoring Correction Factors based on Species status
Appendix 4h. List of Fish Species and their Species Status in 2002

Appendix 4a. Scoring Factors based on the Severity of Barriers

[Severity of Barrier]	[Code Description]	[Barrier Factor]	[Barrier Factor Description]
B1	A significant obstruction/barrier to upstream fish migration of all age classes and species present or suspected upstream of the culvert (*for details see* Barrier Criteria)	**3**	The default barrier factor for "B1" is 3 to raise immediate attention toward sites that are known to be limiting fish production. This factor is used to differentiate the priority scores for sites where culvert replacements or repairs may be appropriate without further assessment and sites where immediate work will be the most beneficial for fish without additional assessments of fish distribution.
B2	Partial obstruction to fish migration at any time and for any age class of fish present or suspected present upstream of the culvert [*for details see* Barrier Criteria]	**1**	The default barrier factor for "B2" is 1 to help differentiate the high priorities for immediate repair or replacement of culverts at sites from the priorities for more detailed assessments of fish presence, the severity of the obstruction, and the quantity and quality of habitat upstream of the obstruction. Because the severity of partial obstructions is so variable and dependent on a multitude of factors, culverts of this status are grouped together and the habitat value upstream of the culvert becomes the predominant value used to determine priorities for future work (i.e. Fish Presence Factor, Habitat Units, and Species Factors).
B3	No Obstruction to fish migration could be identified if none of the above criteria are met	**0**	This value is 0 and should not be modified. To reduce the number of sites that receive this value, adjustments should be made to [Barrier Criteria]

[Barrier Type]	[Code Description]	[Barrier Criteria]	[Barrier Criteria Description]
B1_GR	Culvert Gradient is a significant Obstruction/Barrier to fish migration [Severity of Barrier] = "B1"	**3%**	The default value is 3% and tries to account for inconsistent gradients through the culvert that may provide some holding areas for fish or if where the water velocity was measured was not representative of the total length of the culvert. Although it is possible that some large adult fish may be able to pass through this gradient if the culvert is not too long, this default value for culvert gradient is considered to obstruct fish passage enough to qualify a site to be "B1" for severity.
B1_VEL	Velocity in culvert is a significant Obstruction/Barrier to fish migration [Severity of Barrier] = "B1"	**2.5 m/sec**	The default value is 2.5 m/s based on average prolonged swimming abilities for adults of the species that were identified during this study (range: 1.8 to 4.2 m/sec, Whyte *et al*. 1997). Water velocity through most of the culverts were measured during only moderate discharge, thus this criteria value intends to recognize that flows may be higher during higher flow conditions. Although the prolonged swimming ability of some species is less than 2.5 m/sec, this value considers the variability of velocity within the entire length of each culvert that often allows burst-swimming capabilities to play a significant role. Although some species may be able to migrate through this velocity (prolonged swimming abilities up to 4.2 m/sec), this default value for velocity is considered to obstruct even stronger swimming fish enough to qualify a site to be "B1" for severity.
B1_DR	Vertical drop from outlet is a barrier if width or diameter of the culvert is < 2 metres [Severity of Barrier] = "B1"	**0.6 m**	The default value is a 0.6 metre drop at the outfall from any culvert less than 2 metres in diameter is a significant obstruction/barrier to juvenile and adult fish migration. Although the maximum jump height for various species is greater than 0.6 metres, this default value is considered to obstruct fish passage enough to qualify a site to be "B1" for severity regardless of the pool depth. Detailed reviews of the severity of these drops should be conducted on all sites with culvert size greater than or equal to 2 metres.
B1_D-P	Drop – pool depth at the outlet of a culvert is a significant Obstruction/ Barrier to fish migration if width or diameter of culvert is <1.5 metres [Severity of Barrier] = "B1"	**0.3 m**	The default value is >0.3 since a drop of less height than the criteria for "B_DR" from a relatively small culvert will obstruct fish passage enough to qualify a site to be "B1" (i.e a significant obstruction). Detailed reviews of the severity of drops should be conducted on all sites with culvert size greater than or equal to 1.5 metres.
B1_Lgth	Length of culvert	**45**	The default value is 45 metres to ensure that attention is given to all long culverts regardless of drop from the outlet or gradient.

Appendix 4b. Barrier Criteria used for identifying significant obstructions to fish passage (i.e. "B1" Severity)

Appendix 4c. Barrier criteria used for identifying partial obstructions to fish passage (i.e. "B2" Severity)

[Barrier Type]	[Code Description]	[Barrier Criteria]	[Barrier Criteria Description]
B2_GR	Culvert Gradient is suspected to be a partial obstruction to juvenile and/or adult fish migration if width or diameter of culvert is < 2 metres [Severity of Barrier] = "B2"	2%	The default value is 2% to identify where migration by juvenile and some adult species is being significantly obstructed. This criteria value is set to ensure that even minor obstructions are considered for future attention. The priority for attention at these sites will be based mostly on the quality and quantity of habitat upstream of the culvert.
B2_VEL	Culvert Velocity Gradient is suspected to be a partial obstruction to juvenile and/or adult fish migration if width or diameter of culvert is < 2 metres [Severity of Barrier] = "B2"	**1 m/sec**	The default value is 1 m/sec based on estimated prolonged swimming abilities for juvenile adults of the species that were identified during this study. Water velocity through most of the culverts were measured during only moderate discharge, thus this value intends to recognize that flows may be higher during higher flow conditions. Although the prolonged swimming ability by juveniles of some species is less than 1 m/sec, the criteria value considers the variability of velocity within the entire length of each culvert that often allows burst-swimming capabilities to play a significant role in fish passage. This criteria value is set to ensure that even minor obstructions are considered for future attention based on the quality and quantity of habitat upstream of the culvert.
B2_D-P	Drop – pool depth at the outlet of a culvert is considered to be a Partial Obstruction/ Barrier to fish migration if width or diameter of culvert is <1.5 metres [Severity of Barrier] = "B2"	**>0.15**	The default value is 0.15 metres to allow this scoring matrix to identify minor obstructions to fish passage. This criteria value is set to ensure that even minor obstructions are considered for future attention based on the quality and quantity of habitat upstream of the culvert.
B2_LGTH	Length of culvert if width or diameter is <2 metres [Severity of Barrier] = "B2"	**35**	The default value is for culverts >35 metres long to ensure that sites with very long lengths of culvert are considered when priorities for culvert replacement or maintenance are being reviewed. This criteria value is set to ensure that no potentially obstructions to fish passage are ignored.

Appendix 4d. Scoring Factors for the potentially for fish use upstream of culverts impeding fish passage

[Fish Presence Type]	[Code Description]	[Fish Presence Factor]
FP	Fish Present based on Historical Records	**3**
SFP1	Fish Suspected based on reach gradient < 10%)	**2**
SFP2	Fish Suspected based on Gradient 10-20%, or potentially barrier downstream	**0.5**
FA	Fish Absent based on Historical Records, or reach gradient > 20%)	**0**

Appendix 4e. Habitat Units used to evaluate quality of habitat upstream of culverts based on map interpretation

[Habitat Unit]	[Code Description]	[Map Gradient Criteria]	[Description of Map Gradient Criteria]
≥ 3rd order streams			
3_G	Good Quality, Suitable Habitat	<5	Good: 5% units are used due to their easy identification based on 20m contours on TRIM
3_M	Moderate Quality, Suitable Habitat	5-10	Moderate: Considered moderate due to the significantly lower quantity and quality of rearing habitat present as stream gradient increases.
3_L	Limited Quality due to Gradient	10-20	Low: designated to sections of stream with 10-20% gradient sections or sections upstream of a likely obstruction to fish passage based on airphoto and TRIM map interpretation
2nd order streams			
2_G	Good Quality, Suitable Habitat	<5	Good: 5% units are used due to their easy identification based on 20m contours on TRIM
2_M	Moderate Quality, Suitable Habitat	5-10	Moderate: Considered moderate due to the significantly lower quantity and quality of rearing habitat present as stream gradient increases.
2_L	Limited Quality due to Gradient	10-20	Low: designated to sections of stream with 10-20% gradient sections or sections upstream of a likely obstruction to fish passage based on airphoto and TRIM map interpretation
1st order streams			
1_G	Good Quality, Suitable Habitat	<5	Good: 5% units are used due to their easy identification based on 20m contours on TRIM
1_M	Moderate Quality, Suitable Habitat	5-10	Moderate: Considered moderate due to the significantly lower quantity and quality of rearing habitat present as stream gradient increases.
1_L	Limited Quality due to Gradient	10-20	Low: designated to sections of stream with 10-20% gradient sections or sections upstream of a likely obstruction to fish passage based on airphoto and TRIM map interpretation

Appendix 4f. Scoring Factors used to calculate the value of habitat upstream of the culvert dependent on specific species that are either present or suspected present.

[Species Code]	[Habitat Species Factor] *(default settings)*								
	≥ 3rd order streams			***2nd order streams***			***1st order streams***		
	3_G	3_M	3_L	2_G	2_M	2_L	1_G	1_M	1_L
BT	**3**	**2**	**1**	**1**	**0.5**	**0.25**	**0**	**0**	**0**
CH	**3**	**1**	**0**	**.05**	**0**	**0**	**0**	**0**	**0**
CM	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
CO	**3**	**2**	**0**	**3**	**1**	**0.5**	**1**	**0.5**	**0.25**
CT_C	**3**	**2**	**1**	**3**	**2**	**1**	**1**	**0.5**	**0.25**
CT	**3**	**2**	**1**	**3**	**2**	**1**	**1**	**0.5**	**0.25**
DV	**3**	**2**	**1**	**3**	**2**	**1**	**1**	**0.5**	**0.25**
GR	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
MW	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
PK	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
RB	**3**	**2**	**1**	**3**	**2**	**0.5**	**1**	**0.5**	**0.1**
SK	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
ST	**3**	**2**	**1**	**3**	**2**	**0.5**	**1**	**0.5**	**0.1**
ST_NS	**3**	**2**	**1**	**3**	**2**	**0.5**	**1**	**0.5**	**0.1**
RB/CT	**3**	**2**	**1**	**3**	**2**	**1**	**1**	**0.5**	**0.25**
RB/ST	**3**	**2**	**1**	**3**	**2**	**0.5**	**1**	**0.5**	**0.1**

Appendix 4h. List of Fish Species and their Species Status in 2002

[Species Code]	[Code Description]	[Species Status]	[Description of Species Status]
BT	Bull trout	PS_B	Species Status is set as "PS_B" based on 2002 status
CH	Chinook Salmon	FPC	Species Status is set as "FPC" based on 2002 status
CM	Chum Salmon	FPC	Species Status is set as "FPC" based on 2002 status
CO	Coho Salmon	FPC	Species Status is set as "FPC" based on 2002 status
CT_C	Coastal Cutthroat	PS_B	Species Status is set as "PS_B" based on 2002 status
CT	Cutthroat trout	PS_B	Species Status is set as "PS_B" based on 2002 status
DV	Dolly Varden char	PS_B	Species Status is set as "PS_B" based on 2002 status
GR	Arctic Grayling	PS_B	Species Status is set as "PS_B" based on 2002 status
MW	Mountain Whitefish	FPC	Species Status is set as "FPC" based on 2002 status
PK	Pink Salmon	FPC	Species Status is set as "FPC" based on 2002 status
RB	Rainbow trout	FPC	Species Status is set as "FPC" based on 2002 status
SK	Sockeye Salmon	FPC	Species Status is set as "FPC" based on 2002 status
ST	Steelhead trout	FPC	Species Status is set as "FPC" based on 2002 status
ST_NS	Nass River Summer Run Steelhead	RS	Species Status is set as "FPC" based on 2002 status
RB/CT	Species not distinguished	FPC	Species Status is set as "FPC" based on 2002 status
RB/ST	Species not distinguished	FPC	Species Status is set as "FPC" based on 2002 status
_____	Other species can be entered		Species Status is designated during data entry

Appendix 4g. Scoring Correction Factors based on Species status

[Species Status]	[Code Description]	[Species Correction Factor]	[Factor Description]
PS_R	Provincially Significant Red listed	1.5	
PS_B	Provincially Significant Blue listed	1.33	
RS	Region Significant	1.33	
FPC	Forest Practice Code Listed Species	1	
Other	Not Forest Practice Code Listed	0	

All salmonids are given the same value (1.5) in this study.