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True North Gems - Culvert/Stream Crossings Report

Prepared for:

True North Gems
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Vancouver, BC
V6B 1P2

Prepared by:

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FSC Project No. 2005-0550
June 06, 2005

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Our file: 2005-0550
June 06, 2005

Bonnie Pemberton, GIT, G.G.
Project Coordinator, True North Gems Inc.
500-602 West Hastings Street
Vancouver, BC V6B 1P2

Dear Bonnie:

We have completed the assessment and design of the culvert crossings.

We estimated the size of the watershed from topographical mapping (Lake Harbour 25K/13, 1989) as 8.6 square kilometers. Climate normals for snow and rain fall were taken from Environment Canada for the closest station, Iqaluit. A runoff hydrograph was determined using Soil Conservation Service (SCS) approach corrected for freezing conditions in the watershed from November to April.

We determined the culvert size from standard culvert design models and determined a culvert diameter of 1.893 m. We understand that fisheries' requirements would see the bottom of the culvert embedded in the streambed to at least 40% of the culvert diameter. Therefore, the two (2) 1000mm diameter culverts, you have proposed, at each stream crossing would be appropriate to meet the flood requirements on the watershed and the fisheries' requirements. The culverts should be installed in the streambed at a grade less than 0.5%.

We arrived at a culvert length of 13 m based on a road width of 5m, sideslope of 3:1, culvert top cover of at least 500mm and allowance of 500 mm for rip rap either ends of the culverts.

We have sent you by email the following:

- Climate Normal Data;
- Peak Flood SCS Method;
- Culvert Design calculations; plus
- Stream Crossing Guidelines; and
- A Project Description Form provided by DFO.

Please contact me if we can provide you with additional assistance.

Yours truly,

Kevin Hodgins, P. Eng.
Principal

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Culvert Design

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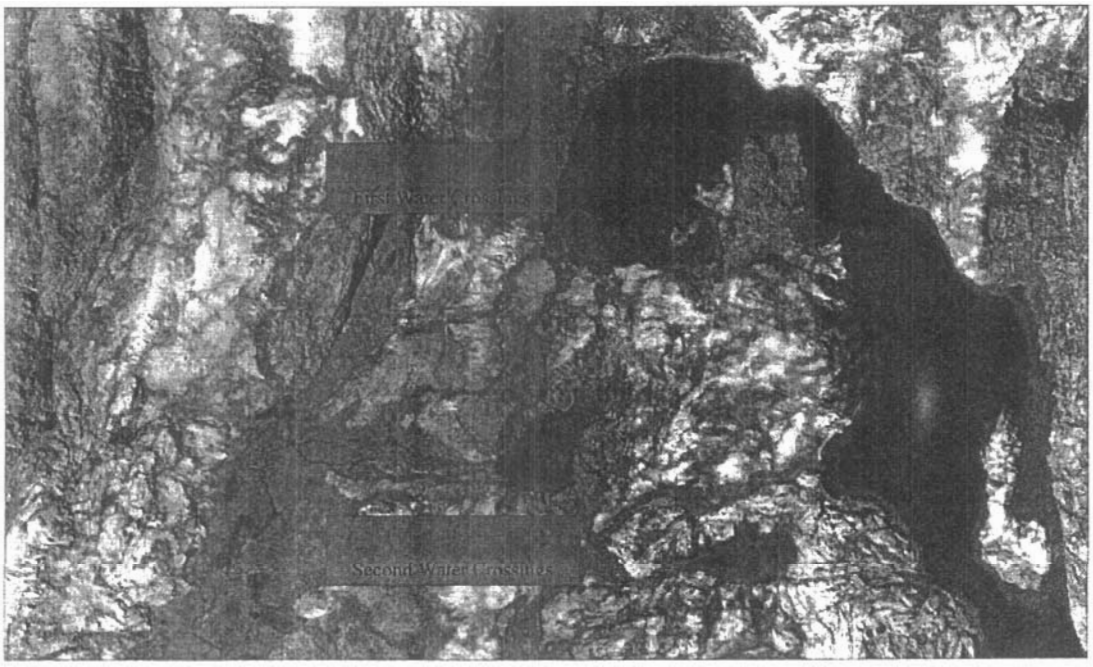
1. PROJECT BACKGROUND

FSC was retained by True North Gems Inc. for engineering services for the design of culverts and assistance in attaining approvals of the Nunavut Impact /Review Board (NIRB) and the Nunavut Water Board) for the access road servicing the sapphire discovery in the vicinity of Kimmirut Nunavut.

2. SETTING

The two proposed crossings occupy the low ground at and below lake level in the region before the upslope in the distance as shown.



This air photo was taken looking south southwest towards the Beluga sapphire deposit on the skyline, from the existing road out of Kimmirut.

The upland surface is generally arid and well-drained in character, underlain by porous carbonate rocks, and covered by negligible soil, mostly thin detrital regolith. The Hamlet of Kimmirut maintains a borrow-pit or municipal quarry for road mettle in these same carbonate rocks. That source would provide the construction material available locally for any elevated running surface.

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3. CULVERT DESIGN

3.1 RUNOFF

Runoff is that fraction of the rainfall that moves over the surface or through the soil toward surface water features (ponds, lakes, streams, rivers, *etc.*). For most purposes, runoff refers to surface runoff only. Runoff occurs when the rainfall exceeds the demands of interception, evaporation, infiltration, and surface storage.

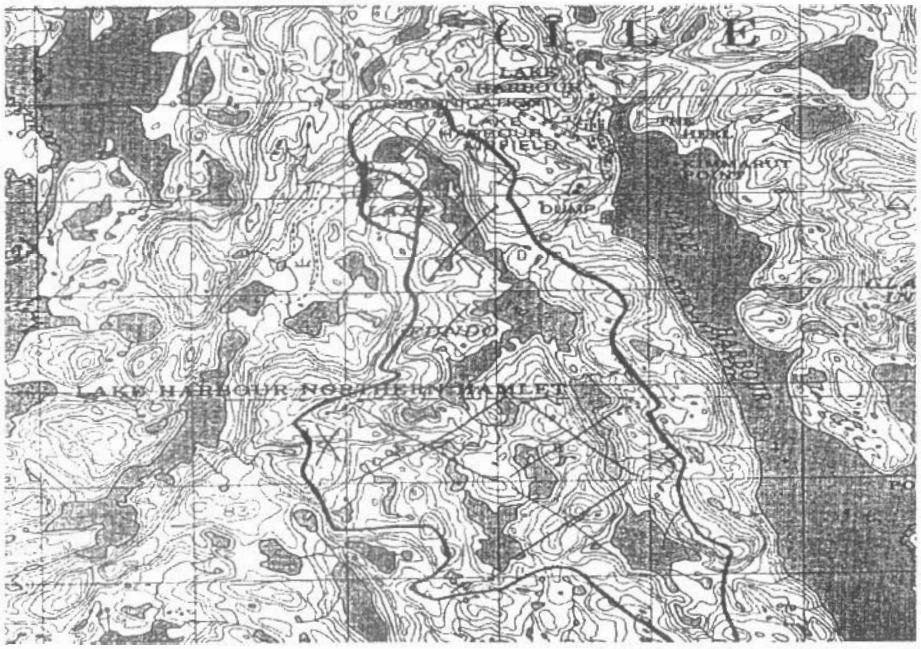
In this setting, spring freshet would exceed storm runoff.

3.2 CLIMATE NORMALS

Climate normals for snow and rain fall shown in Appendix 1, were taken from Environment Canada for the closest station, Iqaluit.

3.3 WATERSHED

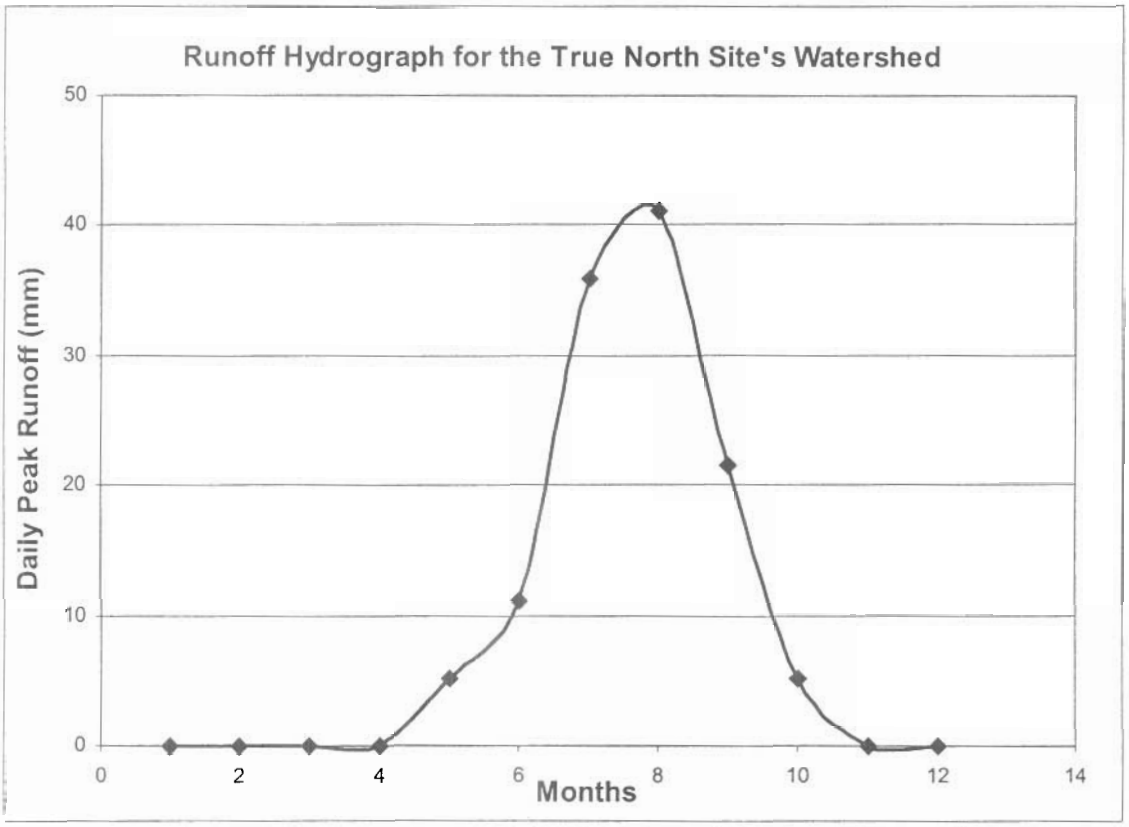
We estimated the size of the watershed from topographical mapping (Lake Harbour 25K/13, 1989) as 8.6 square kilometers.



3.4 HYDROGRAPH

The common approaches for deriving flood hydrographs are Rational Method, Regional Approach and the Soil Conservation Service (SCS) method. The rational method is only applicable for watersheds having surface area less than 150 hectares. The regional approach (commonly used in British Columbia and other locations with relatively uniform hydrogeology) is not applicable to the north, where hydrology is largely diverse. An appropriate approach for this project is the Soil Conservation Service (SCS) approach.

A runoff hydrograph for the watershed was determined using the SCS approach corrected for freezing conditions in the watershed from November to April. Maximum runoff and Extreme Snow Depth values were used in the computation to provide for worst-case scenarios.



3.5 CULVERT CALCULATIONS

The culvert size was determined from standard culvert design models shown in Appendix 2. The minimum culvert diameter required is 1.893 m. A culvert consisting of 2x1000mm diameter pipes will be sufficient to contain the peak runoffs from the watershed.

The Stream Crossing Guidelines (Appendix 3) requires that for a circular culvert, culvert embedment (bottom of culvert covered with gravel) should make up at least 40% of the culvert diameter. This requirement reduces the effective culvert diameter available for transporting the surface runoff and imposes additional requirement of close to twice the culvert dimensions originally required.

Therefore, the 2x1000mm culverts you have proposed at each crossing would be appropriate. The culvert should be installed in the streambed at a grade less than 0.5%.

4. FISHERIES REQUIREMENTS

We contacted Derrick Moggy, Habitat Management Biologist, Fisheries & Oceans Canada Eastern Arctic Area, Iqaluit. He provided the appended information in stream crossing guidelines. Mr. Moggy advised that Nunavut did not have specific criteria; the BC guidelines would be appropriate.

Specific guidance that directly affects this project is detailed in section 3 of that guideline.

Also provided is project form that should be completed and submitted to DFO. Although the form is for the lower Fraser Valley, it should be modified for this project.

Mr. Moggy advised that if the latitudes and longitudes of the stream crossing were provided, DFO would check to see if they have any fisheries information. The local Hunter's and Trappers Organization (Mayukalik Hunters' and Trappers' Association, P.O. Box 99, Kimmirut, NU, XOA ONO, Telephone (867) 939-2355) may have some information as well.

Mr. Moggy requested that pictures be provided of the crossings, as soon as possible, so they can determine whether a fisheries consultant will be necessary to investigate the streams for further

Meeting these fisheries requirements should be sufficient for the NIRB/NWB process.

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APPENDIX 1 – Climate Normals

Canadian Climate Normals from Environment Canada

Temperature: Temperature:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily Average (°C)	-26.6	-28	-23.7	-14.8	-4.4	3.6	7.7	6.8	2.2	-4.9	-12.8	-22.7
Standard Deviation	5	3.8	3.7	2.6	2.1	1.7	1	0.9	1.1	2.5	3.6	4.7
Daily Maximum (°C)	-22.5	-23.8	-18.8	-9.9	-0.9	6.8	11.6	10.3	4.7	-2	-8.9	-18.5
Daily Minimum (°C)	-30.6	-32.2	-28.6	-19.6	-7.8	0.3	3.7	3.3	-0.4	-7.7	-16.7	-26.9
Extreme Maximum (°C)	3.9	4.4	3.9	7.2	13.3	21.7	**25.8**	25.5	17.2	7.3	5.6	3.4
Date (yyyy/dd)	1958/21	1965/22	1955/19	1981/23	1954/30	55/22+	**2001/28**	1991/08	64/03+	1981/05	1952/19	2001/29
Extreme Minimum (°C)	-45	**-45.6**	-44.7	-34.2	-26.1	-10.2	-2.8	-2.5	-12.8	-27.1	-36.2	-43.4
Date (yyyy/dd)	1953/24+	**1967/10+**	1991/01	1983/10	1949/02	978/02	1961/03	1996/31	965/30	1978/30	1978/18+	1993/30
Precipitation: Precipitation:												
Rainfall (mm)	0.1	0	0	0.2	2.8	24.7	59.2	64.8	41.5	4.5	0.5	0
Snowfall (cm)	22.8	16.8	25.3	32.4	25.1	9.8	0.1	0.8	13.7	34.9	32.4	21.7
Precipitation (mm)	21.1	15	21.8	28.2	26.9	35	59.4	65.7	55	36.7	29.1	18.2
Average Snow Depth (cm)	22	23	25	29	18	2	0	0	0	6	16	20
Median Snow Depth (cm)	21	23	25	28	16	1	0	0	0	6	15	19
Snow Depth at Month-end (cm	23	25	29	27	10	0	0	0	1	10	21	21
Extreme Daily Rainfall (mm)	2.5	2	0.5	5.1	11.7	28.4	**52.8**	48.2	40.4	23.3	11.9	0.5
Date (yyyy/dd)	1958/21	1963/03	1958/09	1950/20	1986/14	961/30	**1968/14**	1995/08	979/01	1985/24	1955/01	1963/16
Extreme Daily Snowfall (cm)	30.7	**32.2**	24.6	21.8	29.5	19.2	3.6	6.2	21.3	20.6	27.9	21.8
Date (yyyy/dd)	1958/18	**1981/12**	1973/08	1973/07	1965/09	984/09	1970/08	1981/29	946/26	1961/08	1960/24	1951/03
Extreme Daily Precipitation (n	30.7	27.4	23.9	23.9	27.4	30.2	**52.8**	48.2	40.4	27.2	27.9	21.8
Date (yyyy/dd)	1958/18	1981/12	1953/29	1973/07	1965/09	980/06	**1968/14**	1995/08	979/01	1985/25	1960/24	1951/03
Extreme Snow Depth (cm)	57	74	69	**86**	86	43	1	3	15	33	52	48
Date (yyyy/dd)	1977/15+	1956/27	1963/01+	**1958/30**	1958/01+	987/02	1978/01+	1957/24+	992/29	1961/29+	1989/27	1958/23

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APPENDIX 2 – Hydrograph & Culvert Spreadsheets

Rainfall, Snowfall and Precipitation Data - From Canadian Climate Normals (1971-2000) - Environment Canada

Month	Peak Daily Rainfall	Peak Daily Snowfall	Peak Daily Precipitation	Extreme Snow Depth
Jan	0.10	22.80	21.10	57.00
Feb	0.00	16.80	15.00	74.00
March	0.00	25.30	21.80	69.00
April	0.20	32.40	28.20	86.00
May	2.80	25.10	26.90	86.00
June	24.70	9.80	35.00	43.00
July	59.20	0.10	59.40	1.00
August	64.80	0.80	65.70	3.00
September	41.50	13.70	55.00	15.00
October	4.50	34.90	36.70	33.00
November	0.50	32.40	29.10	52.00
December	0.00	21.70	18.20	48.00

Rainfall Summer months = 193.00 (for snowmelt distr. in summer months; extreme Snow Depth used for worst case)

Runoff Estimates using Soil Conservation Service (SCS) 1972) Approach

Snowmelt/spring runoff (distribution of summer months) = 10cm of snow produces 1mm of water

Curve Number, CN = 70 WS. Max. Ret. S = 108.8571

Month	Rainfall	Runoff from SCS Estimates	Snowmelt Contribution	Total Runoff
Jan	0.10	0.00	0.00	0.00
Feb	0.00	0.00	0.00	0.00
March	0.00	0.00	0.00	0.00
April	0.20	0.00	0.00	0.00
May	2.80	4.00	1.25	5.25
June	24.70	0.08	11.01	11.08
July	59.20	9.58	26.38	35.96
August	64.80	12.19	28.87	41.06
September	41.50	3.03	18.49	21.52
October	4.50	3.26	2.01	5.26
November	0.50	0.00	0.00	0.00
December	0.00	0.00	0.00	0.00

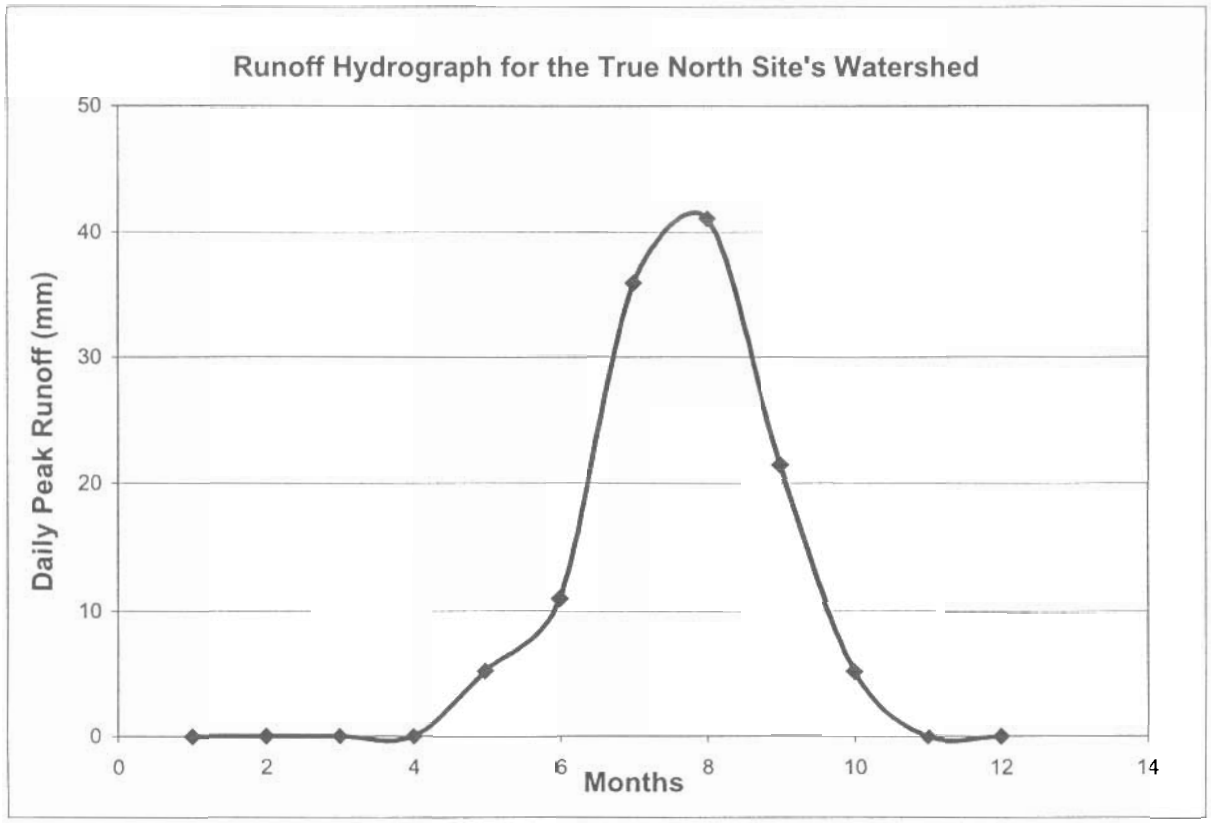
Design Flow, Q:

Peak Runoff, 41.06 (depth per unit area)

Design Flow, K.A

Area of watershed, A 8.6 km2

Q = 353154.0218 m3/day
4.087430808 m3/s



Culvert

True North Culvert Design Project

TO FIND THE DESIGN FLOW

RATIONAL FORMULA : Design Flow, Q= A I R / 360 (Not applicable for watersheds greater than 150 hectares)

REGIONAL APPROACH Design Flow, Q= k A^n (Not appropriate for the North due wide variations in geologic and climatic data)

SOIL CONSERVATION SERVICE (SCS) APPROACH

$$\text{Peak Runoff} = \frac{((P-0.2S)^2)}{(P-0.8S)}$$

S= Watershed Retention capacity = (25400/CN) - 254

P= Precipitation

CN= Curve Number (obtained from CSC table) - CN =80 adopted

$$\text{Design Flow, } Q = \text{Peak Runoff} \times \text{Watershed Area}$$

Obtain Peak Runoff from the Hydrograph

Peak Runoff = 41.06 mm/day

Watershed Area = hectares

Design Flow, Q= 353154 m3/day

4.087 m3/sec

TO FIND THE REQUIRED PIPE DIAMETER

MANNING FORMULA : $Q = \frac{A * R^{0.667} * S^{0.5}}{n}$

Q= DESIGN FLOW (m3/sec)	4.087 m3/sec	
A= CROSS SECTIONAL AREA (m2)	**solve for**	
R= HYDRAULIC RADIUS (m)	0.225	for 900 flowing full
S= SLOPE OF HYDRAULIC GRADE (m/m)	0.50%	
n = ROUGHNESS COEFFICIENT	0.018	

$$Q = \frac{A \times 0.1125^{.667} \times 0.0025^{0.5}}{0.018}$$

$$4.087 \text{ m3/sec} = \frac{A \times 0.370 \times .071 \text{ m/m}}{0.018}$$

THEREFORE $A = \frac{4.087 \text{ m3/sec} \times 0.018}{.37 \text{ m} \times 0.0707}$

A= 2.8141 m2

FIND DIA. $2.8141 \text{ m2} = \frac{\text{pi} \times D^2}{4}$ $D^2 = \frac{2.814 \times 4}{3.142}$

$\text{dia}^2 =$ 3.583

REQ'D DIAMETER = 1.893 m

Use 2 - 1000 mm (Surface Runoff Requirements)

Additional 2 - 1000 mm - Fisheries Requirements

USE 2 - 1000 mm DIA CULVERT AT EACH STREAM CROSSING

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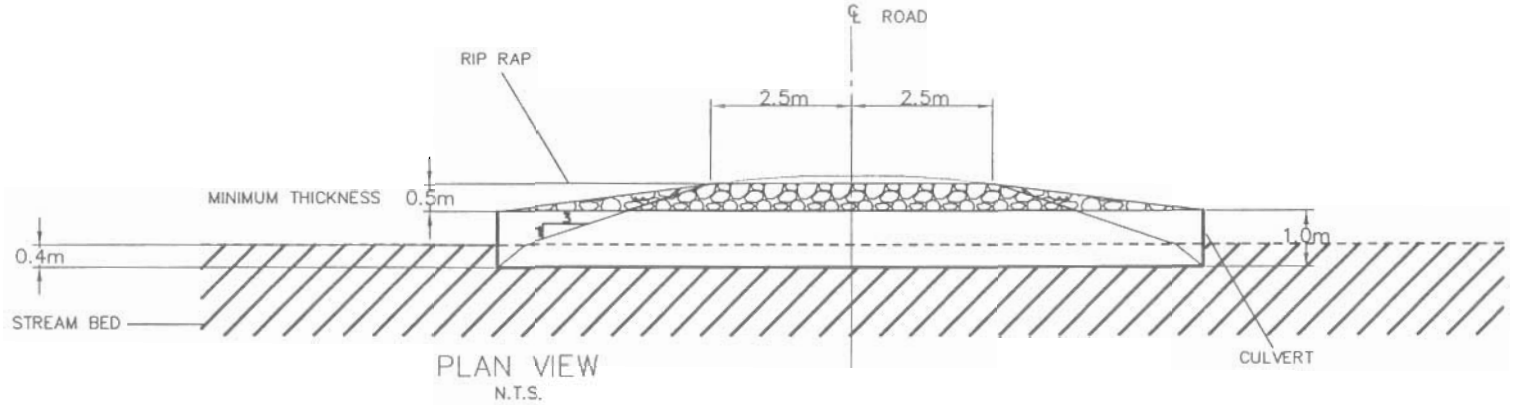
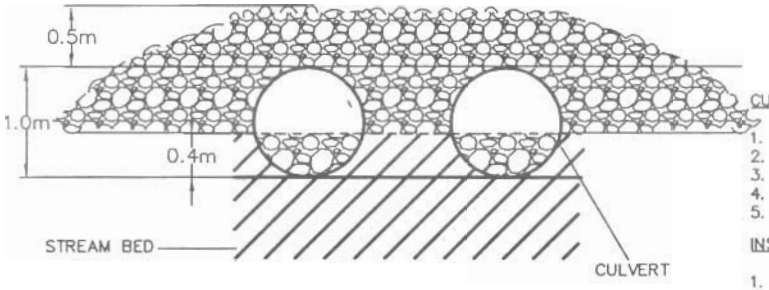
APPENDIX 3 – CULVERT DESIGN DRAWINGS



PLAN VIEW
N.T.S.



CROSS SECTION
N.T.S.

CULVERT LENGTH CALCULATED BASED ON:

1. ROAD WIDTH OF 5.0 METERS
2. TOP COVER OF AT LEAST 0.5 METER
3. ROADSIDE SLOPE OF 3:1
4. EMBEDMENT INTO STREAMBED OF 0.4 METER
5. SIDE CLEARANCE OF 0.5 METER FOR RIP RAP

INSTALLATION:

1. ASSEMBLE ALL MATERIALS IN ADVANCE
2. SURVEY THE WORK SITE
3. PREPARE AND GRADE THE CULVERT BED
4. USE GEOTEXTILES TO PREVENT LOSS OF FINES & GRAVEL THROUGH SEEPAGE ALONG THE CULVERT WALL
5. DRAINAGE
6. PREVENT CONSTRICTING THE STREAM
7. CONSIDER EROSION PROTECTION
8. ESTABLISH AN INSTREAM WEIR WITH IN 1.5 TO 2 CHANNEL WIDTH DOWNSTREAM OF THE CULVERT OUTLET
9. BACKFILL
10. 3-6% FINAL GRADE

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JOB TITLE
TRUE NORTH GEMS

DRAWING TITLE
PLAN VIEW
AND
CROSS SECTION

DESIGNED BY: DM	SCALE: NTS
DRAWN BY: RA	DATE: JUNE 8, 05
CHECKED BY: DM	JOB NUMBER: 2005-0550
SHEET: 1 OF 1	DRAWING NO: 1

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APPENDIX 4 – Stream Crossing Guidelines

FOREST PRACTICES CODE

of

BRITISH COLUMBIA

Fish-stream Crossing Guidebook

March 2002

BRITISH COLUMBIA

Ministry of Forests

Ministry of Water, Land and Air Protection

Ministry of Energy and Mines

Fisheries and Oceans Canada | Pêches et Océans Canada

OIL AND GAS COMMISSION

FOREST PRACTICES

CODE

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BRITISH COLUMBIA

Fish-stream Crossing Guidebook

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Guidebooks are also available on the
British Columbia Ministry of Forests website at:
http://www.for.gov.bc.ca/tasb/legsregs/fpc/FPCGUIDE/Guidetoc.htm

Contents

Figures

1 Introduction

This guidebook is designed to help forest and other resource managers and practitioners plan, prescribe, and implement sound forest practices for fish-stream crossings that comply with both the Forest Practices Code and the federal *Fisheries Act*.

It was prepared under the direction of a multi-agency steering committee, with technical input from provincial and federal government agency staff, resource industry personnel, and individuals in private practice. Represented on the steering committee were:

- the Province of British Columbia: Ministry of Forests; Ministry of Water, Land and Air Protection; Ministry of Energy and Mines; and Oil and Gas Commission
- the Government of Canada: Department of Fisheries and Oceans (DFO)
- the Council of Forest Industries (COFI)

The guidelines contained here are the product of considerable communication and consensus-building effort among the committee members and their technical reviewers. With the support of management and the executive of each organization, the steering committee was able to achieve the desired policy objectives. The result is that the processes and practices are considered to be reasonable, practical, and acceptable to both practitioners and review agencies alike.

By following the procedures detailed in this guidebook, users can work to achieve a balance among the needs of the forest, mining, and oil and gas industries, as well as of the needs of those who are empowered to protect the fishery resource. The information provided here should help users exercise their professional and technical judgement in developing site-specific management strategies and prescriptions to meet resource management objectives. The recommendations set out a range of options or outcomes considered to be acceptable under varying circumstances.

Specifically, the guidebook provides users with technical, statutory reference, and process guidance for selecting and designing fish-stream[1] crossings on forest roads (as well as mineral and petroleum access roads) that should (1) avoid harming fish and fish habitat, and (2) provide fish passage at stream crossing sites. Examples are given to illustrate the methods and recommended procedures for road crossings of streams in an effective and efficient manner. The *Forest Practices Code of British Columbia Act* and the federal *Fisheries Act* provide for safe fish passage and the protection of fish and fish habitat. (See the Glossary for the federal definition of fish and fish habitat.)

1 The Forest Practices Code definition of a fish stream is included in the Glossary. See also the *Forest Practices Code Fish Stream Identification Guidebook*.

Not provided here is guidance for engineering practices related to the design and stability of drainage structures. Rather, the emphasis is on fish habitat and fish passage. For further discussion on structural or hydrological requirements, refer to the Forest Practices Code *Forest Road Engineering Guidebook* and the Ministry of Forests *Bridge Design and Construction Manual*.

These guidelines do not preclude the use of other processes and structures, provided they meet the requirements of provincial and federal legislation. See "References and Recommended Additional Reading" at the end of the guidebook.

1.1 Guidebook Objectives

This guidebook aims to provide forest and other resource management practitioners with guidance in:

- protecting fish and fish habitat and accommodating the safe passage of fish during the location, design, installation, maintenance, and deactivation of stream crossings;
- administering an efficient proponent submission and review process that addresses all federal and provincial legal requirements involved in the construction, maintenance, and deactivation of stream crossing structures; and
- pursuing options that recognize the value and sensitivity of fish and fish habitat in balance with other environmental, social, resource, and economic values.

1.2 Legislative Authorities and Approvals

The Forest Practices Code regulates the construction, maintenance, and deactivation of stream crossings on Crown land in a provincial forest. However, other federal and provincial authorities also have jurisdiction in some cases to regulate works in and about streams. For example, Habitat staff in the Department of Fisheries and Oceans operate under the Federal *Fisheries Act,* which has prohibitions related to fish passage and fish habitat. The staff are further guided by their department's "Policy for the Management of Fish Habitat," which contains a long-term objective of net gain of the productive capacity of fish habitats.

1.3 Provincial Legislation

1.3.1 Forest Practices Code of British Columbia Act

The *Forest Practices Code of British Columbia Act* has a legal framework that consists of an Act and planning and practices regulations. The Code provides the umbrella legislation for forest practices in British Columbia, including the design, construction, maintenance, and deactivation of stream crossings on forest roads. Those proponents who receive authorization to carry out instream works must do so in accordance with the Act and the regulations.

The regulations define fish streams and provide detailed requirements directing the administration, planning, design, and field practices associated with fish-stream crossings.

1.3.2 Petroleum and Natural Gas Act

The Oil and Gas Commission is the regulatory body that provides the approvals for petroleum roads. The layout and design of petroleum roads, including stream crossings, are considered and approved under the *Petroleum and Natural Gas Act*, and are not subject to the Forest Practices Code. However, the construction, maintenance, and deactivation of petroleum roads are covered under the Code and the provisions of the Forest Road Regulations. (Readers requiring more information should contact the Oil and Gas Commission for more information on the petroleum road application and review process.)

1.3.3 Mines Act, Mineral Tenure Act, *and* Mining Right of Way Act

The Ministry of Energy and Mines regulates exploration activities on mineral tenures, under the Mineral Exploration Code. The Mineral Exploration Code is a regulation of the *Mines Act* and its standards are similar to, and supersede, the *Water Act* and the Forest Practices Code. Off-tenure roads must meet the requirements of the Forest Practices Code for construction, maintenance, and deactivation.

Under the *Mineral Tenure Act*, a free miner has the right to enter all mineral lands in order to locate a claim or explore for, develop, and produce minerals. Additionally, the *Mining Right of Way Act* gives a mineral claim holder or free miner the right-of-way to construct or maintain mining facilities and to transport mineral or equipment and supplies into and from the mining property.

1.3.4 Water Act

Water Management Branch of the Ministry of Water, Land and Air Protection licenses and regulates water under the *Water Act*. The Oil and Gas Commission also has authority for certain sections of the *Water Act* that pertain to any alterations to, and work in and about, a stream for a petroleum road or other petroleum- or pipeline-related operation. (For more information, readers should contact the Oil and Gas Commission.)

The *Water Act* permits forest activities under the *Forest Practices Code of British Columbia Act* to be conducted without the requirement to notify the Water Management Branch.

Section 44(3) of the *Water Act* Regulation also exempts a person who holds a permit under Section 10 of the *Mines Act* from having to comply with the regulation, as long as that person complies with Part 11 of the Health, Safety

and Reclamation Code for Mines in B.C., and with all conditions of the permit respecting changes in and about the stream.

1.4 Federal Legislation

1.4.1 Fisheries Act

Responsibility for the administration of the *Fisheries Act* rests with the federal Minister of Fisheries and Oceans Canada (DFO). Habitat management staff in the department (DFO-Habitat) have responsibility for protecting fish and fish habitat under the habitat provisions of the *Fisheries Act*.

The following prohibitions in the *Fisheries Act* are relevant to stream crossings:

- obstructions of fish migration (section 22 and 26);
- destruction of fish (section 32);
- harmful alteration, disruption, or destruction (HADD) to fish habitat (section 35) unless authorized; and
- depositing of substances deleterious to fish in waters frequented by fish (section 36).

The Minister of Fisheries and Oceans Canada may require a proponent to submit plans or specifications for works or undertakings that result, or may likely result, in the harmful alteration, disruption, or destruction of fish habitat (section 37).

If a particular stream crossing is deemed an obstruction to fish passage, the Minister may also require a proponent to ensure the free passage of fish (Section 20).

Where a stream crossing may result in the harmful alteration, disruption, or destruction of fish habitat, DFO-Habitat staff can authorize the activity to go ahead only under Section 35(2) of the *Fisheries Act*. To do that, DFO-Habitat first conducts a screening-level assessment of the stream crossing project under the *Canadian Environmental Assessment Act* (CEAA) and refer the project plans and specifications to other federal agencies, such as the Canadian Wildlife Service and the Canadian Coast Guard Navigable Waters Protection Division. Any residual impacts (piers, etc.) to fish habitat from authorized stream crossings are also subject to compensation under the *Fisheries Act*.

1.4.2 Navigable Waters Protection Act

The *Navigable Waters Protection Act* of Canada regulates any activity in, around, under, and over navigable waters,[2] and is administered by the Canadian Coast Guard of the DFO. Authorization under this Act is required for all stream crossings on navigable waters. Approval for works on navigable waters requires consultation with the Canadian Coast Guard, as does approval for work occurring on navigable waters below the high water mark, such as dredging, placement of rip rap, or bridge or major culvert replacement

2 Navigable waters are defined as any waters capable of being used for commerce, transportation, or recreation.

2 Review Processes

This section provides guidance on the agency review requirements and for selecting the appropriate type of structure for any given site, based on stream gradient and fish habitat present. The approval of forest road layout and design falls under the Forest Practices Code.

The approval of petroleum road layout and design falls under the jurisdiction of the Oil and Gas Commission. Exploration activities on mineral tenures are regulated by the Mineral Exploration Code (discussed in Section 1.3.3).

2.1 New Installations

> **Note:** **Stream channel width** is an important concept used throughout this guidebook. It is defined as the horizontal distance between the streambanks on opposite sides of the stream, measured at right angles to the general orientation of the banks. The point on each bank from which width is measured is usually indicated by a clearly visible change in vegetation and sediment texture. This border is sometimes shown by the edges of rooted terrestrial vegetation. Above this border, the soils and terrestrial plants appear undisturbed by recent stream erosion. Below this border, the banks typically show signs of both scouring and sediment deposition. Figure 9 provides two illustrations of stream channel width. In addition, a methodology for determining stream channel width is described in Appendix 1.

- The proponent should conduct an evaluation of the fish habitat at the crossing site to determine whether the habitat is critical, important, or marginal. These terms are defined in Figure 1. This habitat evaluation should be conducted by a qualified professional or technologist with adequate training and knowledge of fish habitat. Consideration should be given to flow, current, cover, depth, substrate, and general habitat type (pool, riffle, glide) to justify classification of marginal habitat. Where economics or other issues warrant, the proponent may default to a clear span structure.

Figure 2 provides a matrix to assist the proponent in selecting the most appropriate crossing structure type, selected from:

- open bottom structures (e.g., bridges, open bottom culverts [log culverts, arch culverts])
- closed bottom structures (e.g., corrugated metal pipes)
- other structures (e.g., ice bridges and snowfill)

These structures are discussed in detail in Section 3.

	Habitat at Crossing Site		
	Critical	**Important**	**Marginal**
Definition	Habitat that is critical in sustaining a subsistence, commercial, or recreational fishery, or species at risk (red- and blue-listed and COSEWIC list) because of its relative rareness, productivity, and sensitivity.[a]	Habitat that is used by fish for feeding, growth, and migration, but is not deemed to be critical. This category of habitat usually contains a large amount of similar habitat that is readily available to the stock.	Habitat that has low productive capacity and contributes marginally to fish production.
Indicators[b]	• The presence of high-value spawning or rearing habitat (e.g., locations with an abundance of suitably sized spawning gravels, deep pools, undercut banks, or stable debris, which are critical to the fish population present)	• Important migration corridors • The presence of suitable spawning habitat • Habitat with moderate rearing potential for the fish species present	• The absence of suitable spawning habitat, and habitat with low rearing potential (e.g., locations with a distinct absence of deep pools, undercut banks, or stable debris, and with little or no suitably sized spawning gravels for the fish species present)

a See www.gov.bc.ca/wlap/ or http://www.cosewicgc.ca/cosewic.

b The indicators provided here are highly generalized and require regional interpretation. Those involved in conducting habitat assessments should contact the regional office of DFO-Habitat and the Ministry of Water, Land and Air Protection.

Figure 1. Definition and indicators of fish habitat types.

Once the most appropriate type of crossing structure has been determined (using Figures 1 and 2), Figure 3 can further assist the proponent in determining whether or not an authorization is required from DFO-Habitat.

- The review process for forest roads crossing fish streams potentially involves two levels of government — provincial and federal. The provincial review process is outlined below in Section 2.3; the federal review process is outlined in Section 2.4. To expedite the review, fisheries agency referrals should be accompanied by a proponent application plan (see Section 2.5) that contains all necessary information.

- In general, an open bottom structure (OBS) does not require site-specific fisheries agency approval if the crossing is constructed within the timing window (see Appendix 2), and if it spans the stream without:
  - disturbing instream fish habitat,
  - encroaching on the stream channel width, and
  - causing excessive[3] loss of riparian vegetation.

Note:
Some small, arch-type structures installed on fish streams require excavation and reconstruction of the streambed and streambanks. ***These should be treated as closed bottom structures for review process purposes.***

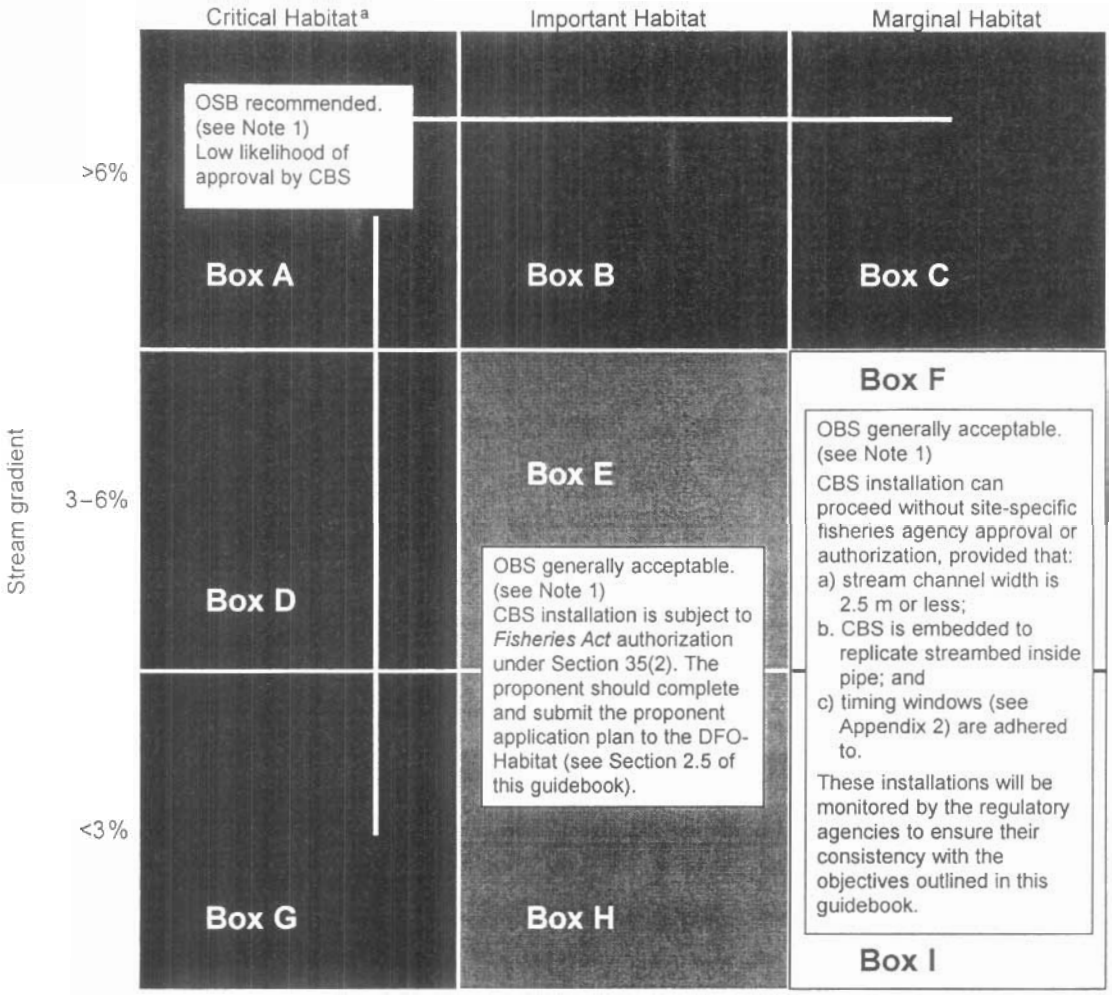
- In marginal fish habitat, where the stream gradient is 6% or less and where the streambed is wide and deep enough to be excavated and the closed bottom structure (CBS) properly embedded, the proponent can proceed without site-specific fisheries agency approval, provided that (1) the installation is carried out within the timing window and (2) design and installation are carried out according to Section 3.2 of this guidebook.

- In important and critical fish habitats, and in marginal fish habitat where stream gradient exceeds 6% (boxes A to E and G to H, Figure 2), the installation may likely require a Section 35(2) authorization (*Fisheries Act*), so a referral to DFO-Habitat is highly recommended.

Fisheries agency approval for a closed bottom structure in the black portion of the habitat/gradient matrix (Figure 2) is unlikely because of the difficulty in providing and maintaining fish passage in such conditions and in protecting the existing critical habitat. Approval would be considered only where no other practicable alternative exists.

- Plans and specifications for crossings constructed without fisheries agency referral should be retained by the proponent and made available to the agency upon request.

3 Only the vegetation required to meet operational and safety concerns for the crossing structure and the approaches is to be removed. All efforts should be made to minimize impacts on the riparian fish habitat beyond the toe of the fill at the crossing site.



a See Figure 1 for habitat definitions and examples. OBS — open bottom structure, CBS — closed bottom stucture.

Figure 2. Decision-making matrix for selecting type of new installation acceptable for fish-stream crossings.

Notes:

1. No agency approval or authorization is necessary for any OBS, if the crossing spans the stream without (a) disturbing instream habitat, (b) encroaching on stream channel, or (c) causing excessive loss of riparian habitat. If (a), (b), or (c) is anticipated, a *Fisheries Act* authorization is required regardless of habitat value or stream gradient. The proponent should complete and submit the proponent application plan for a Section 35(2) authorization to the DFO-Habitat (see Section 2.5 of this guidebook). Figure 4 outlines the review process.
2. The figure includes a gradient breakdown at 3% that has no influence on the outcome of the matrix. It is shown here to emphasize the increased risk associated with the maintenance of substrate in embedded culverts as slope increases. Requirements for substrate size and placement also differ for culverts installed at gradients greater than 3% (see Section 3.2).
3. Other factors (such as fans and debris potential) may also need to be considered for the selection of a structure and assessment of its structural integrity.