Toboggan Creek

Watershed Restoration Project

Survey and Design

Contract F1681-7-0004

Prepared for: Department of Fisheries and Oceans

Prepared By: Sean Mitchell and Jason Wiley
Nortec Consulting

April 1998

ACKNOWLEDGEMENTS

For the completion of this project, we would like to acknowledge the participation and assistance of:

Landowners

Mr. and Mrs. K. Landrock
Mr. L. Hopps
Mr. and Mrs. D. Mott
Mr. P. Lychak
Mr. R. Grubliunas
Mr. and Mrs. A. Booth

As well we also thank Barry Peters, Gord Wadley and Lara Gibson for reviews of drafts and constructive criticism to improve the final report.

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1.0 INTRODUCTION

The Toboggan Creek Watershed Restoration Project (WRP) was initiated in September of 1997 with a combined Level 1 (Overview) and Level 2 (Detailed Assessment) (Gibson 1997). A number of areas of concern and general prescriptions for rehabilitation were identified from this work. Several sites required further Survey and Design in order to determine the logistics and expense of the work required.

Survey and design of 19 sites was conducted between March 9 and March 31, 1998 by Nortec Consulting under contract to the Department of Fisheries and Oceans. Fifteen of the sites are on the Toboggan Creek mainstem, three on Owen Creek, and one on Hopps Brook. Unfortunately, snow on the ground and in the channel limited the detail possible from this survey However, previous experience on this creek and past knowledge of the system allowed for the filling in of these survey gaps.

The results of this survey and design are presented, with photographs and figures and followed by recommendations regarding priorities of works and strategies.

1.1 General Comments

Though not identified for survey and design, strategies and works for managing the beavers and their activities is required in Toboggan Creek. There are several dams which largely control hydrology in the system, one is on Toboggan Creek immediately below the lake and the other on Owen Creek above the powerline crossing. These dams require consideration as part of any works undertaken downstream of them (which involves most of the surveys and designs).

In this document riparian planting is a prevalent recommendation. For the recommended tree species planting densities or required trees are given based on Anonymous (1994). Recommendations for planting of shrubs (willow and red-osier dogwood) do not provide densities, but instead planting of these is simply recommended as the "step-and-thrust" procedure - take a step, thrust a whip into the ground, take a step, thrust a whip, etc. This will not work!

Large Woody Debris (LWD) is another common requirement through these recommendations. Some landowners have expressed that they have some available LWD; this should be utilized to the greatest extent to minimize the cost of trucking from distant locations. The Toboggan Creek system is extremely LWD poor, the only way to counter this is to import LWD from elsewhere (short-term) and planting (long-term).

2.0 RESULTS

Survey and Design Number: SD-1
Prescription Number: Toboggan 1

LOCATION: Highway 16 culvert, 120 m upstream of the confluence of Toboggan Creek and the Bulkley River. UTM coordinates 6089200, 607500.

IMPACT: There is a 0.6 m drop from culvert outflow to stream which has been suggested to be posing a barrier to pink salmon (*Oncorhyncus gorbuscha*), explaining their absence from the Toboggan Creek system since 1991 (Gibson, 1997). This drop is anticipated to increase as water power continues to erode surrounding banks.

PHOTO(S): TB-1

DESCRIPTION OF PROPOSED WORKS: Construction of two pools in series (Figures 1 and 2) to lessen the drop into each pool so pink salmon can proceed from pool to pool in a step-wise fashion. The water drop from the culvert outlet to pool # 1, from pool #1 to pool #2, and from pool #2 to the stream are to be 0.3 m or less. The outflow from pool #2 will be directed away from the eroding banks downstream. LWD should also be installed within the rip-rap matrix to provide in-pool cover and break up the energy of the water. In addition, live plantings (willow [70%], red-osier dogwood [30%]) should be integrated within the rip-rap matrix.

Downstream of these constructed pools placement of LWD deflectors along the eroding banks is also recommended (Figure 1) in order to prevent channel movement into and behind the new pools. The baffles within the culvert should also be assessed for stability and function at this same time (August low flows).

Recognizing the expense of these required works this is rated as a moderate priority, with the caveat that if these works are not completed, then a monitoring program for assessing pink salmon passage (or lack thereof) through the culvert is a high priority.

ANTICIPATED BENEFITS: This project is anticipated to provide:

- ❒ Passage for pink salmon into the culvert and up into the Toboggan Creek system above this culvert.
- ❒ Reduction of erosion at the culvert outflow.
- ❒ Reduction of erosion of banks downstream of the culvert.
- ❒ Local employment for machine work and joint planting.

SCHEDULE FOR IMPLEMENTATION:

1. Acquire approvals
2. Order required planting stock, rip-rap, LWD
3. Assess baffles (August)
4. Delivery of rip-rap & LWD (August)
5. Placement of rip-rap/LWD (August)
6. Bank deflector placement (August)
7. Monitoring of pink salmon for passage (August)
8. Joint planting (Spring 1999)
9. Post works monitoring (Spring flows 1999)

ESTIMATED COST FOR COMPLETION:

OPTION 1: Pool Development

Machinery - Hoe (2 days @ $1,000/day)		$ 2,000
- Chainsaw/Drill rental (2 days @ $50/day)		$ 100
Materials - 250 m^3 of rip-rap (@ $50/$m^3$)		$12,500 (estimate)
(150 m^3 for pool #1, 100 m^3 for pool #2)		
Negotiable with Ministry of Highways		
- Geotextile (200 m^2 @ $1.25/$m^2$)		$ 250
- LWD (as available)		
- Rebar/cable		$ 50
- Plantings (whips)		$ 100 (estimate)
Labor - 2 man-days ($450/man-day)		$ 900
2 man-days ($250/man/day)		$ 500
Traffic control		$ 500 (estimate)
Monitoring after Works		
- 0.5 man-day (@$450/man-day)		$ 225
	Total	**$17,125**

OPTION 2: Pink Salmon Monitoring

Labor - 2 man-days ($450/man-day)		$ 900
8 man-days ($250/man/day)		$ 2,000
	Total	**$ 2,900**

APPROVALS REQUIRED: Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks, Ministry of Highways.

TOBOGGAN CREEK SURVEY AND DESIGN FIELD PHOTOGRAPH

Photo Number: TB-1
Survey & Design/Prescription #: SD-1 / Toboggan 1
Location: Highway 16 culvert
Comments: Culvert with water drop (upper photo), note erodable banks. Pool at culvert outflow in early Spring (lower photo), snow roughly defines proposed upper pool diameter.
Date Taken/Photographer: Upper photo - October 24, 1997 / G. Wadley
Lower photo - March 16, 1998 / S. Mitchell

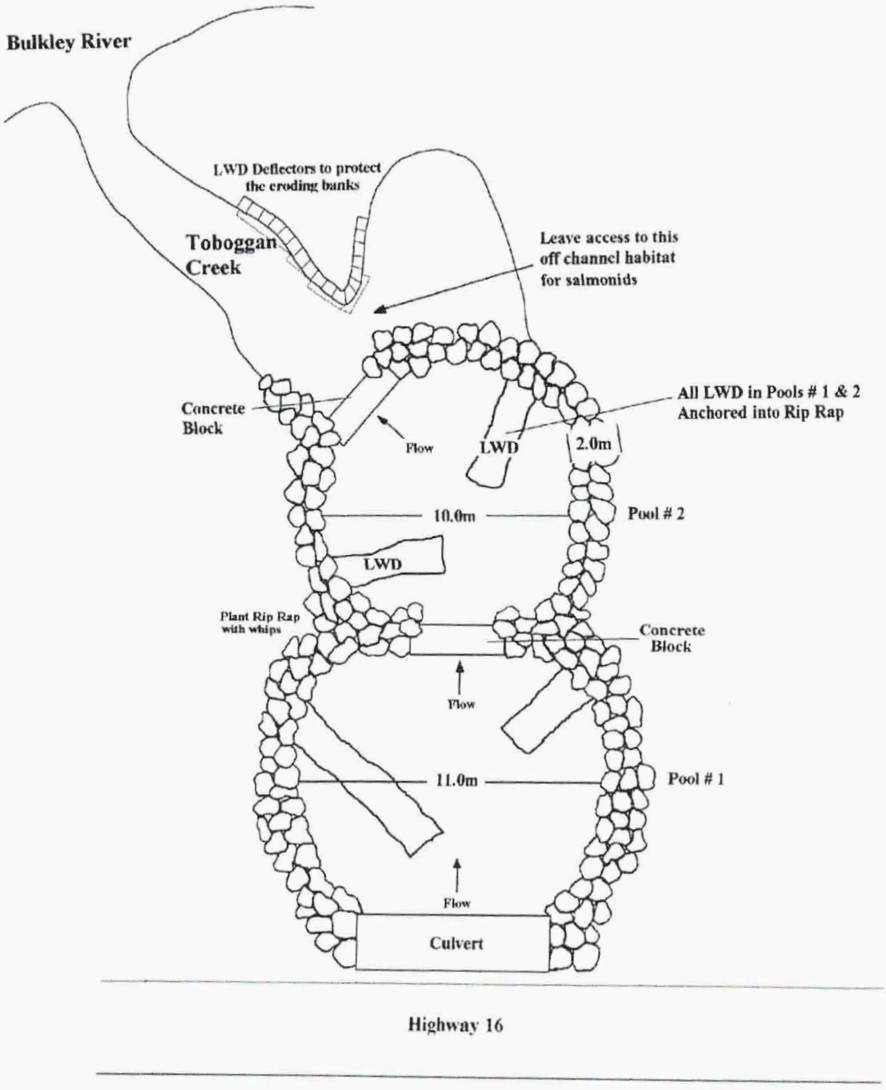


Figure 1: Top view of proposed pool development downstream of Highway 16 culvert (SD-1)

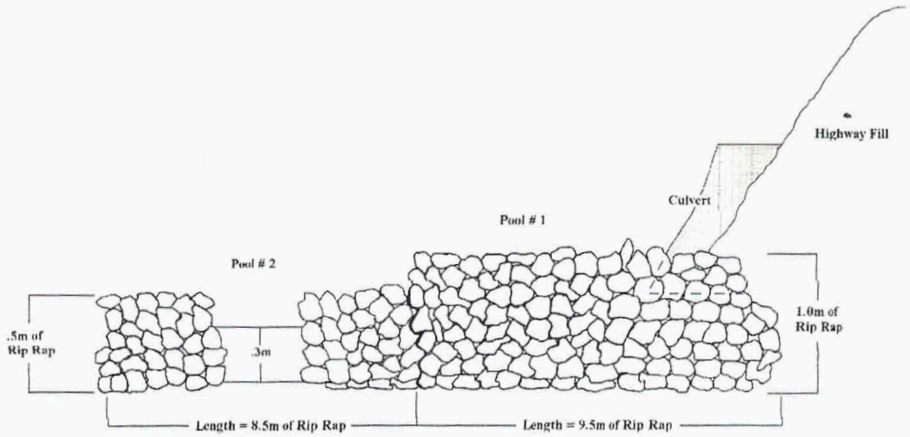


Figure 2: Side view of proposed pool developmet downstream of Highway 16 culvert (SD-1)

Survey and Design Number: SD-2
Prescription Number: Toboggan 3

LOCATION: 681 m upstream of the Toboggan Creek- Bulkley River confluence. UTM coordinates 6089900, 607820.

IMPACT: Old bridge crossing with extensive bars and eroding banks (gravels and sands) contributing sediments to the stream.

PHOTO(S): TB-2

DESCRIPTION OF PROPOSED WORKS: Installation of tree revetment composed of eight trees interspersed with five downstream angled log deflectors along this bank to deflect the current toward the centre of the stream (Figure 3). Along the left bank immediately above the bridge place two log deflectors (2 logs high) to decrease erosion during high flows and place an upstream log deflector out from the bank for eddy construction. Hand excavation of side-channel along left bar below bridge is also recommended to ensure access and use of this off-channel area.

ANTICIPATED BENEFITS: This project is anticipated to provide:

- ❒ Reduced erosion and increased stability of banks above and below the old bridge crossing.
- ❒ Pool cover/habitat and subtle redirection of current to mid-channel.
- ❒ Enhanced side-channel rearing habitat.
- ❒ Reduced velocity of water along the left bank undercutting the bridge abutment.
- ❒ Local employment for slope stabilization and channel excavation.

SCHEDULE FOR IMPLEMENTATION:

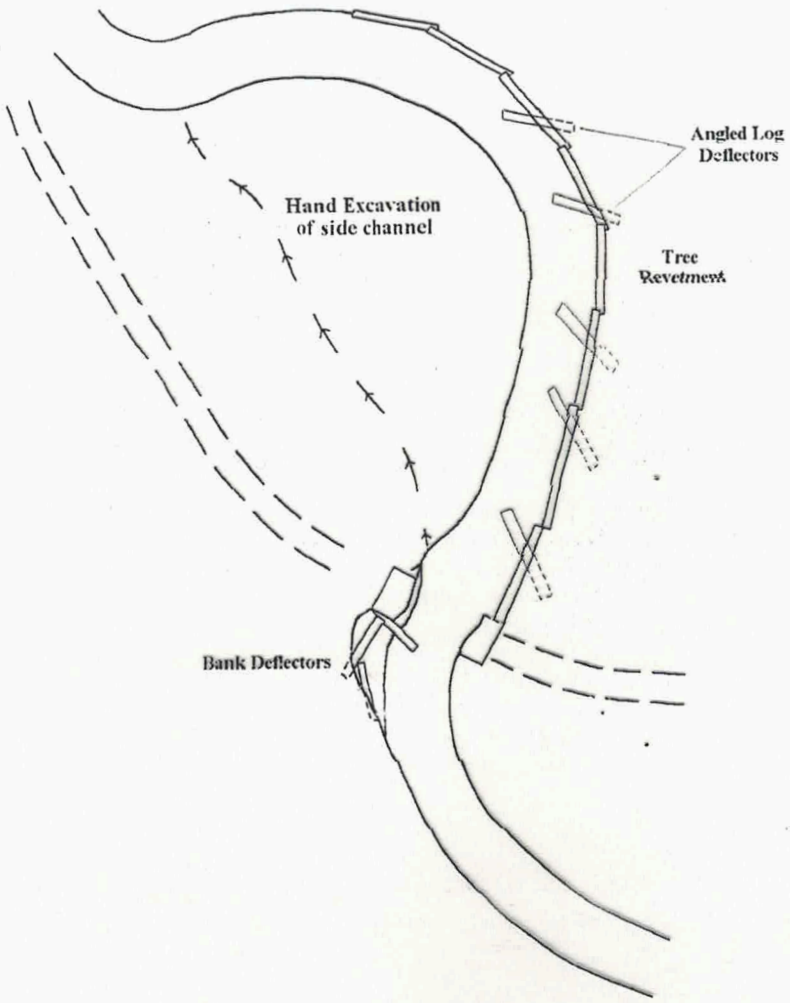
1. Acquire approvals
2. Delivery of LWD for revetments, deflectors, etc. (August)
3. Placement of LWD (August)
4. Hand excavation of side channels (August)
5. Post works monitoring (Spring flows 1999)

ESTIMATED COST FOR COMPLETION:

Machinery - Hoe (1 day @ $1,000/day)	$ 1,000
- Chainsaw/Drill rental (2 days @ $50/day)	$ 100
Materials - LWD/trees (18-20 pieces)	$ 4,000
- Geotextile (150 m^2 @ $1.25/$m^2$)	$ 188
- Rebar/cable	$ 100
Labor - 1 man-days ($450/man-day)	$ 450
- 2 man-days ($250/man-day)	$ 500
Monitoring after Works	
- 0.5 man-day (@$450/man-day)	$ 225
Total	**$6,563**

APPROVALS REQUIRED: Mr. Butz (Landowner), Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks.

Photo Number: TB-2
Survey & Design/Prescription #: SD-2 / Toboggan 3
Location: Old bridge crossing 680 m upstream of Toboggan Creek - Bulkley River confluence.
Comments: Eroding banks on outer bend (upper photo), note erodable banks (lower photo).
Date Taken/Photographer: March 16, 1998 / S. Mitchell


Angled Log
Deflectors
Hand Excavation
of side channel
Tree
Revetment
Bank Deflectors

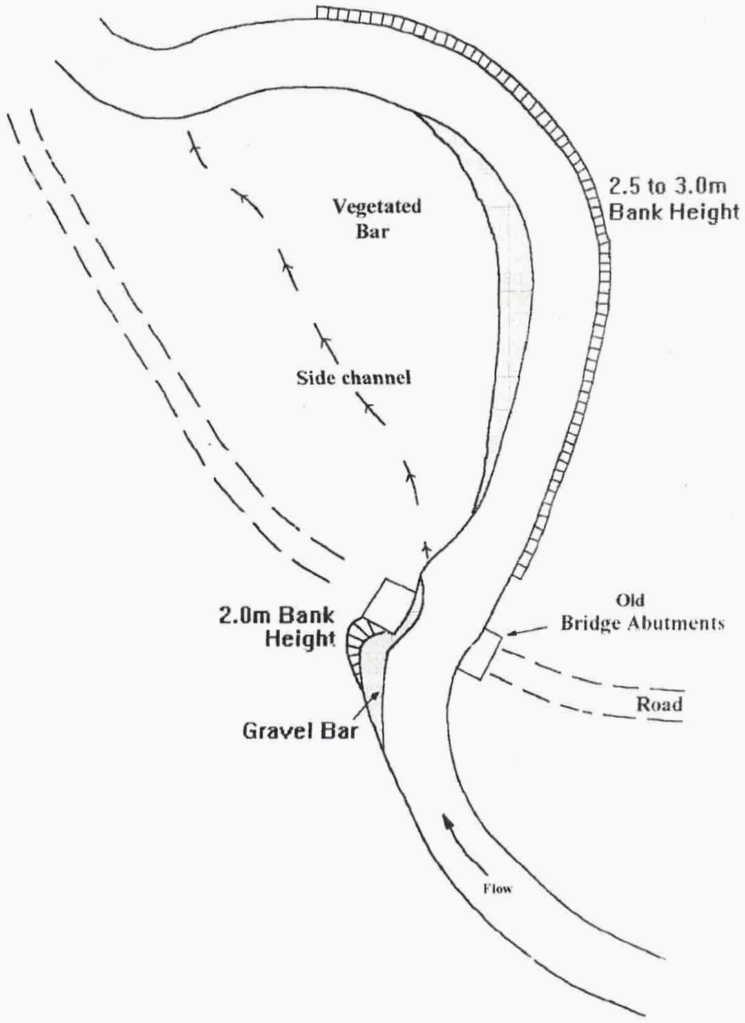


Figure 3: Site map and proposed works for Survey and Design SD-2. See Appendix 1 for details of anchoring tree revetment.

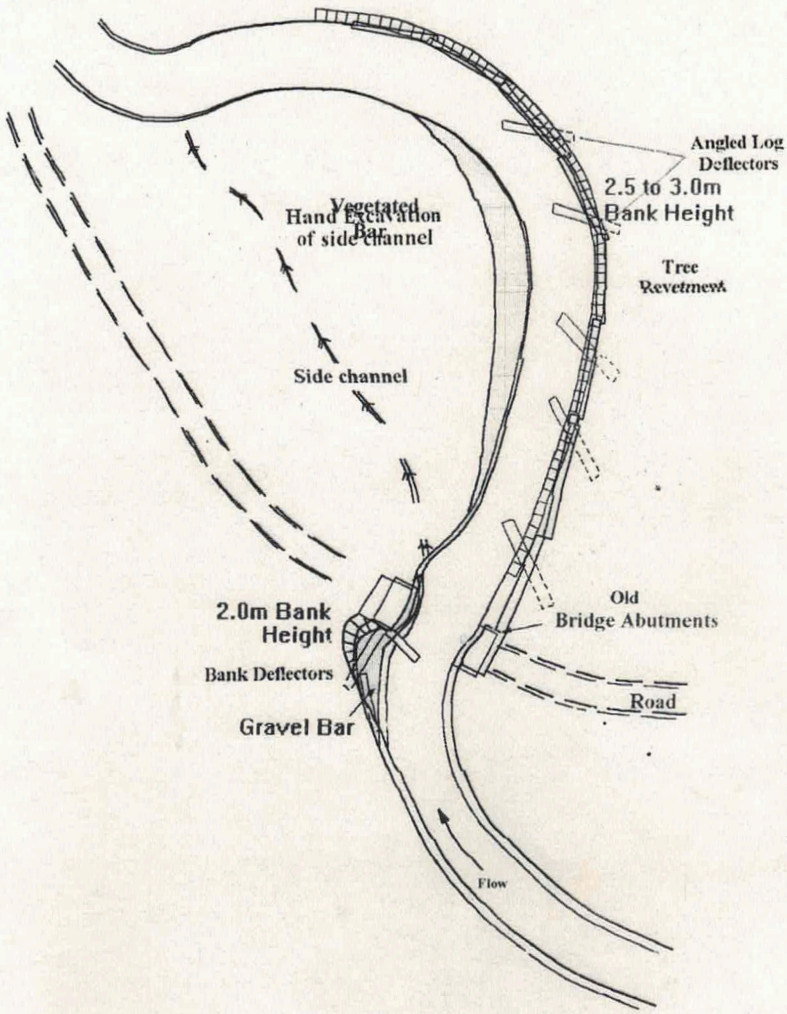


Figure 3: Site map and proposed works for Survey and Design SD-2. See Appendix 1 for details of anchoring tree revetment.

Survey and Design Number: SD-3
Prescription Number: Toboggan 4

LOCATION: Approximately 1.6 km upstream of Toboggan Creek-Bulkley River confluence. UTM coordinates 6088577, 608695.

IMPACT: A series of large eroding banks contributing sediments to Toboggan Creek (Figure 4). Slope #1 is the largest and is unprotected along the toe. This large (20+ m at a slope > 70%) high bank is failing as the stream cuts the toe of the slope. Slope #2 is of low priority, the local area may be useful for off-channel development as mitigation of the sedimentation associated with these slope failures. Slope #3 is protected by rip-rap along the toe of the slope. Slope #4 is a small (~2 m high) bank with unprotected toe. Slope #5 is a large failure (approximately 10 m high at a slope >70%) eroding the banks, largely the result of a culvert overhanging from the old highway. There is a large amount of water draining in this area further contributing to the failure. The toe of the slope has been protected in the past but the quality of the rip-rap and the effectiveness of this protection is uncertain (P. Lemieux, pers. comm.).

PHOTO(S): TB-3 & TB-4

DESCRIPTION OF PROPOSED WORKS: In order to minimize costs not all of the proposed works need to be undertaken, individual slopes may be rehabilitated rather than treating the whole as a package. In order, the priority for rehabilitation is Slope 5 > Slope 4 > Slope 3 > Slope 1 >Slope 2. Proposed works for each slope are described below:

Slope #1 - To reduce continued failure of this slope and the contributions of large quantities of sediments to Toboggan Creek, erosion from the force of the creek along the toe of the slope must be reduced and the slope above the water stabilized. To do this, the toe of the slope should be armored with joint planting (70% willow, 30% red-osier dogwood) rip-rap, and the slope stabilized with live slope gratings planted with willow (Appendix 1). The landowner has agreed to road construction through the property to access the stream in order to place rip-rap along the slope toe. There is a large quantity of local LWD which could be placed in stream as angled log deflectors to redirect the stream toward the channel centre rather than along the left bank. However, the logistics and expense of accessing and rehabilitating this area, which is a natural slope failure, makes the feasibility of this option questionable.

Slope #2 - The high water channel is the only concern with this slope. To compensate for the sediment introduction upstream and downstream, this channel could benefit from development. Such development should include excavation (hand) to ensure connection with the mainstem, placement of 4-6 pieces of LWD (preferably root-wads) in the side channel to provide cover, and wattle fences along the slope adjacent to the channel to minimize sediment contribution from this slope. The area of side-channel development is estimated at <50 m^2 which

would result in an estimated increase in production of 30-35 coho smolts, 3-4 coho adults, and 3-7 cutthroat trout (*Salmo clarkii*) in this area (Koning and Keeley, 1997).

Slope #3 - Slope #3 has been armored at the toe and the landowner (Mr. R. Grebliunas) states that the protection appears to be working well. The recommended works for this slope is for the planting of a 5-10 m wide band (est. 0.1 ha) of shrubs and trees (willow, red-osier dogwood, cottonwood, aspen, and spruce) along the top of the slope in order to reduce water movement through the ground and over the edge, which is contributing to slope erosion from the top. It is recommended that the composition be aspen (25%), cottonwood (15%) and spruce (10%) with a total of 200 trees being planted. Willow (30%) and red-osier dogwood (20%) should be used to fill in areas between planted stock. The trees should be planted well back from the slope, so that their size at maturity does not itself cause slope failure.

Slope #4 - Slope #4 is a low (~2 m high) bank failure with an unprotected toe. There is access for equipment to it and it is recommended that two bank log deflectors be anchored and rip-rap placed in this area to reduce erosion of the bank. After works, the top of the slope should be planted with willow (75%) and red-osier dogwood (25%).

Slope #5 - This large slope requires protection along the toe to ensure the water is not eating out the slope behind the existing protection. Further rip-rap placement may be required. The slope itself should be pulled back to an angle of 45° with spoil deposited in a location suitable to the landowner (R. Grebliunas) and landscaped. The slope must then be stabilized with wattle fences (Figure 5). The landowner has expressed interest in having this slope terraced, which could then be planted with willow (50%) and alder (50%). The culvert spilling water from a height is a problem as the energy of the falling water is eroding the slope; lining a channel down to the stream with gravels and cobbles is required in order to confine this flow and dissipate the energy of the moving water. This flow must finally spill onto well draining rock such as the rip-rap at the toe of the slope. Planting of a 5-10 m wide band (est. 0.1 ha) of shrubs and trees (willow, red-osier dogwood, cottonwood, aspen, and spruce) along the top of the slope in order to reduce water movement through the ground and over the edge, which is contributing to slope erosion from the top. It is recommended that the composition be aspen (25%), cottonwood (15%) and spruce (10%) with a total of 200 trees being planted. Willow (30%) and red-osier dogwood (20%) should be used to fill in areas between planted stock. The trees should be planted well back from the slope, so that their size at maturity does not itself cause slope failure.

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ Protection of eroding areas of slopes reducing sediment contribution in the short term.
- ❒ Provision of off-channel habitat for rearing of coho salmon and cutthroat trout.
- ❒ Long-term slope stabilization leading to long-term reduction of sediment contribution.
- ❒ Local employment / community involvement for slope stabilization and planting.

SCHEDULE FOR IMPLEMENTATION: The schedule for the proposed works is:

1. Acquire approvals
2. Arrange delivery of LWD, rip-rap and ordering/storing of planting stock
3. Works by Slope:
   - Slope #1: Construction of live slope gratings (June/July)
     Construction of 500 m of road to access creek (August)
     Delivery and placement of LWD and rip-rap (August)
     Joint planting of rip-rap and placement of live slope gratings (Spring 1999).
   - Slope #2: Channel excavation (by hand) to stream to ensure fish access (August)
     Placement of root wads (August)
     Construction and placement of wattle fences (Spring 1999)
   - Slope #3: Planting of shrubs and trees at top of slope (Spring 1999)
   - Slope #4: Delivery and placement of rip-rap and LWD deflectors (August)
     Planting of top of slope (Spring 1999)
   - Slope #5: Delivery and placement of rip-rap, slope pullback (August)
     Channel drain development to stream (August)
     Wattle fences, terracing, planting (Spring 1999)
4. Post works monitoring (Spring flows 1999)

ESTIMATED COST FOR COMPLETION:

Slope #1

Machinery - Hoe (2 days @ $1,000/day)		$ 2,000
- Road construction		$ 5,000 (estimate)
- Chainsaw/Drill rental (3 days @ $50/day)		$ 150
Materials - Rip-rap (200 m^3 @ $50/$m^3$)		$ 10,000 (estimate)
- Geotextile (200 m^2 @ $1.25/$m^2$)		$ 250
- LWD/trees (As available)		
- Rebar/cable		$ 100
- Lumber (live slope gratings)		$ 300
- Stock (whips)		$ 300 (estimate)
Labor - 2 man-days ($450/man-day)		$ 900
- 6 man-days ($250/man-day)		$ 1,500
	Sub-Total =	**$20,500**

Slope #2

Machinery - Chainsaw/Drill rental (2 days @ $50/day)		$ 100
Materials - LWD/root wads (As available)		
- Rebar/cable		$ 50
- Stock (whips)		$ 200 (estimate)
Labor - 0.5 man-days ($450/man-day)		$ 225
- 2 man-days ($250/man-day)		$ 500
	Sub-Total	**$ 1,075**

Slope #3

Materials - Stock (whips)		$ 200 (estimate)
- Stock (trees)		$ 200 (estimate)
Labor - 2 man-days ($250/man-day)		$ 500
	Sub-Total	**$ 900**

Slope #4

Machinery - Hoe (0.5 days @ $1,000/day)		$ 500
- Chainsaw/Drill rental (1 day @ $50/day)		$ 50
Materials - Rip-rap (20 m^3 @ $50/$m^3$)		$ 1,000 (estimate)
- Geotextile (50 m^2 @ $1.25/$m^2$)		$ 63
- LWD/trees (As available)		
- Rebar/cable		$ 50

- Stock (whips)	$ 100 (estimate)
Labor - 1 man-days ($450/man-day)	$ 450
- 1 man-days ($250/man-day)	$ 250
Sub-Total	**$ 2,463**

Slope #5

Machinery - Hoe (1 days @ $1,000/day)	$ 1,000
Materials - Rip-rap (60 m^3 @ $50/$m^{3)}$	$ 3,000 (estimate)
- Geotextile (100 m^2 @ $1.25/$m^2$)	$ 125
- Stock (whips)	$ 200 (estimate)
- Stock (trees)	$ 200 (estimate)
- Grass seed (landscaping spoil)	$ 50
Labor - 1 man-days ($450/man-day)	$ 450
- 6 man-days ($250/man-day)	$ 1,500
Sub-Total	**$ 6,525**
Monitoring after Works	
- 0.5 man-day (@$450/man-day)	$ 225

Estimated Total Cost for all slopes = $ 31,688

APPROVALS REQUIRED: Mr. R. Grebliunas (Landowner), Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks.

TOBOGGAN CREEK SURVEY AND DESIGN FIELD PHOTOGRAPH

Photo Number: TB-3

Survey & Design/Prescription #: SD-3 / Toboggan 4

Location: Approximately 1.6 km upstream of Toboggan Creek - Bulkley River confluence.

Comments: Large eroding banks on outer bend (Slope #1).

Date Taken/Photographer: March 18, 1998 / S. Mitchell

TOBOGGAN CREEK SURVEY AND DESIGN FIELD PHOTOGRAPH

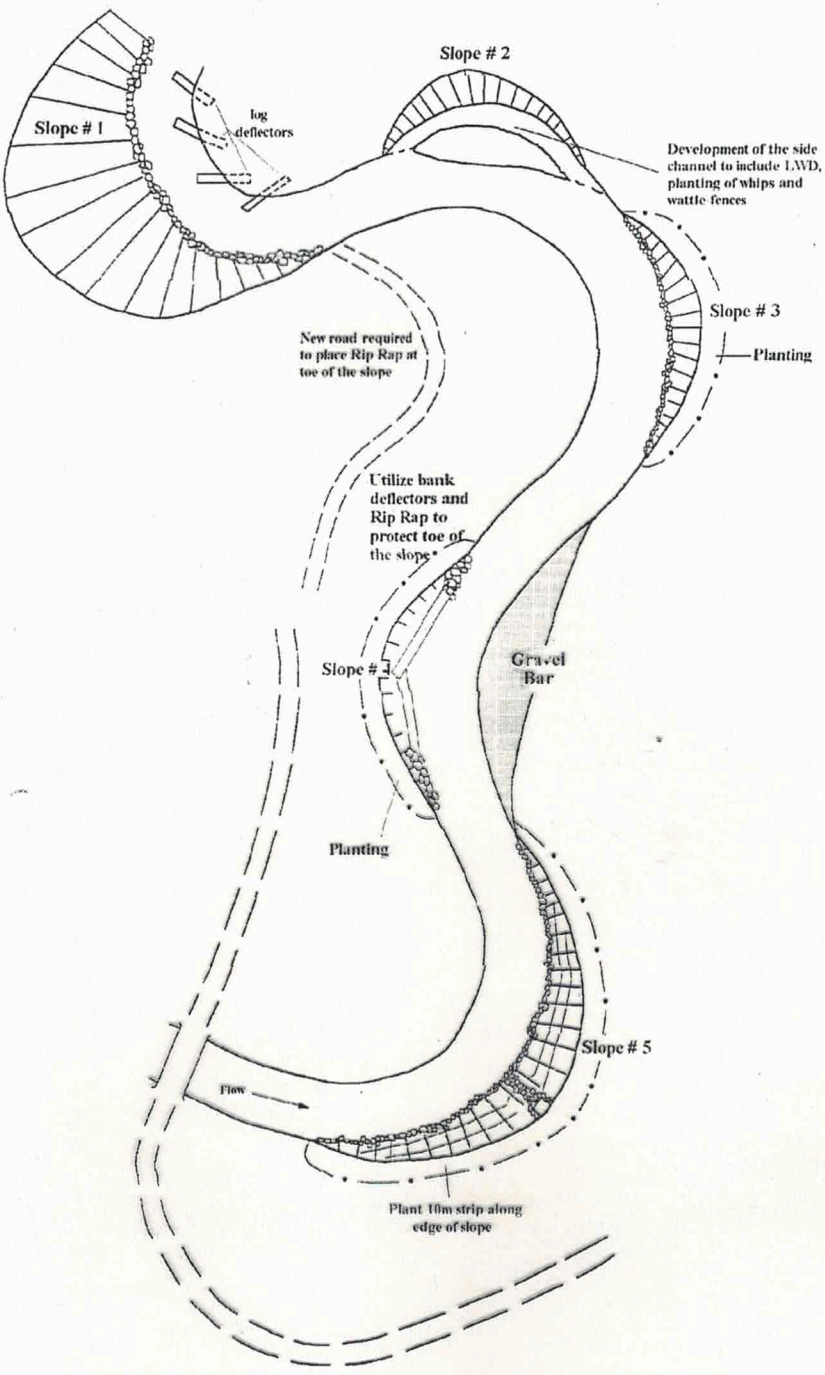
Photo Number: TB-4

Survey & Design/Prescription #: SD-3 / Toboggan 4

Location: Approximately 1.6 km upstream of Toboggan Creek - Bulkley River confluence.

Comments: Perched culvert causing a great deal of erosion on this outer bend (Slope #5)

Date Taken/Photographer: March 18, 1998 / S. Mitchell


Slope # 1
log deflectors
Slope # 2
Development of the side channel to include LWD, planting of whips and wattle fences
Slope # 3
Planting
New road required to place Rip Rap at toe of the slope
Utilize bank deflectors and Rip Rap to protect toe of the slope
Slope # 4
Gravel Bar
Planting
Slope # 5
Flow
Plant 10m strip along edge of slope

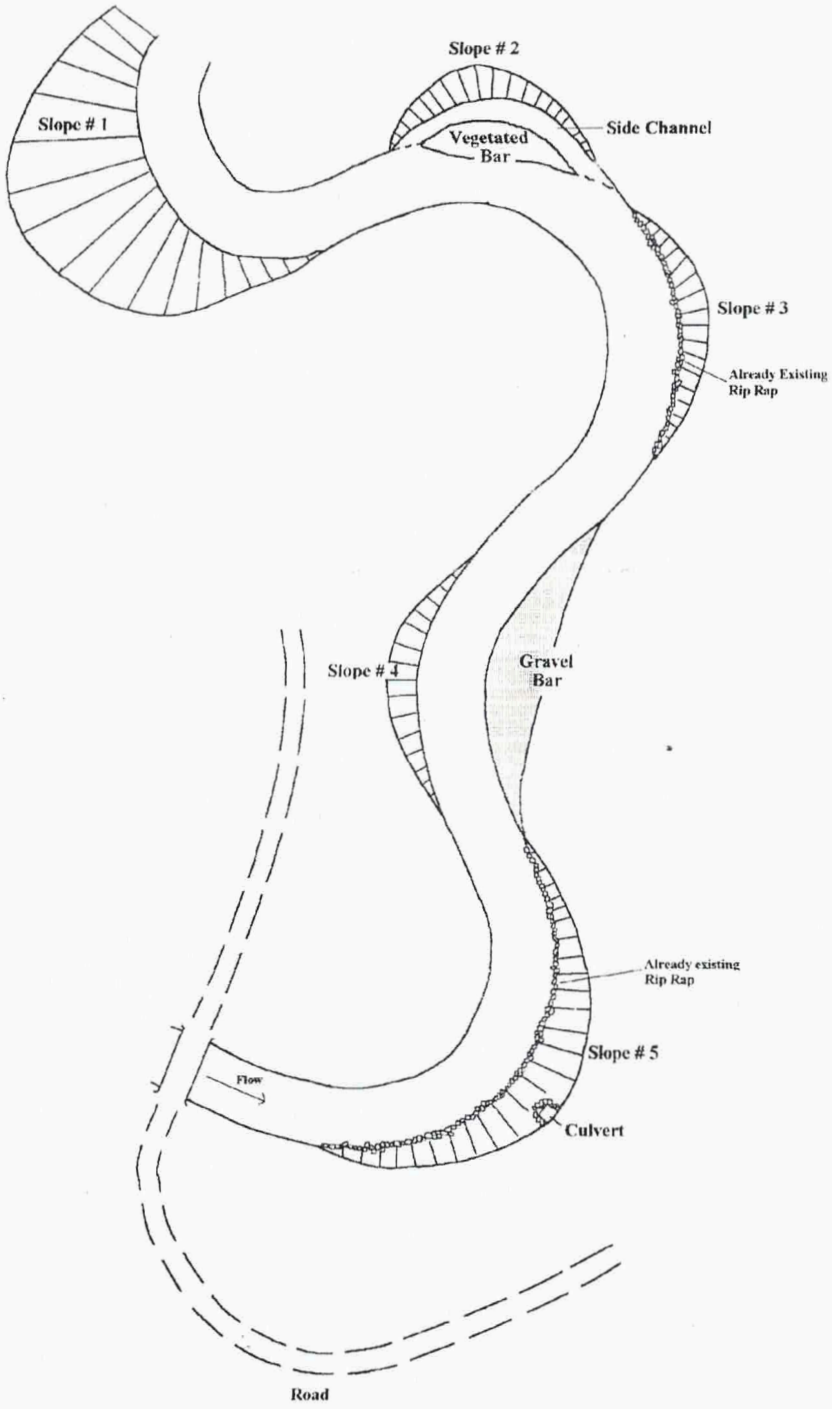


Figure 4: Site map and proposed works for Survey and Design SD-3. See Figure 5 for details of Slope #5.

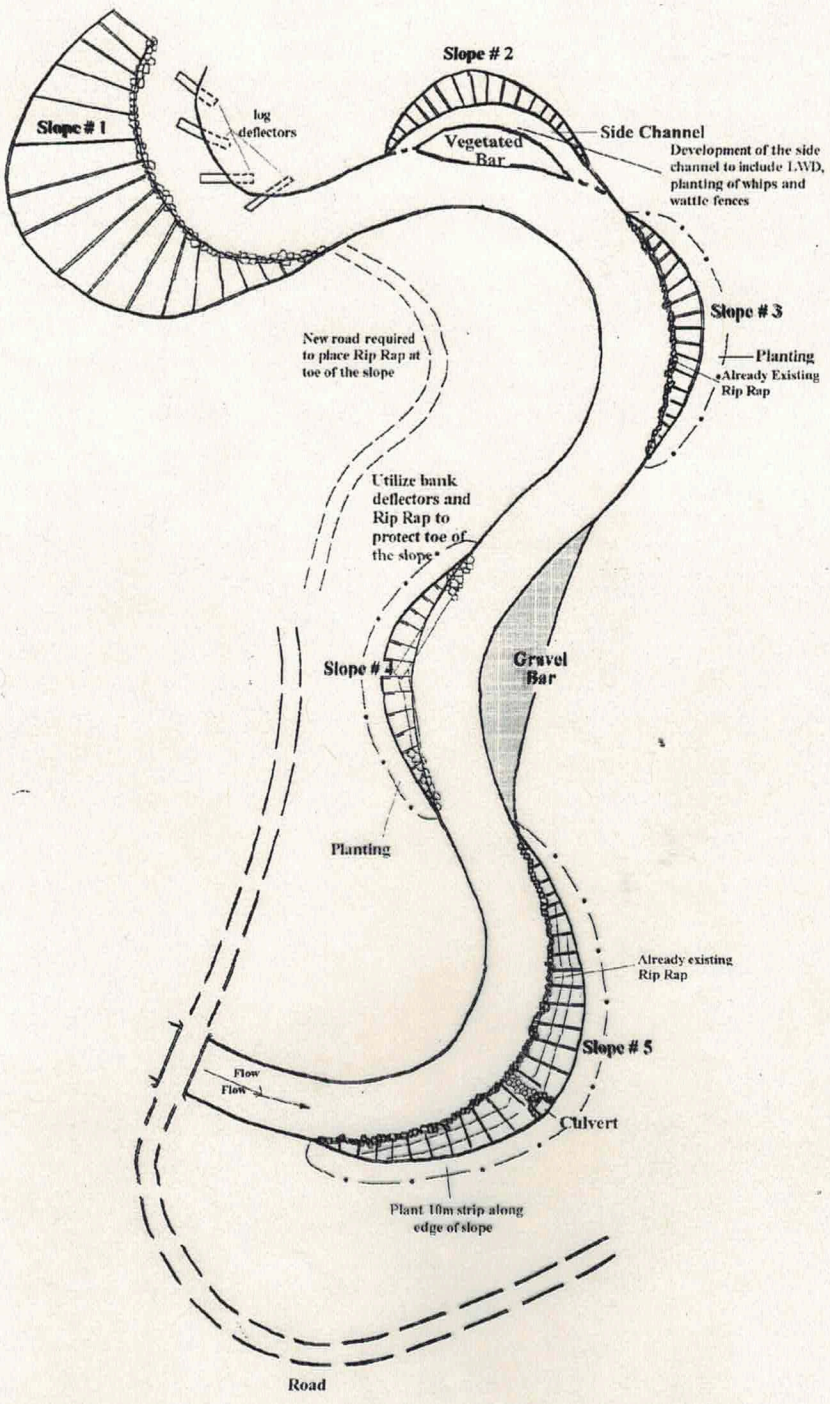


Figure 4: Site map and proposed works for Survey and Design SD-3. See Figure 5 for details of Slope #5.

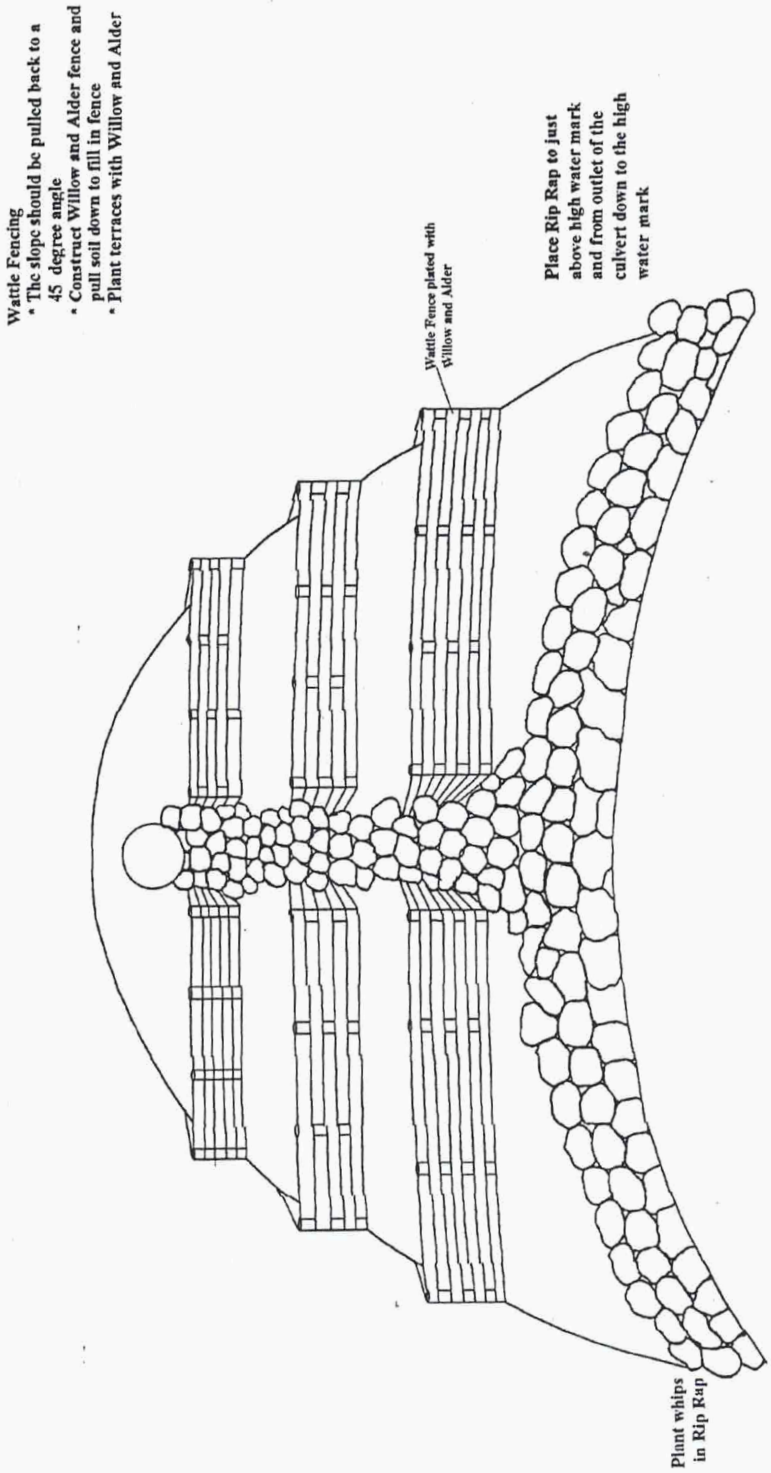


Figure 5: Details of Slope # 5 in SD-3. See Appendix 1 for details of construction

Survey and Design Number: SD-4
Prescription Number: Toboggan 5

LOCATION: 75 m downstream of the fish counting fence located 2.5 km upstream of the Toboggan Creek - Bulkley River confluence. UTM coordinates 7087580, 609080

IMPACT: Bank erosion along left bank (1-1.5 m in height) contributing sediments to stream.

PHOTO(S): None

DESCRIPTION OF PROPOSED WORKS: Wattle fences for 13 m along bank for lower extent and live crib walls along 25 m of bank in upper area (Figure 6) are recommended for this site. Riparian planting with willow (20%), alder (70%) and red-osier dogwood (10%) in a 10 m wide band for a distance of 75 m (~0.1 ha) along the top of the bank is also required.

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ Reduction in erosion/sediment contribution and channel movement.
- ❒ Re-establishment of riparian integrity
- ❒ Local employment for slope stabilization and planting

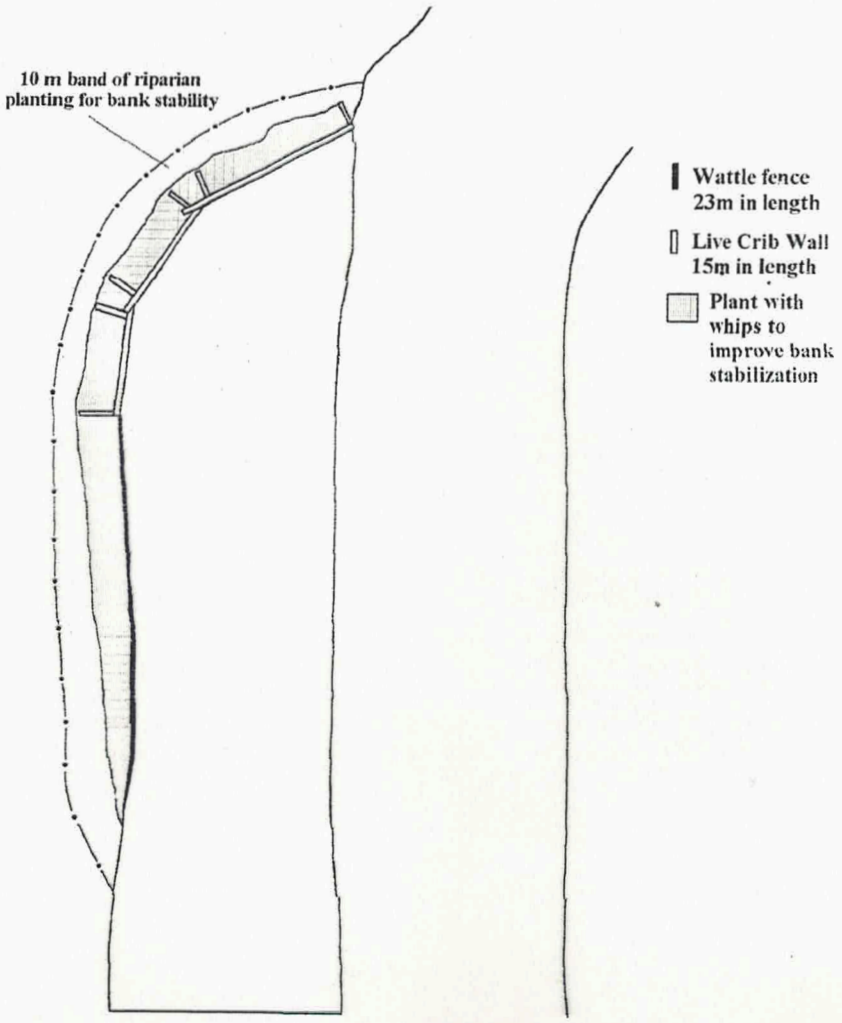
SCHEDULE FOR IMPLEMENTATION: The schedule for proposed works is:

1. Acquire approvals
2. Order and store planting/bioengineering stock
3. Crib wall construction (June/July)
4. Live crib walls placed in-channel (August low flows)
5. Wattle fence construction & riparian planting (Spring 1999)
6. Post-Works monitoring (Spring flows 1999)

ESTIMATED COST FOR COMPLETION:

Machinery - Chainsaw/drill rental (1 day @ $50/day)	$ 50
Materials - Rebar/cable	$ 50
- Geotextile (80 m^2 @ $1.25/$m^2$)	$ 100
- Lumber (live crib walls)	$ 200
- Stock (whips & wattling)	$ 300 (estimate)
- Stock (shrubs for planting)	$ 200 (estimate)
Labor - 1 man-days ($450/man-day)	$ 450
- 6 man-days ($250/man-day)	$ 1,500
Monitoring - 0.5 man-day (@$450/man-day)	$ 225
Total	**$3,075**

APPROVALS REQUIRED: Mr. K. Landrock (Landowner), Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks.


10 m band of riparian planting for bank stability
Wattle fence 23m in length
Live Crib Wall 15m in length
Plant with whips to improve bank stabilization

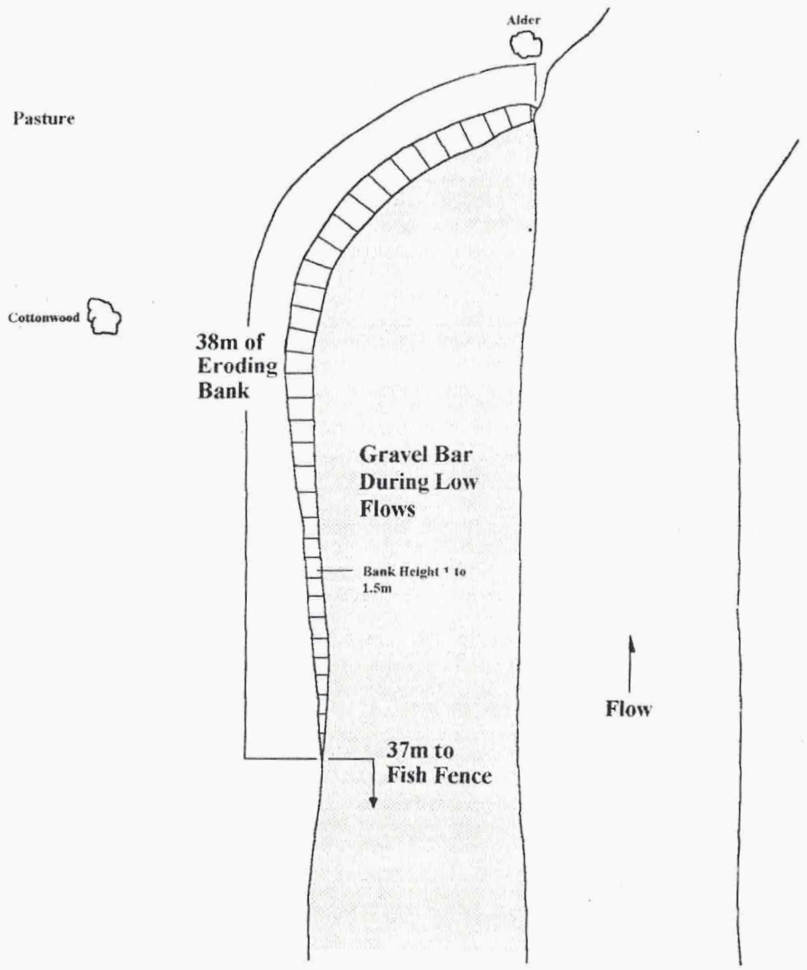


Figure 6: Site map and proposed works for Survey and Design SD-4. See Appendix 1 for live crib wall construction details.

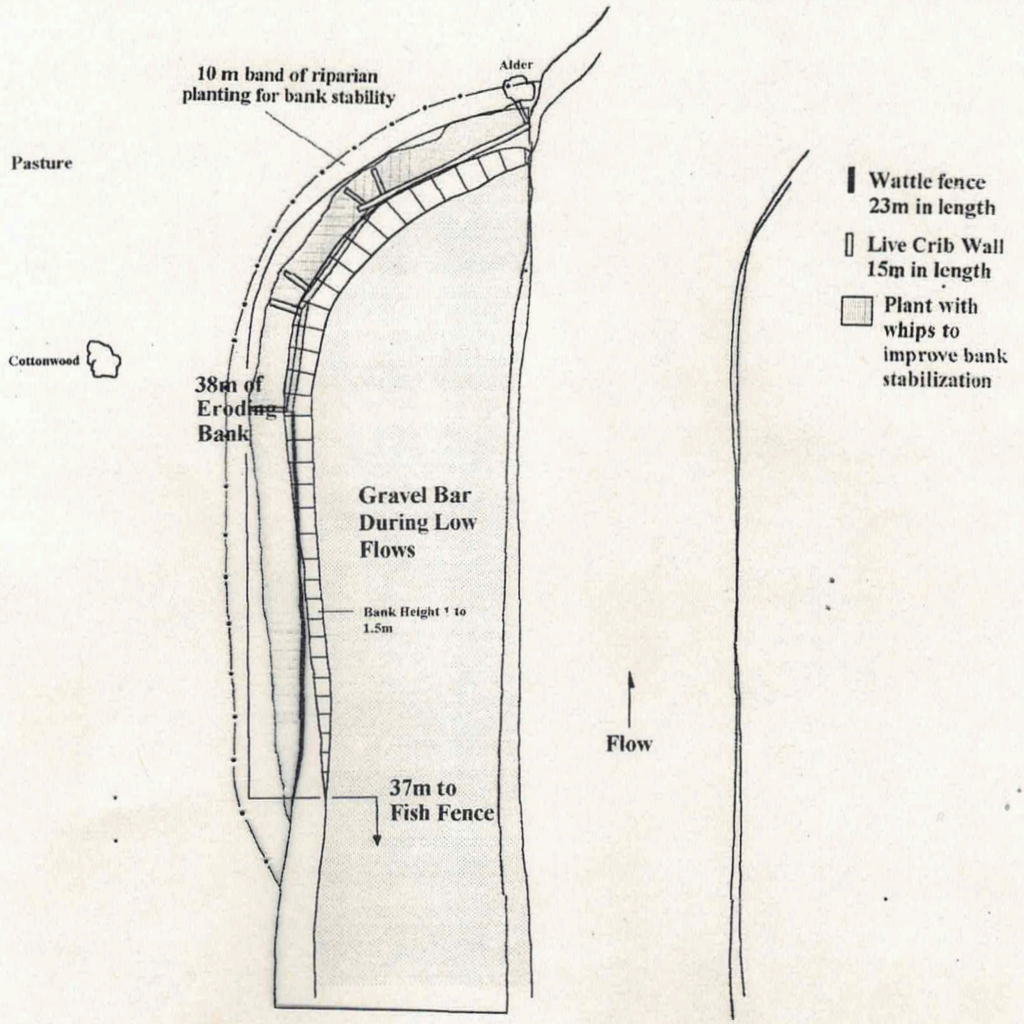


Figure 6: Site map and proposed works for Survey and Design SD-4. See Appendix 1 for live crib wall construction details.

Survey and Design Number: SD-5
Prescription Number: Toboggan 6

LOCATION: Approximately 150 m upstream of fish counting fence located 2.5 km upstream of the Toboggan Creek - Bulkley River confluence. UTM coordinates 6087420, 609020.

IMPACT: Bank erosion/slumping on outside bend of stream. Stock trampling in this area to access water has exacerbated the slumping.

PHOTO(S): TB-5

DESCRIPTION OF PROPOSED WORKS: Mr. Hopps (Landowner) is proposing to fence the left side of the stream and use that pasture primarily for his stock. The pasture on the right bank (the area of concern) will probably only be of use for 10 bulls for approximately four months of the year under this scheme. This will reduce the impact to the area. To rehabilitate this section of stream and minimize future impacts from stock, works should include (Figure 7):

1. Rip-rap placement (joint planting [100% willow]) along outside bend of the stream to stabilize bank,
2. Pull back small failing bank to 45° and planting (0.05 ha) with willow (60%) and red-osier dogwood (30%), aspen (20 trees) and spruce (20 trees) to ensure long-term stability,
3. Placement of obstacles (i.e. tree trunks) around this failing curve to prevent stock from accessing the stream at this point,
4. Excavation of watering channel for stock to discourage their use of the stream.

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ Reduced sediment contribution to Toboggan Creek from slumping banks
- ❒ Reduced livestock trampling along stream
- ❒ Increased bank stability at the bend of the stream
- ❒ Improved riparian integrity
- ❒ Local employment for slope stabilization.

SCHEDULE FOR IMPLEMENTATION: The schedule for proposed works is:

1. Acquire approvals
2. Delivery of required rip-rap and LWD for obstacles (July/August)
3. Placement of rip-rap & excavation of watering channel (August)
4. Pull back slope to 45° & placement of obstacles (August/September)
5. Joint planting of rip-rap and planting of slope (Spring 1999)
6. Post-Works monitoring (Spring flows 1999)

ESTIMATED COST FOR COMPLETION:

Machinery - Hoe (1.5 day @ $1,000/day)	$ 1,500	
Materials - Rip-rap (60 m^3 @ $50/$m^3$)	$ 3,000	
- Geotextile (100m^2 @ $1.25/$m^2$)	$ 125	
- Stock (whips & joint plantings)	$ 300	(estimate)
- Stock (trees)	$ 50	(estimate)
- Obstacles (available from landowner)		
Labor - 1 man-day ($450/man-day)	$ 450	
- 3 man-days ($250/man-day)	$ 750	
Monitoring - 0.5 man-day (@$450/man-day)	$ 225	
Total	**$6,400**	

APPROVALS REQUIRED: Mr. L. Hopps (Landowner), Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks.

TOBOGGAN CREEK SURVEY AND DESIGN FIELD PHOTOGRAPH

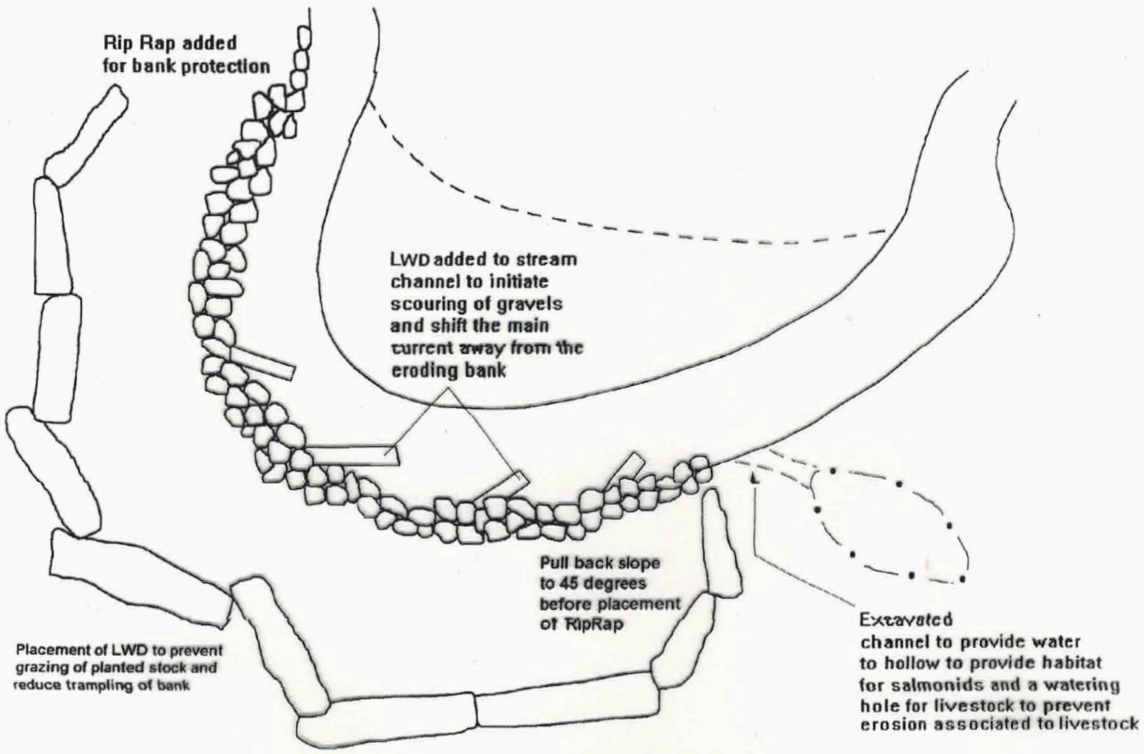
Photo Number: TB-5

Survey & Design/Prescription #: SD-5 / Toboggan 6

Location: Approximately 150 m upstream of fish counting fence.

Comments: Outside bend (where person is standing, streamflow toward photographer) being rapidly eroded by stream and livestock trampling.

Date Taken/Photographer: March 16, 1998 / S. Mitchell


Rip Rap added
for bank protection
LWD added to stream
channel to initiate
scouring of gravels
and shift the main
current away from the
eroding bank
Pull back slope
to 45 degrees
before placement
of RipRap
Placement of LWD to prevent
grazing of planted stock and
reduce trampling of bank
Excavated
channel to provide water
to hollow to provide habitat
for salmonids and a watering
hole for livestock to prevent
erosion associated to livestock

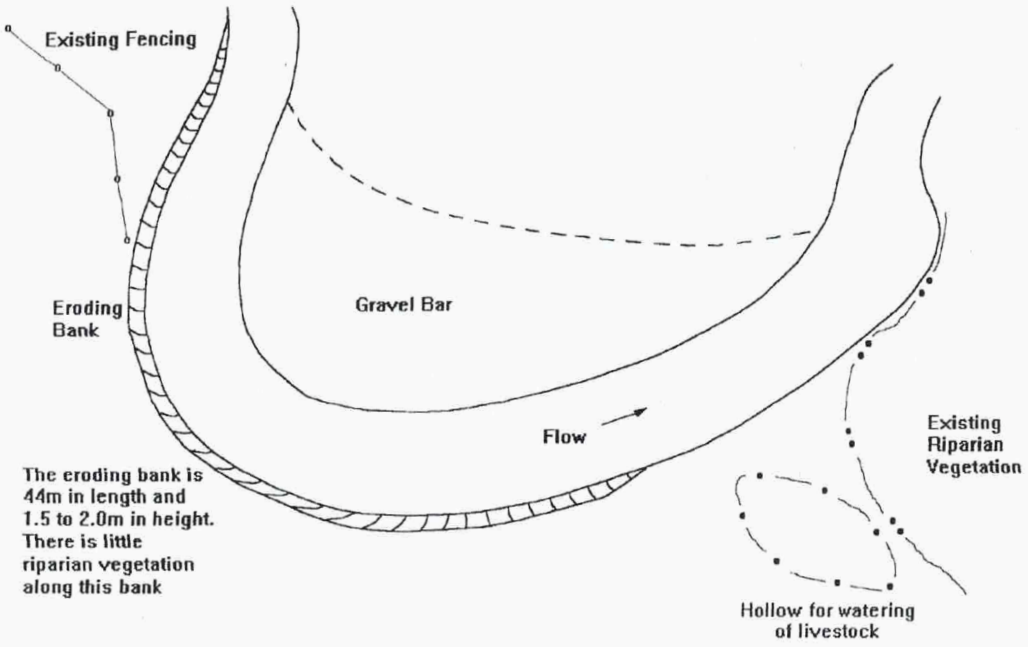


Figure 7: Site map and proposed works for Survey and Design SD-5

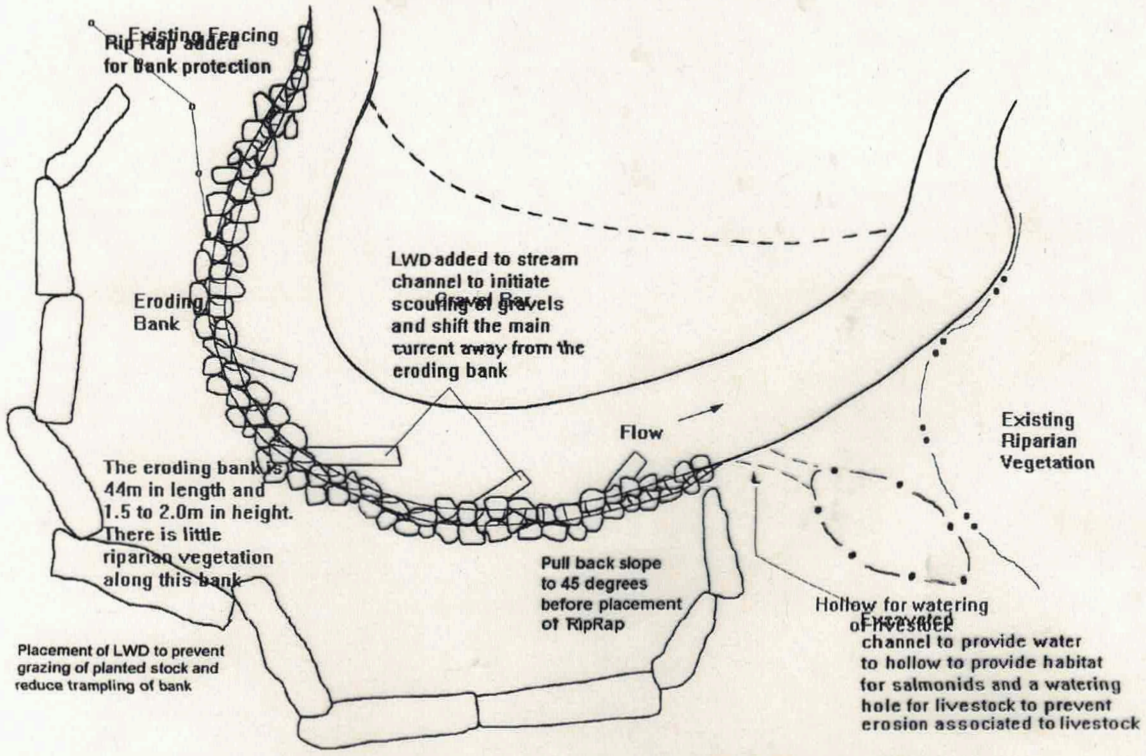


Figure 7: Site map and proposed works for Survey and Design SD-5

Survey and Design Number: SD-6
Prescription Number: Toboggan 7

LOCATION: Approximately 250 m upstream of fish counting fence located 2.5 km upstream of the Toboggan Creek - Bulkley River confluence. UTM coordinates 6087380, 609240.

IMPACT: Large bank failure along right bank contributing large quantities of sediment to Toboggan Creek. The toe of the slope is being cut by the stream, there are discrete points of groundwater seepage exiting the failure further contributing to the erosion and sedimentation, and overland flow over the top of the bank is hastening the cutting into the soft soils.

PHOTO(S): TB-6

DESCRIPTION OF PROPOSED WORKS: The required works fall into three areas (Figures 8 and 9):

1. Toe of the slope - Placement of a three large logs as bank deflectors (2 high by three long, cabled at upstream end and anchored by rebar to substrate) is recommended to deflect the force of the water away from the eroding slope. Rip-rap is recommended at the upstream end to prevent digging out of the bank behind the structure.
2. Mid-slope - Live crib walls are recommended above the revetment to stabilize the slope. Construction of terraces is recommended to relieve the angle of the slope and provide level areas for seed colonization, accumulation of litter, etc. In the four areas of groundwater seepage lining small channels down to the stream with willow whips across the slope to break up the force of the water and collect sediments recommended in order to confine these flows and dissipate the energy of the moving water. At the point where these four channels meet the deflectors large rock (small boulder/rip-rap) should be placed behind the deflectors in order to allow the water to drain rather than either running over the deflectors or eroding the banks behind them. Planting of the terraces is also required (willow 70% and red-osier dogwood 30%). The exposed slopes should also be seeded with a grass (recommend creeping red fescue) for rapid stability.
3. Top of slope - The planting of the strip of land between the bank edge and existing fence is required to reduce the movement of water overland and through the soil. Species planted should include red-osier dogwood, cottonwood, aspen, and spruce (15 trees each). In addition, the landowner (Mr. Hopps) has agreed with extending short fences from his existing fence to the slope failure in order to prevent stock access to the top of the slope.

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ Reduced sediment input to Toboggan Creek
- ❒ Short and long term bank stability to minimize lateral channel movement in this direction
- ❒ Local employment for slope stabilization and planting

SCHEDULE FOR IMPLEMENTATION: The schedule for proposed works is:

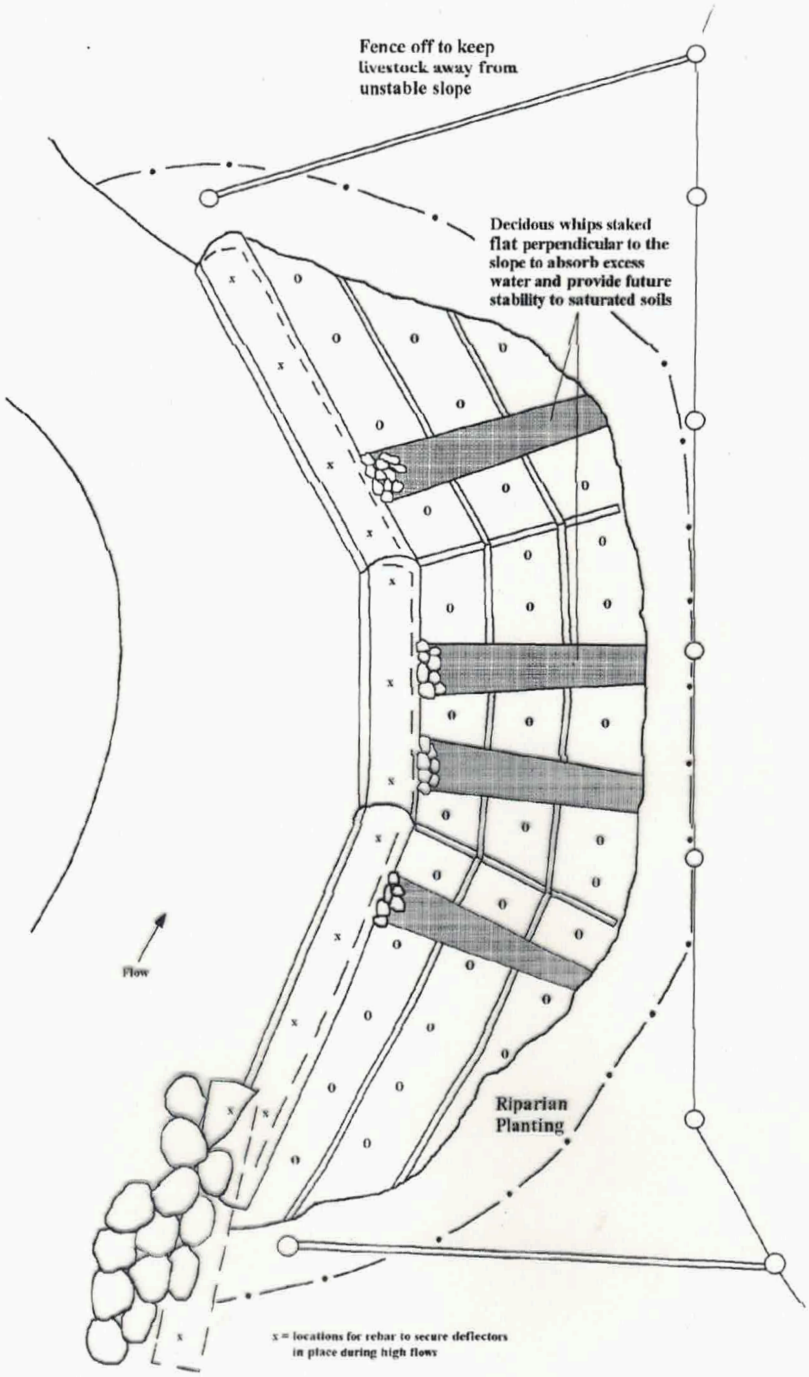
1. Acquire approvals
2. Delivery of required trees and rip-rap for structures (July/August)
3. Construction and anchoring of deflectors (August)
4. Construction of crib walls and drainage channels, grass seeding of slope, erection of fence to exclude livestock (August/September)
5. Planting of crib walls and top of slope (Spring 1999)
6. Post-Works monitoring (Spring flows 1999)

ESTIMATED COST FOR COMPLETION:

Machinery - Hoe (1 day @ $1,000/day)	$ 1,000	
- Chainsaw/drill rental (4 days @ $50/day)	$ 200	
Materials - Rip-rap/gravels for channels (25m^3 @ $50/$m^3$)	$ 1,250	
- Geotextile (300 m^2 @ $1.25/$m^2$)	$ 375	
- Trees for revetments (six)	$ 2,000	(estimate)
- Stock (whips & joint plantings)	$ 400	(estimate)
- Stock (trees/grass seed)	$ 100	(estimate)
- Lumber (crib walls)	$ 400	
- Rebar/cable	$ 100	
Labor - 1 man-day ($450/man-day)	$ 450	
- 8 man-days ($250/man-day)	$ 2,000	
Monitoring - 0.5 man-day (@$450/man-day)	$ 225	
Total	**$ 8,500**	

APPROVALS REQUIRED: Mr. L. Hopps (Landowner), Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks

Photo Number: TB-6
Survey & Design/Prescription #: SD-6 / Toboggan 7
Location: Approximately 250 m upstream of fish counting fence.
Comments: Large eroding right bank. Upper photo looking downstream, lower photo looking upstream.
Date Taken/Photographer: October 24, 1997 / G. Wadley (upper photo)
March 16, 1998 / S. Mitchell (lower photo)


Fence off to keep livestock away from unstable slope
Deciduous whips staked flat perpendicular to the slope to absorb excess water and provide future stability to saturated soils
Flow
Riparian Planting
x = locations for rebar to secure deflectors in place during high flows

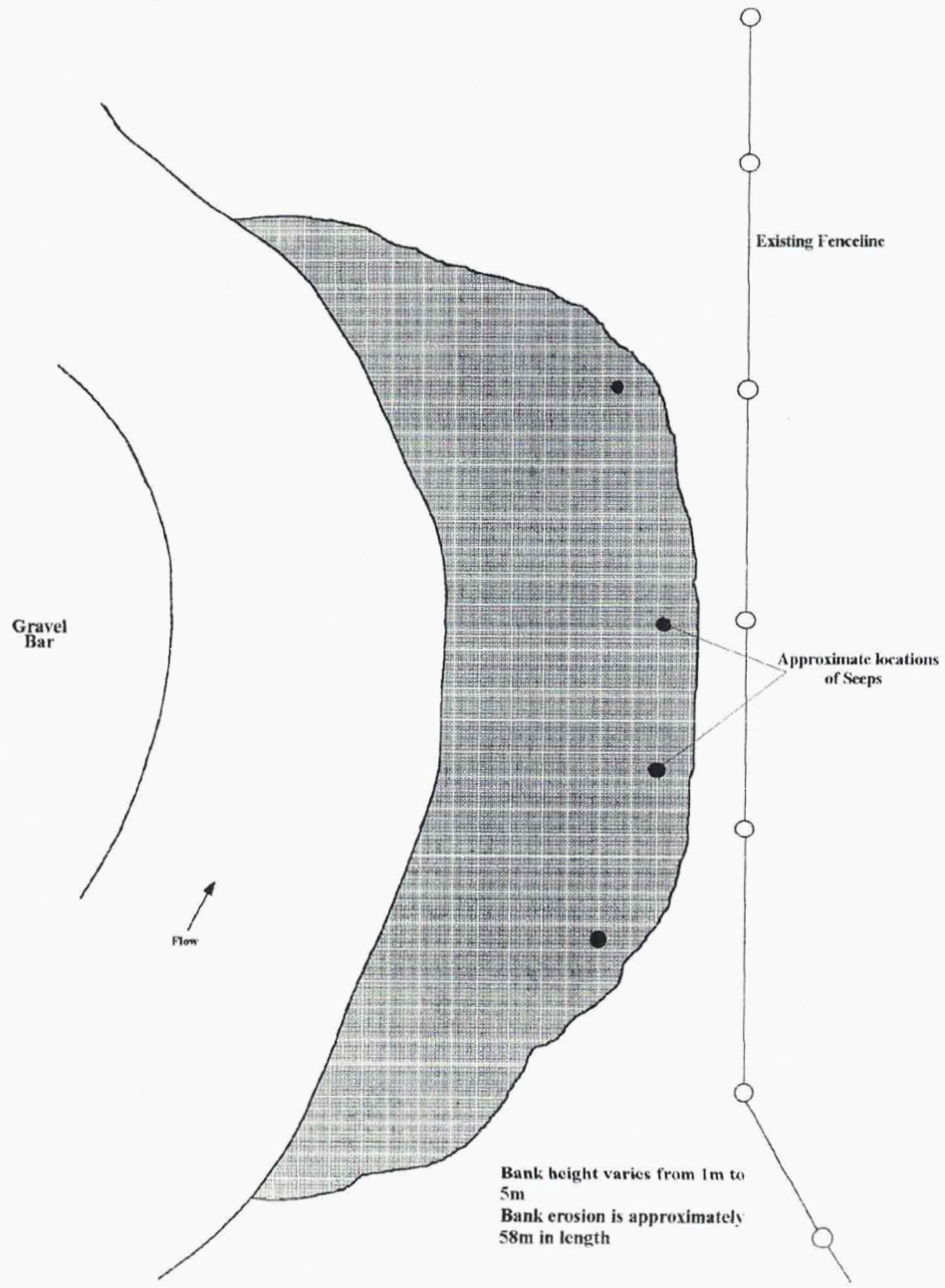


Figure 8: Site map and proposed woks for Survey and Design SD-6. See also Figure 9 and Appendix 1 for details

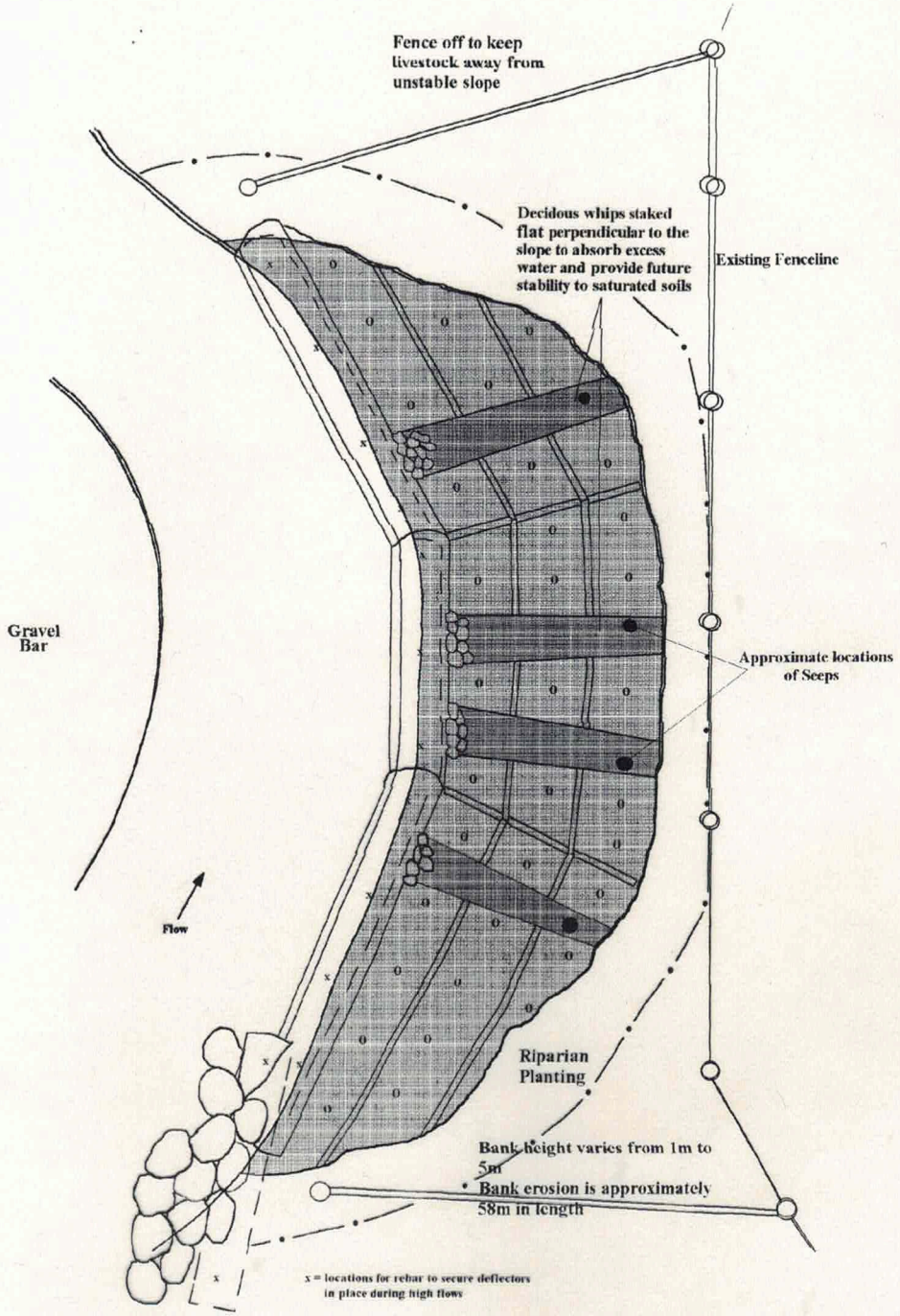


Figure 8: Site map and proposed woks for Survey and Design SD-6. See also Figure 9 and Appendix 1 for details

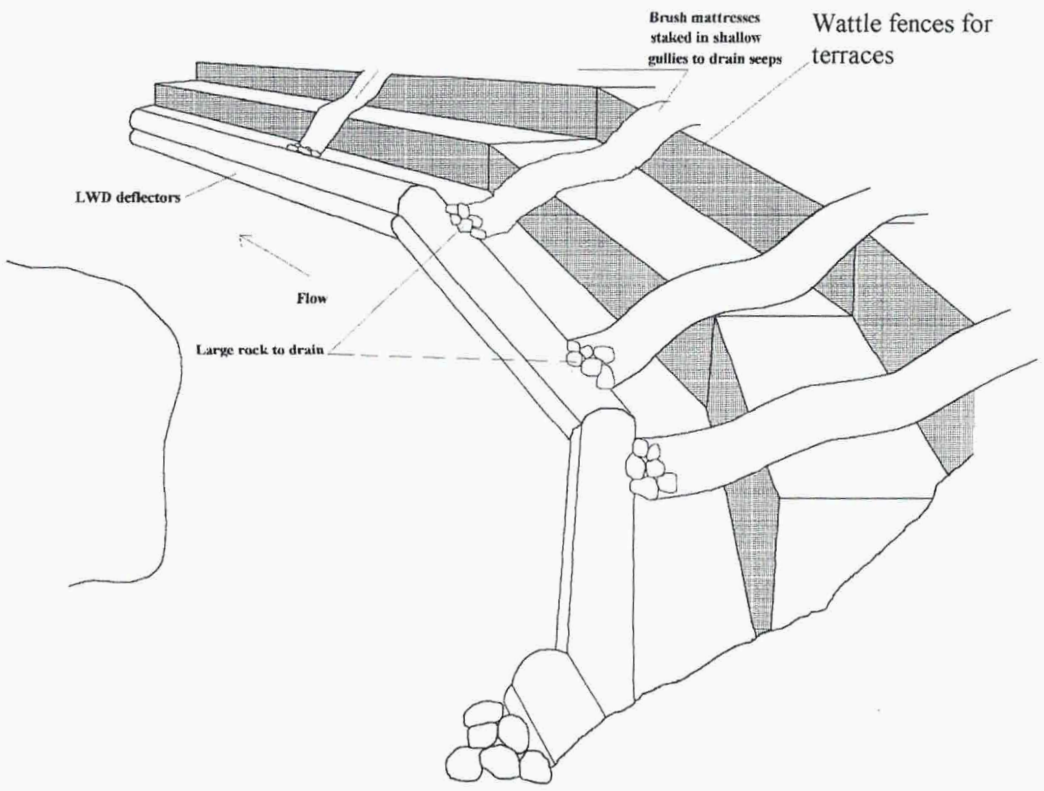


Figure 9: Oblique view of proposed works for Survey and Design SD-6

Survey and Design Number: SD-7
Prescription Number: Toboggan 8

LOCATION: Upstream and downstream of Mr. A. Booths bridge crossing across highway from Evelyn Community Hall. UTM coordinates 6086677, 610365

IMPACT: Riparian clearing and numerous areas of bank instability along approximately 600 m of pasture.

PHOTO(S): TB-7

DESCRIPTION OF PROPOSED WORKS: Along the right bank of this 600 m stretch riparian planting of willow, spruce and cottonwood is required (Figure 10). There is some riparian vegetation present, so the planting recommended is clump and fill planting between the water line and the present fenceline (spruce and cottonwood spaced one every 3-4 m [i.e. ~1000 stems/ha]). Recommended in-stream works are for the placement of cabled log deflectors on several outside bends (Figure 10). Channelizing a short section upstream of the bridge between bends in order to provide a straighter approach to the bridge is also recommended. This will also provide local off-channel areas for rearing.

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ improved riparian structural and functional integrity
- ❒ Short term (deflectors) and long term (riparian planting) reduction of sediment contribution from eroding banks
- ❒ Provision of off-channel areas by channelizing through a meander
- ❒ Local employment for bank stabilization and planting

SCHEDULE FOR IMPLEMENTATION: The schedule for proposed works is:

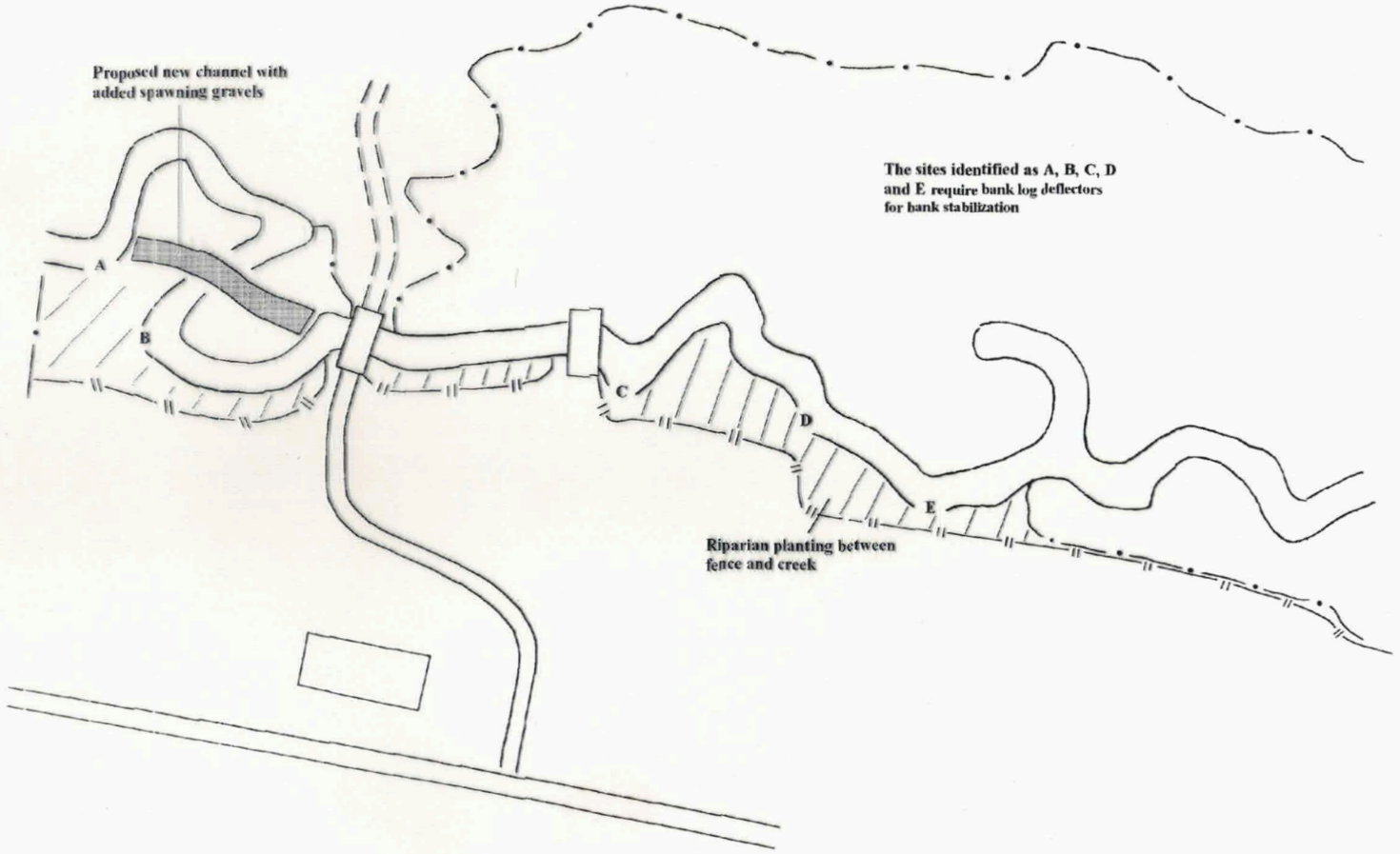
1. Acquire approvals
2. Delivery of LWD for bank deflectors
3. Placement and anchoring of deflectors (August low flows)
4. Channelization of bend upstream of bridge crossing (August low flows)
5. Riparian planting (Spring 1999)
6. Post-Works monitoring (Spring flows 1999)

ESTIMATED COST FOR COMPLETION:

Machinery - Hoe (2 day @ $1,000/day)	$ 2,000
- Chainsaw/drill rental (2 days @ $50/day)	$ 100
Materials - LWD (12-20 pieces)	$ 2,500 (estimate)
- Stock (whips)	$ 200 (estimate)
- Stock (trees)	$ 300 (estimate)
- Rebar/cable	$ 100
Labor - 2 man-days ($450/man-day)	$ 900
- 5 man-days ($250/man-day)	$ 1,250
Monitoring - 0.5 man-day (@$450/man-day)	$ 225
Total	**$ 7,575**

APPROVALS REQUIRED: Mr. A. Booth (Landowner), Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks.

Photo Number: TB-7
Survey & Design/Prescription #: SD-7 / Toboggan 8
Location: Across highway from Evelyn Community Hall (A. Booth property).
Comments: Meandering stream with multiple eroding banks and little large riparian stock. Note fine texture of banks in lower photograph.
Date Taken/Photographer: March 18, 1998 / S. Mitchell


Proposed new channel with added spawning gravels
The sites identified as A, B, C, D and E require bank log deflectors for bank stabilization
A
B
C
D
E
Riparian planting between fence and creek

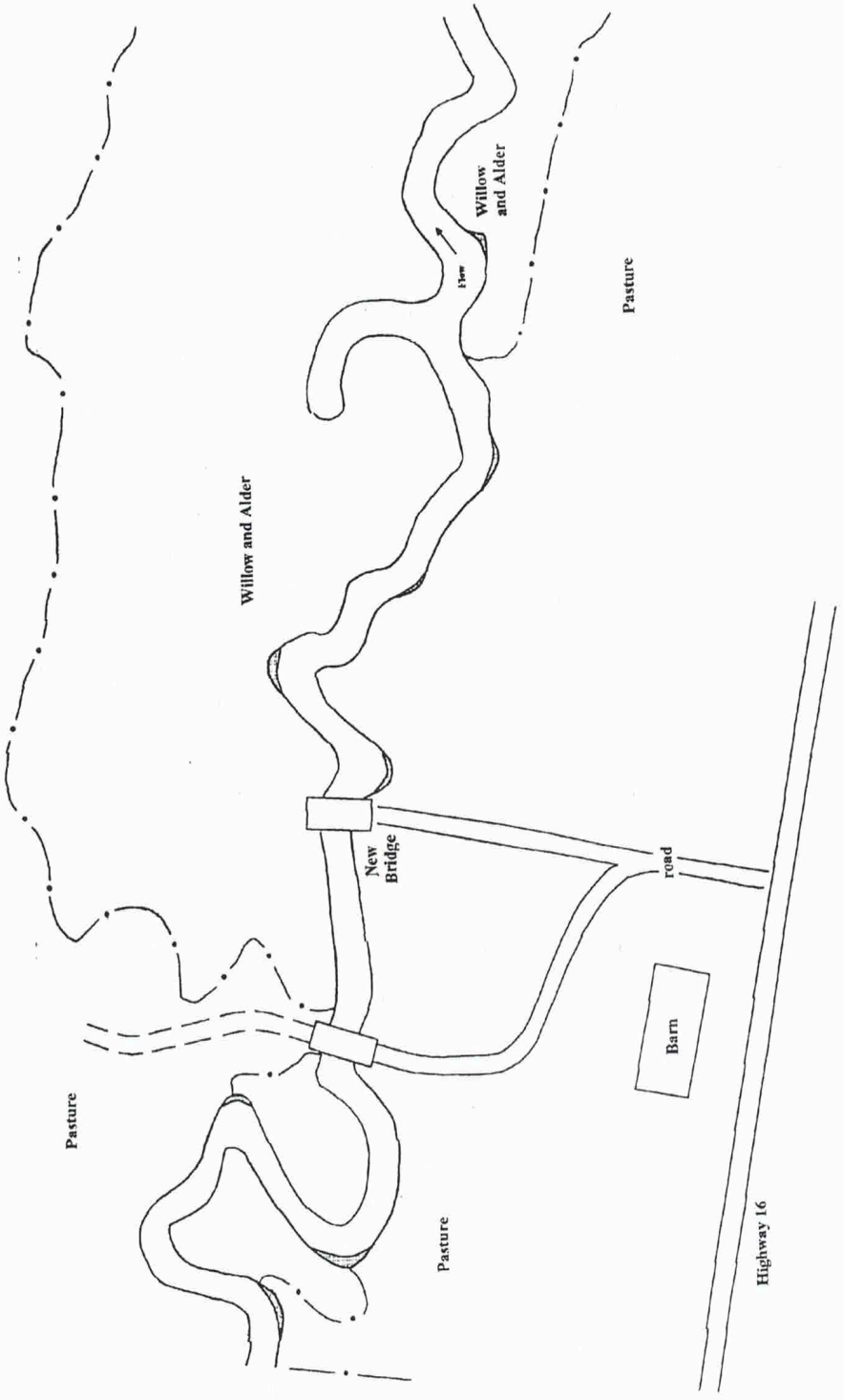


Figure 10: Site map and proposed works for Survey and Design SD-7

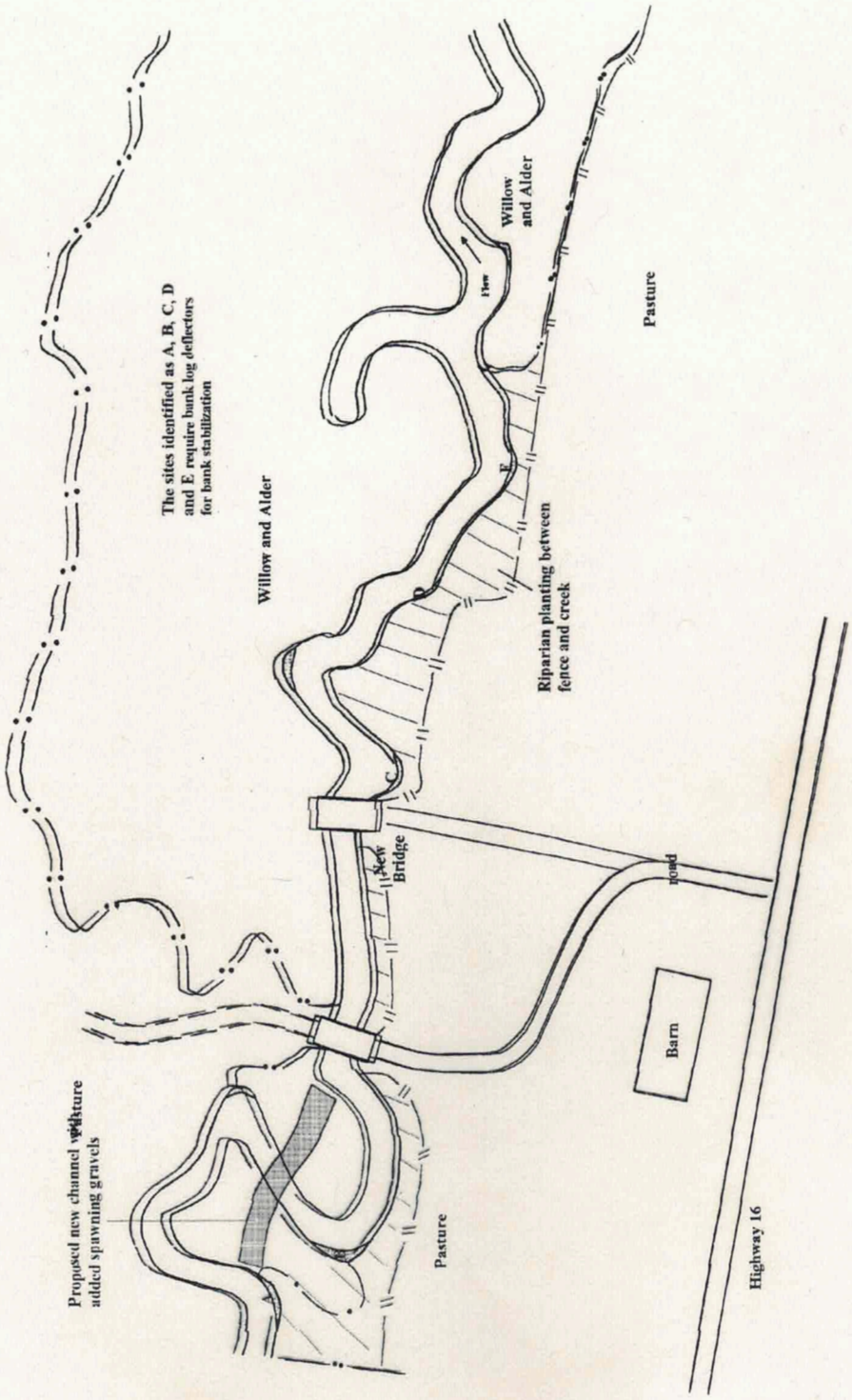


Figure 10: Site map and proposed works for Survey and Design SD-7

Survey and Design Number: SD-8
Prescription Number: Toboggan 9

LOCATION: Approximately 1.3 km downstream of Toboggan Creek Fish Hatchery. UTM coordinates 6084880, 610700

IMPACT: Riparian land clearing and some isolated eroding banks.

PHOTO(S): TB-8

DESCRIPTION OF PROPOSED WORKS: Fill planting with spruce (1 tree every 3-4 m [~1000 stems per ha]); beavers are present and will rapidly destroy planted deciduous stock (P. Lychak, pers. comm.). Both sides of the stream (P. Lychak on left bank, T. Storey on right) should be planted. Placement of bank log deflectors in two areas (Figure 11) are recommended to decrease bank erosion.

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ Riparian structural and functional integrity
- ❒ Short term (deflectors) and long term (riparian planting) reduction of sediment contribution from eroding banks
- ❒ Local employment for bank stabilization and planting

SCHEDULE FOR IMPLEMENTATION: The schedule for proposed works is:

1. Acquire approvals
2. Delivery of LWD for bank deflectors
3. Placement and anchoring of deflectors (August low flows)
4. Riparian fill planting (Spring 1999)
5. Post-Works monitoring (Spring flows 1999)

ESTIMATED COST FOR COMPLETION:

Machinery - Hoe (1 day @ $1,000/day)	$ 1,000
- Chainsaw/Drill rental (1 day @ $50/day)	$ 50
Materials - LWD (6-12 pieces)	$ 2,000 (estimate)
- Stock (trees [spruce])	$ 300 (estimate)
- Rebar/cable	$ 50
Labor - 1 man-day ($450/man-day)	$ 450
- 4 man-days ($250/man-day)	$ 1,000
Monitoring - 0.5 man-day (@$450/man-day)	$ 225
Total	**$ 5,075**

APPROVALS REQUIRED: Mr. P. Lychak (Landowner), Mr. T. Storey (Landowner), Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks.

TOBOGGAN CREEK SURVEY AND DESIGN FIELD PHOTOGRAPH

Photo Number: TB-8

Survey & Design/Prescription #: SD-8 / Toboggan 9

Location: Approximately 1.3 km downstream of Toboggan Creek Fish Hatchery.

Comments: Meandering stream with isolated areas requiring fill planting

Date Taken/Photographer: March 18, 1998 / S. Mitchell

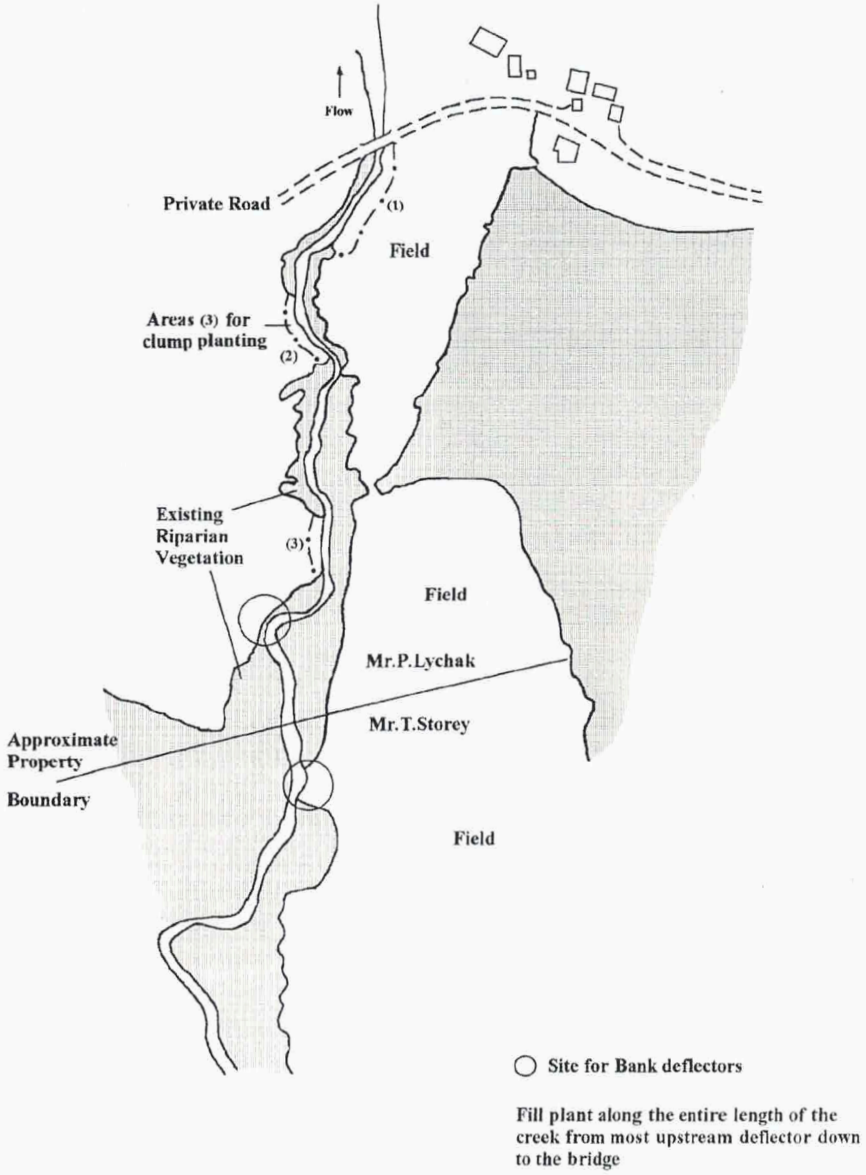


Figure 11: Site map and proposed works for Survey and Design SD-8

Survey and Design Number: SD-9
Prescription Number: Toboggan 12

LOCATION: Ditchline paralleling CN Railway tracks between Elliot Creek and the CN crossing of Toboggan Creek (800 m above Fish Hatchery). UTM coordinates 6083200, 611440

IMPACT: Channelization of ditch. Used by fish, including coho salmon (*Oncorhynchus kisutch*) but there is no deep pool presence or overstream vegetation to provide cover.

PHOTO(S): TB-9 & TB-10

DESCRIPTION OF PROPOSED WORKS: Establishment of five refuge pools and provision of overstream cover is required to improve habitat suitability (Figure 12). Pools should be dug (by hand) and structures (i.e. cross stream and V weirs) placed immediately upstream to ensure continued scour so as to prevent infilling. Construction of seven floating platforms is also recommended to provide low relief cover for fish. These floating platforms should be placed in combination with channel-spanning LWD clumps which also act as cover and should be adjacent to and over the refuge pits. There are two small channels entering the stream which also require development to allow access.

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ Improved habitat for fish spawning and rearing, particularly for coho salmon
- ❒ Habitat heterogeneity in an otherwise very homogenous stretch of stream
- ❒ Compensation for habitat degraded elsewhere
- ❒ Local employment for pool excavation, and structure/platform construction/placement

SCHEDULE FOR IMPLEMENTATION: The schedule for proposed works is:

1. Acquire approvals
2. Construction of floating platforms (June/July)
3. Delivery of LWD for channel spanning and in-stream structures (August)
4. Excavation of refuge pools, placement of in-stream structures, channel spanning structures and floating platforms (August)
5. Development of access to two small tributaries (August)
6. Post-Works monitoring (Spring flows 1999)

ESTIMATED COST FOR COMPLETION:

Machinery - CNR for delivery & placement of LWD		$ To be negotiated
- Chainsaw/Drill rental (3 days @ $50/day)		$ 150
Materials - LWD (30-40 pieces)		$ 5,000 (estimate)
- Geotextile (160 m^2 @ $1.25/$m^2$)		$ 200
- Lumber (floating platforms)		$ 400
- Rebar/cable/hardware		$ 200
Labor - 1 man-day ($450/man-day)		$ 450
- 6 man-days ($250/man-day)		$ 1,500
Monitoring - 0.5 man-day (@$450/man-day)		$ 225
	Total	**$ 7,900**

APPROVALS REQUIRED: CN Rail, Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks

TOBOGGAN CREEK SURVEY AND DESIGN FIELD PHOTOGRAPH

Photo Number: TB-9
Survey & Design/Prescription #: SD-9 / Toboggan 12
Location: Ditchline paralleling CN tracks immediately above Elliot Creek.
Comments: Channelized stream without cover, looking upstream (upper photo) and downstream (lower photo).
Date Taken/Photographer: March 17, 1998 / S. Mitchell

TOBOGGAN CREEK SURVEY AND DESIGN FIELD PHOTOGRAPH

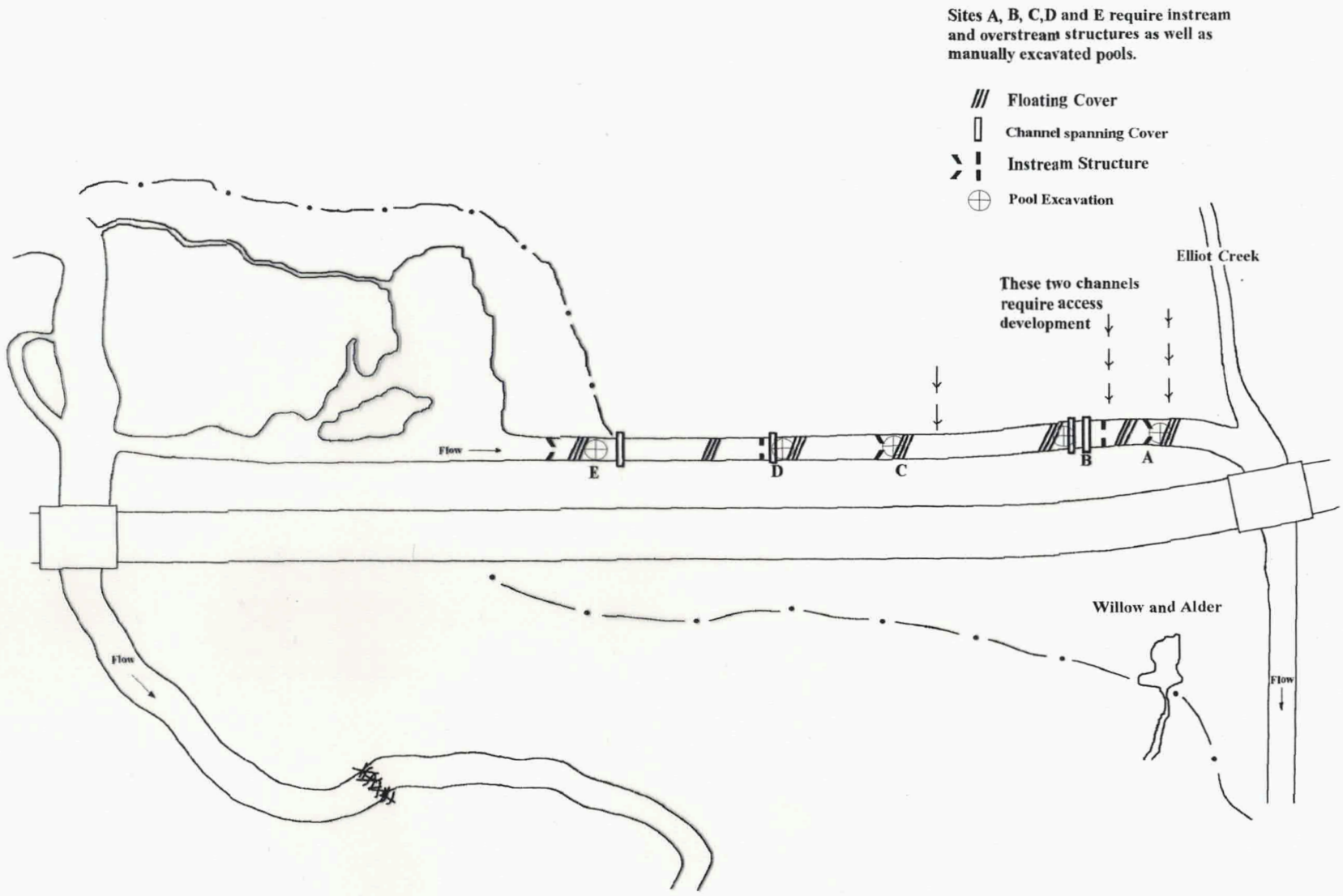
Photo Number: TB-10

Survey & Design/Prescription #: SD-9 / Toboggan 12

Location: Ditchline paralleling CN tracks immediately above Elliot Creek.

Comments: Substrate illustrating shallow depth and quality of substrate; Note high proportion of fines.

Date Taken/Photographer: March 17, 1998 / S. Mitchell


Sites A, B, C,D and E require instream and overstream structures as well as manually excavated pools.
Floating Cover
Channel spanning Cover
Instream Structure
Pool Excavation
Elliot Creek
These two channels require access development
Flow
E
D
C
B
A
Willow and Alder
Flow
Flow

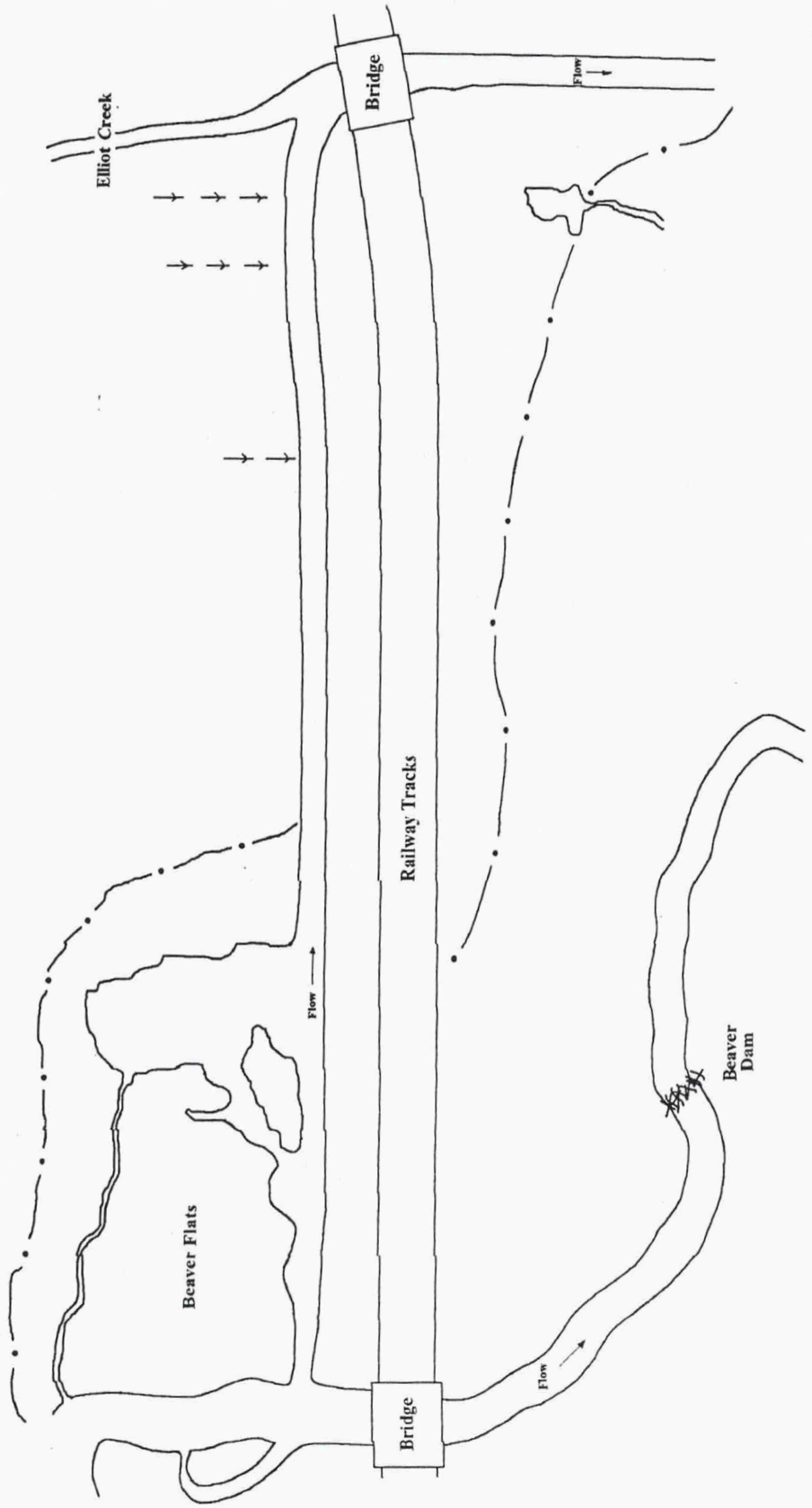


Figure 12: Site map and proposed works for Survey and Design SD-9

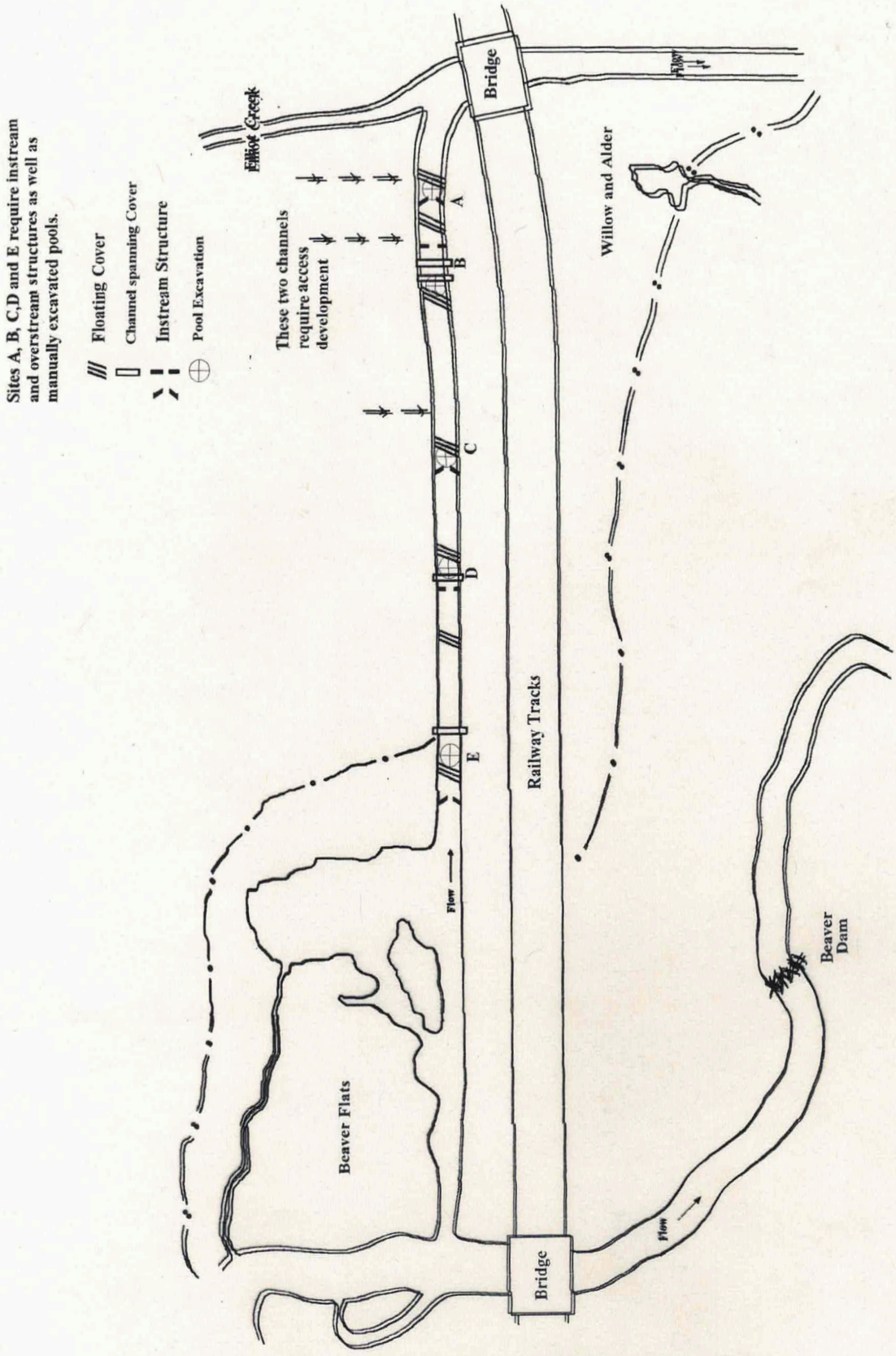


Figure 12: Site map and proposed works for Survey and Design SD-9

Survey and Design Number: SD-10
Prescription Number: Toboggan 13

LOCATION: Approximately 100 m downstream of the CNR bridge crossing which is approximately 800 m above the Toboggan Creek Fish Hatchery. UTM coordinates 6083080, 611460

IMPACT: Lack of riparian structure with resulting loss of shading and cover, and loss of terrestrial insect and litterfall.

PHOTO(S): TB-11

DESCRIPTION OF PROPOSED WORKS: The construction and placement of six floating platforms in six locations (Figure 13) is recommended to provide isolated areas of cover and shade. Riparian planting of a 10 m band on either side of the stream for 150 m below the railway crossing (~0.3 ha) with the shrubs willow, red-osier dogwood, and with cottonwood and spruce at a density of 1 tree every 3-4 m (~1000 stems per ha) is also required for long-term cover, shade, nutrient input and LWD recruitment.

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ Riparian structural and functional integrity
- ❒ Improved habitat for fish rearing in local areas
- ❒ Compensation for habitat degraded elsewhere
- ❒ Local employment for platform construction/placement and riparian planting

SCHEDULE FOR IMPLEMENTATION: The schedule for proposed works is:

1. Acquire approvals
2. Ordering and storing of planting stock
3. Construction of floating platforms (June/July)
4. Placement of floating platforms (August)
5. Riparian planting (Spring 1999)
6. Post-Works monitoring (Spring flows 1999)

ESTIMATED COST FOR COMPLETION:

Machinery - Chainsaw/drill rental (2 days @ $50/day)	$	100
Materials - Lumber (floating platforms)	$	400 (estimate)
- Rebar/cable/hardware	$	200
- Stock (whips & trees)	$	400

Labor - 1 man-day ($450/man-day)	$ 450
- 4 man-days ($250/man-day)	$ 1,000
Monitoring - 0.5 man-day (@$450/man-day)	$ 225
Total	**$ 2,775**

APPROVALS REQUIRED: Mr. E. Johnson (for use of road for access), Department of Fisheries and Oceans, Ministry of Environment. Lands and Parks.

Photo Number: TB-11
Survey & Design/Prescription #: SD-10 / Toboggan 13
Location: Immediately below CN rail crossing of Toboggan Creek upstream of Elliot Creek.
Comments: Lack of riparian or overstream cover reducing use of this area of stream due to lack of cover and terrestrial inputs.
Date Taken/Photographer: March 17, 1998 / S. Mitchell

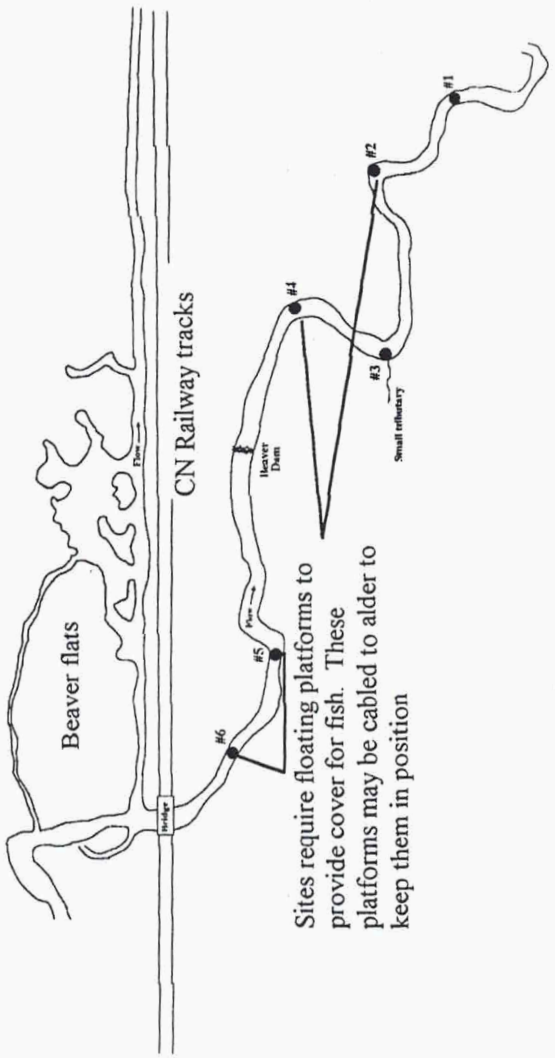


Figure 13: Site map and proposed works for Survey and Design SD-10

Survey and Design Number: SD-11
Prescription Number: Toboggan 14

LOCATION: Toboggan Creek approximately 100 m above confluence with Glacier Gulch Creek. UTM coordinates 6082200, 611520.

IMPACT: Toboggan Creek flows through multiple shallow channels prior to meeting Glacier Gulch Creek. This distribution of water among various shallow channels limits the depth and diversity of available habitat for fish.

PHOTO(S): TB-12

DESCRIPTION OF PROPOSED WORKS: Channelization of stream into single historic channel over 700 m (Figure 14). This is to include incorporation of meanders (wavelength 12 times bankfull width, radius of curvature 2.3 times bankfull width; Newbury et. al., 1997), digging of deep areas for pools, placement of instream LWD (cross stream and upstream angled weirs, angled log deflectors, bank log deflectors where required) to create scour and provide habitat diversity. Structures (i.e. cross stream weir) should be placed immediately upstream of excavated pools to ensure continued scour so as to prevent infilling. Selection of pool and structure placement should be determined in the field by field staff after the Spring high flows. After channel excavation is completed the riparian area should be planted with willow, cottonwood and spruce (1.4 ha at a low density of 500 of each tree species recommended). The intent is to provide a "seed" source rather than a comprehensive reforestation program.

There are two options for location of channel (Figure 14), with the channel nearest the road (Option 1) being preferred. It is the lowest channel and already exists (i.e. it is a natural channel). Any spoil from excavation should be placed to form a berm between the channel and the road so as to provide protection for the road. Option 2 is a straight channel from the upper area down to Toboggan Creek. This is not as likely to succeed as it does not mimic natural channel complexity in pattern and so will not develop as many pools, undercut banks, etc. Whichever option is selected, the channel should be excavated and structures placed up to above the powerline crossing (see also Survey and Design SD-12)

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ Restoration of the natural drainage pattern of the area
- ❒ Improve salmonid access to upstream habitat by confining flow to single channel
- ❒ Improve local salmonid habitat (particularly for coho salmon which are documented in the area)
- ❒ Decrease sediment and silt contribution from fields
- ❒ Local employment for in-stream structure placement and riparian planting

SCHEDULE FOR IMPLEMENTATION: The schedule for proposed works is:

1. Acquire approvals
2. Ordering and storing of planting stock
3. Channelization of stream & pool excavation (August)
4. Placement of instream structures (August)
5. Riparian planting (Spring 1999)
6. Post-Works monitoring (Spring flows 1999)

ESTIMATED COST FOR COMPLETION:

Machinery - Hoe (3 days @ $1,000/day)	$ 3,000
- Electroshocker (1day @ $100/day)	$ 100
- Chainsaw/drill rental (5 days @ $50/day)	$ 250
Materials - LWD (20-30 pieces)	$ 4,000 (estimate)
- Geotextlie (250m^2 @ $1.25/$m^2$)	$ 313
- Rebar/cable/hardware	$ 200
- Stock (whips & trees)	$ 500
Labor - 3 man-day ($450/man-day)	$ 1,350
- 10 man-days ($250/man-day)	$ 2,500
Monitoring - 1 man-day (@$450/man-day)	$ 450
Total	**$ 12,663**

APPROVALS REQUIRED: Mr. E. Johnson (Landowner), Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks, BC Hydro

TOBOGGAN CREEK SURVEY AND DESIGN FIELD PHOTOGRAPH

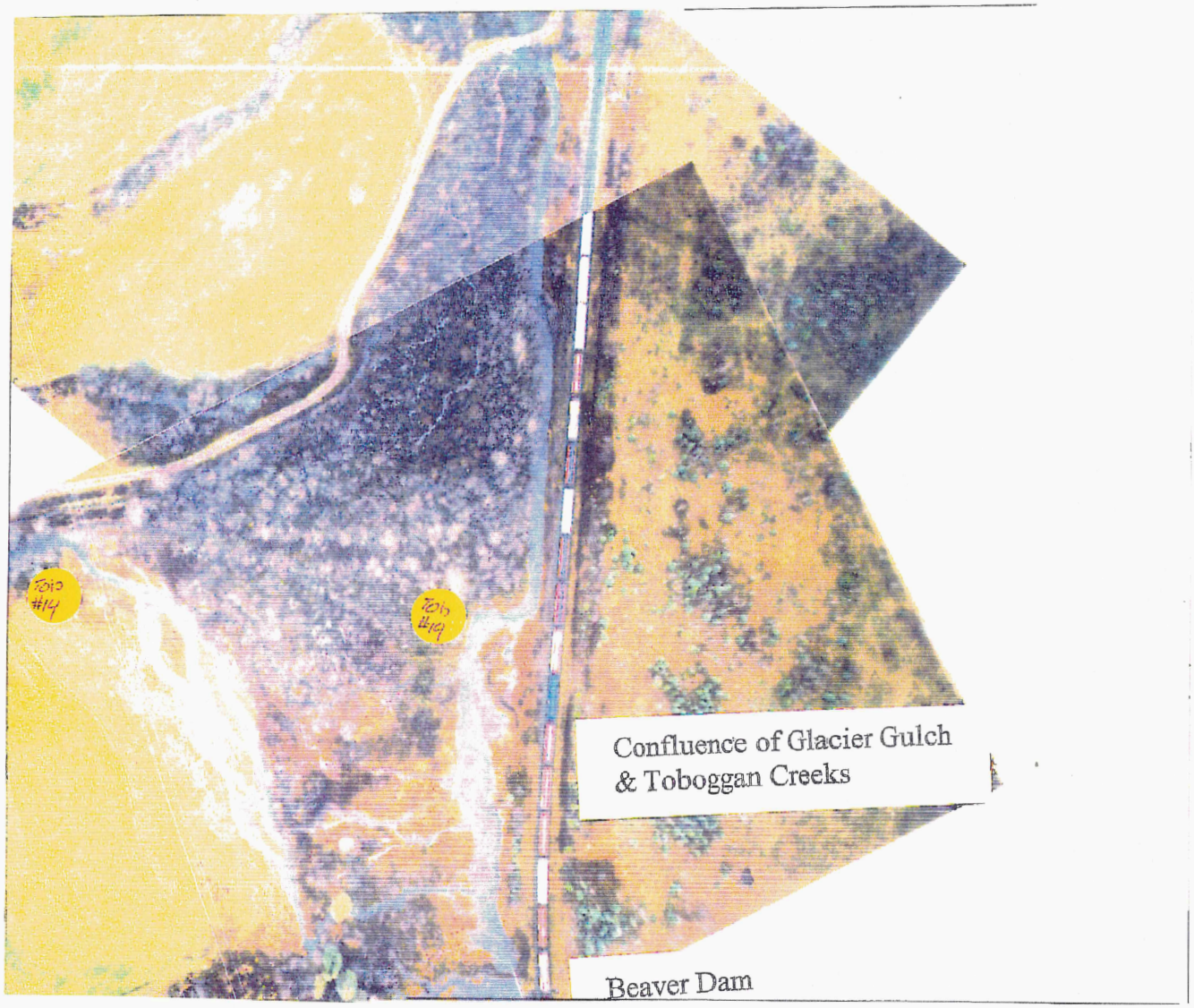


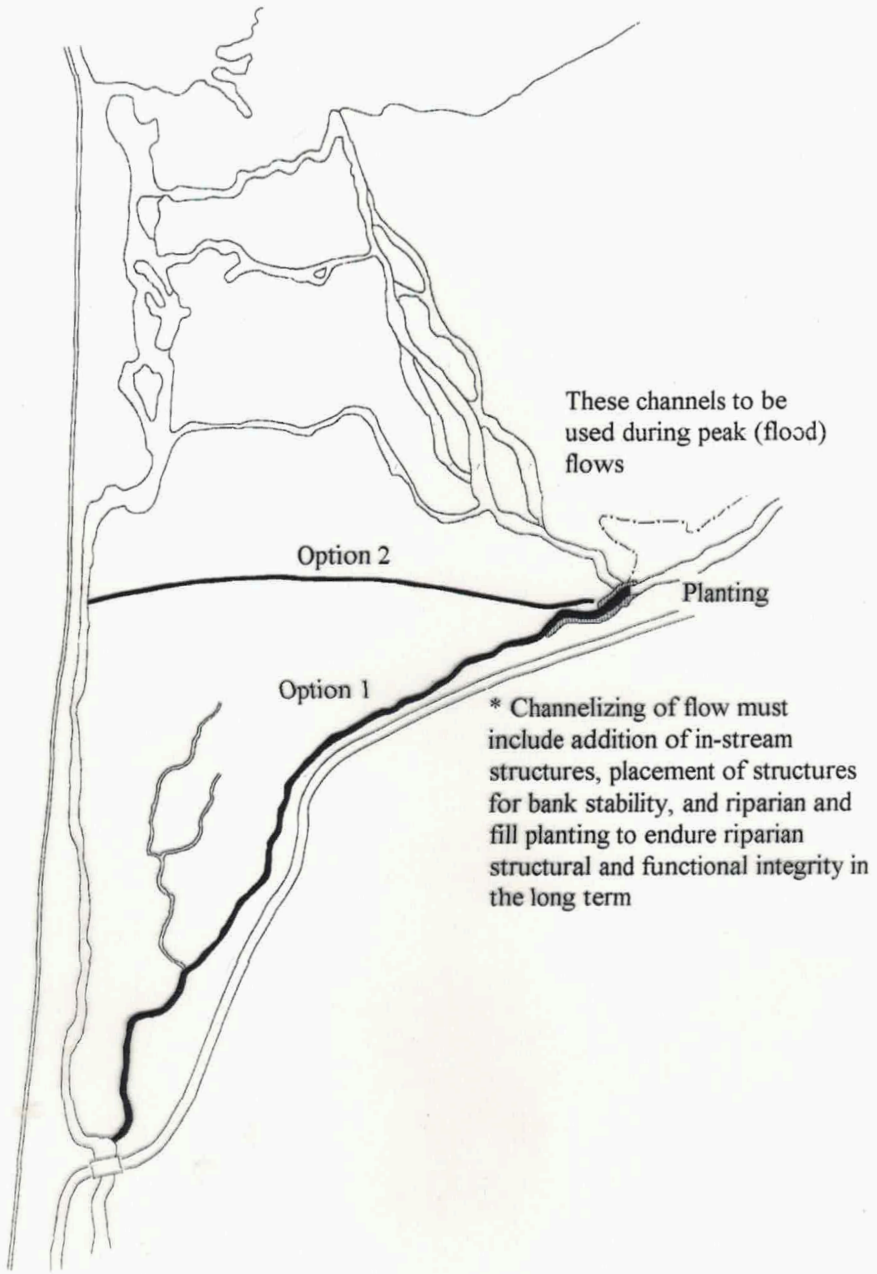
Photo Number: TB-12

Survey & Design/Prescription #: SD-11 / Toboggan 14

Location: Toboggan Creek between Glacier Gulch confluence and powerline through Mr. E. Johnsons property

Comments: Multiple channels distributing flow leading to low quality habitat and carrying sediment loads from the powerline crossing and fields upstream leading to aggradation.

Date Taken/Photographer: October 22, 1997 / L. Gibson


These channels to be used during peak (flood) flows
Option 2
Planting
Option 1
* Channelizing of flow must include addition of in-stream structures, placement of structures for bank stability, and riparian and fill planting to endure riparian structural and functional integrity in the long term

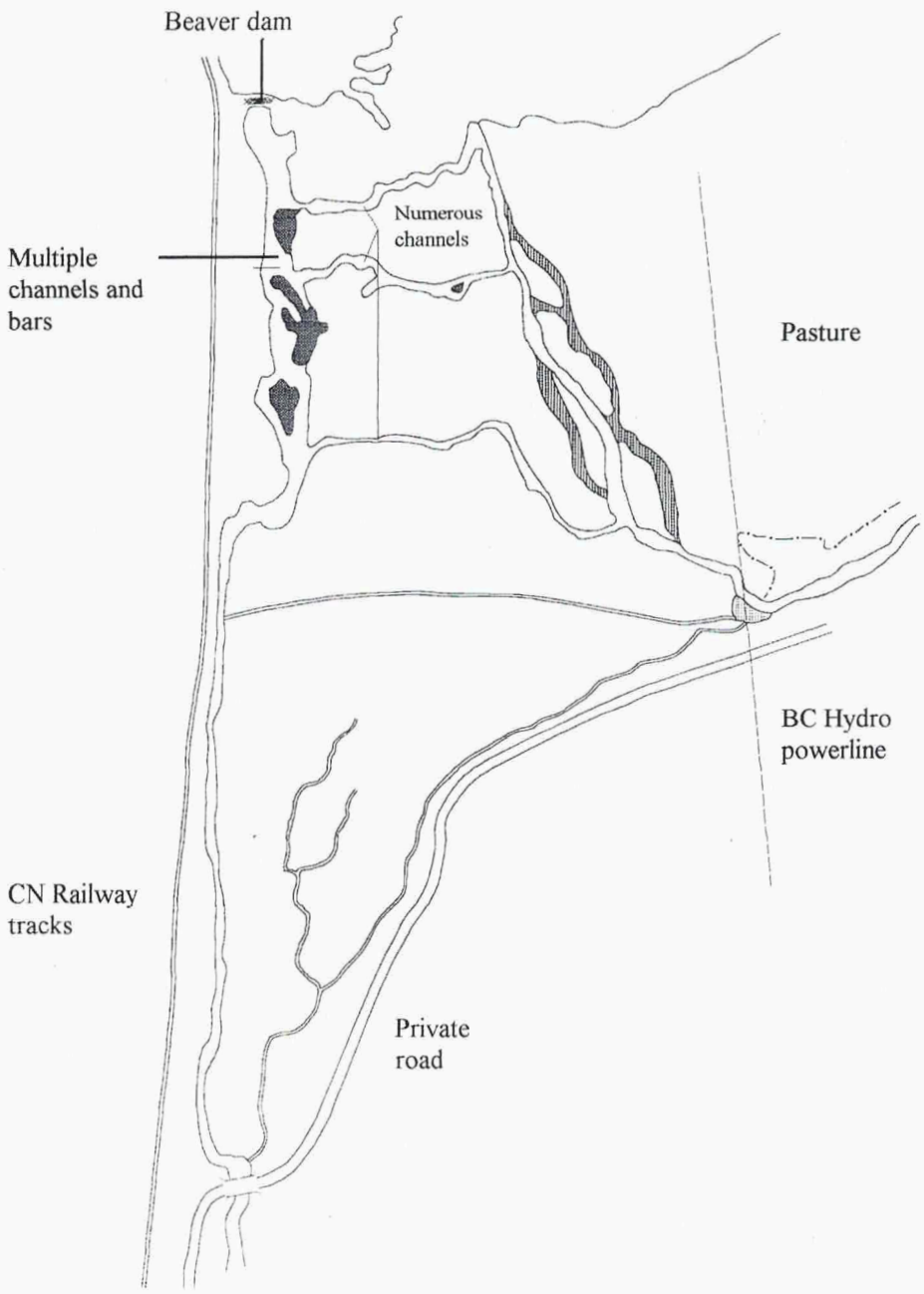


Figure 14: Site map and proposed works for Survey and Design SD-11 and SD-12

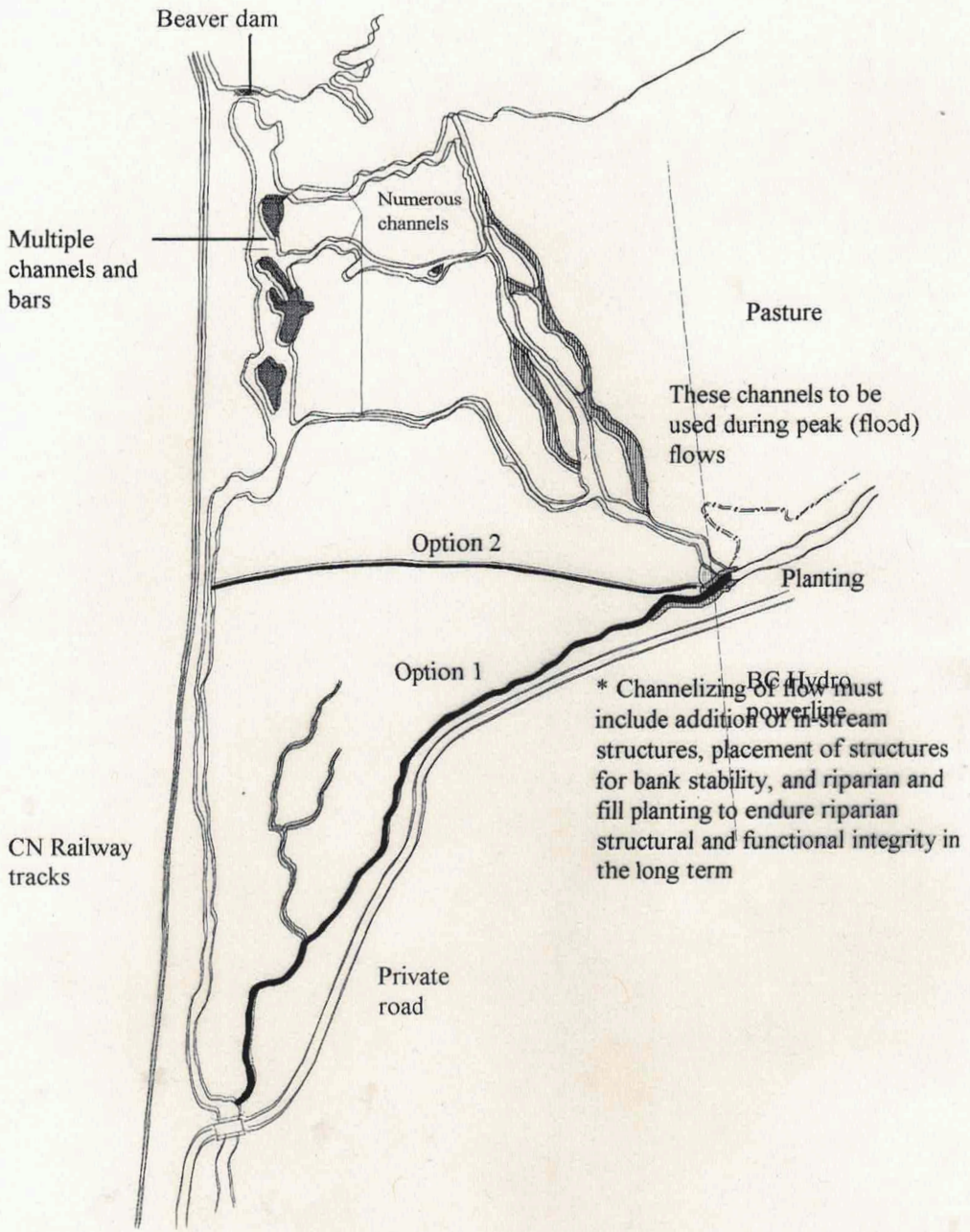


Figure 14: Site map and proposed works for Survey and Design SD-11 and SD-12

Survey and Design Number: SD-12
Prescription Number: Toboggan 15

LOCATION: Powerline crossing of Toboggan Creek approximately 400 m above the confluence of Toboggan and Glacier Gulch Creeks. UTM coordinates 6082260, 611280

IMPACT: Clearing of riparian vegetation to stream edge resulting in local loss of riparian structure and function, and loss of channel stability.

PHOTO(S): TB-12

DESCRIPTION OF PROPOSED WORKS: Installation of ten pieces of LWD as in-stream structures (bank deflectors, angled log deflectors, weirs, etc.) and riparian planting of willow, red-osier dogwood and spruce through clearing along powerline right-of-way (150 m^2) is recommended. Thirty spruce trees should be planted at 5 m intervals with willow and red-osier dogwood fill and clump planted about these. This is to be done concurrently with SD-12 (Figure 14).

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ Increased channel stability by LWD re-enforcement/placement
- ❒ Reestablishment of riparian structure and function.
- ❒ Shading for summer temperature control, terrestrial insect and litterfall in the short term
- ❒ LWD recruitment in the long term
- ❒ Local employment for riparian planting and structure placement

SCHEDULE FOR IMPLEMENTATION: The schedule for proposed works is:

1. Acquire approvals
2. Ordering and storing of planting stock
3. Delivery of LWD & placement of instream structures (August)
4. Riparian planting (Spring 1999)
5. Post-Works monitoring (Spring flows 1999)

ESTIMATED COST FOR COMPLETION:

Machinery - Chainsaw/drill rental (1 day @ $50/day)	$ 50
Materials - LWD (10 pieces)	$ 2,000
- Geotextile (80 m^2 @ $1.25/$m^2$)	$ 100
- Stock (whips & trees)	$ 200
Labor - 4 man-day ($250/man-day)	$ 1,000
Monitoring - 0.5 man-day (@$450/man-day)	$ 225
Total	**$ 3,575**

APPROVALS REQUIRED: Mr. E. Johnson (Landowner), BC Hydro, Ministry of Environment, Lands and Parks, Department of Fisheries and Oceans

Survey and Design Number: SD-13
Prescription Number: Toboggan 17

LOCATION: Upper Toboggan Creek approximately 800 m below Silvern Lakes road crossing. UTM coordinates 6080160, 611260.

IMPACT: A series of two ATV/snowmobile bridges over separate channels are too low to accommodate high (Spring) flows and may become obstructions at these times. This leads to lateral channel movement, erosion of banks and flooding of upstream areas with resultant strandings when water level drops again. All of these result in detrimental impacts to fish habitat.

PHOTO(S): TB-13

DESCRIPTION OF PROPOSED WORKS: It is uncertain who is responsible for the bridge crossings, therefore the first recommended step is to determine bridge ownership/responsibility. Once that is established there are two recommended options.

> Option 1: Remove bridges and use materials elsewhere on the Toboggan Creek system as LWD or building materials. This only a viable option if this road is not used by motorized vehicles (i.e. ATV's & snowmobiles) for recreation.
>
> Option 2: Raise bridges to accommodate higher flows. Deep snow at the time of the Survey and Design (March 1998) precluded a detailed assessment of these bridges but information from last Autumns assessment indicates that these bridges are not intended for heavy vehicle use (i.e. they are for snowmobiles, ATV's etc.) therefore raising the decking by building up bridge abutments is recommended using trees anchored with rebar (Figure 15) and lengthening the approach and departure ramps. This work may be accomplished with hand-tools (come-along, chainsaw, etc.). Those responsible for the bridge construction should be requested to raise or remove these structures.

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ Decreased likelihood of channel obstruction and resultant habitat damage due to low bridge structure.
- ❒ Materials for structure placement in other areas of Toboggan Creek system
- ❒ Local employment for bridge removal/raising

SCHEDULE FOR IMPLEMENTATION: The schedule for proposed works is:

1. Determination of ownership/responsibility
2. Selection of Option 1 or 2
3. Acquire approvals
4. Bridge removal/raising (July)

ESTIMATED COST FOR COMPLETION:

OPTION 1 - BRIDGE REMOVAL

Machinery - ATV (2 days @ $150/day)		$ 300
Labor - 4 man-days @ $250/man-day		$ 1,000
	Total	**$ 1,300**

OPTION 2 - RAISE BRIDGES

Machinery - ATV (2 days @ $150/day)		$ 300
- Chanisaw/Drill (2 days @ $50/day)		$ 100
Materials - Tree trunks (as available, only require short sections)		
- Rebar/Cable		$ 100
- Lumber (for approaches)		$ 400 (estimate)
Labor - 4 man-days @ $250/man-day		$ 1,000
	Total	**$ 1,900**

APPROVALS REQUIRED: Ministry of Forests, Ministry of Environment, Lands and Parks, Department of Fisheries and Oceans, Bridge builder

TOBOGGAN CREEK SURVEY AND DESIGN FIELD PHOTOGRAPH

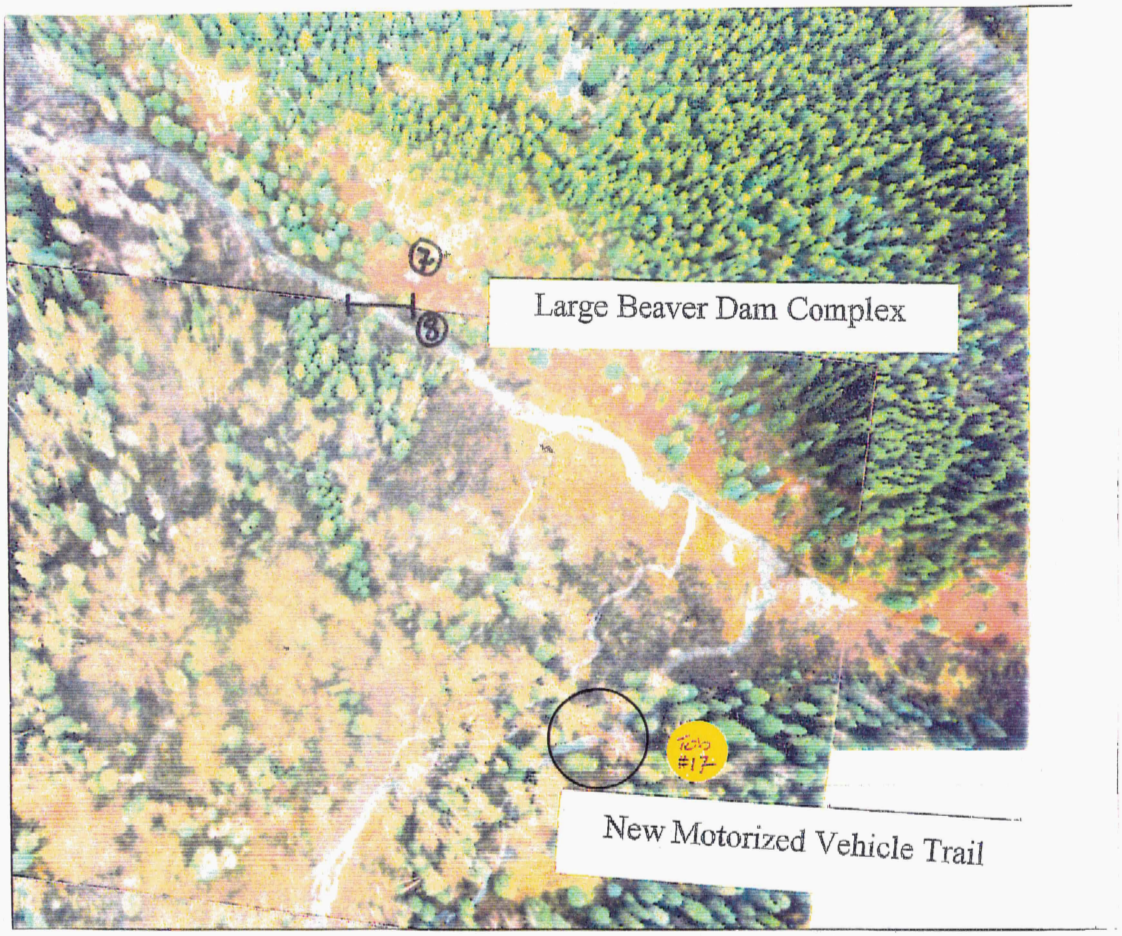


Photo Number: TB-13

Survey & Design/Prescription #: SD-13 / Toboggan 17

Location: Upper Toboggan Creek approx. 800 m below Silvern Lakes road crossings

Comments: Two small bridges crossing channels of Toboggan Creek. Bridges require removal or raising.

Date Taken/Photographer: October 22, 1997 / L. Gibson

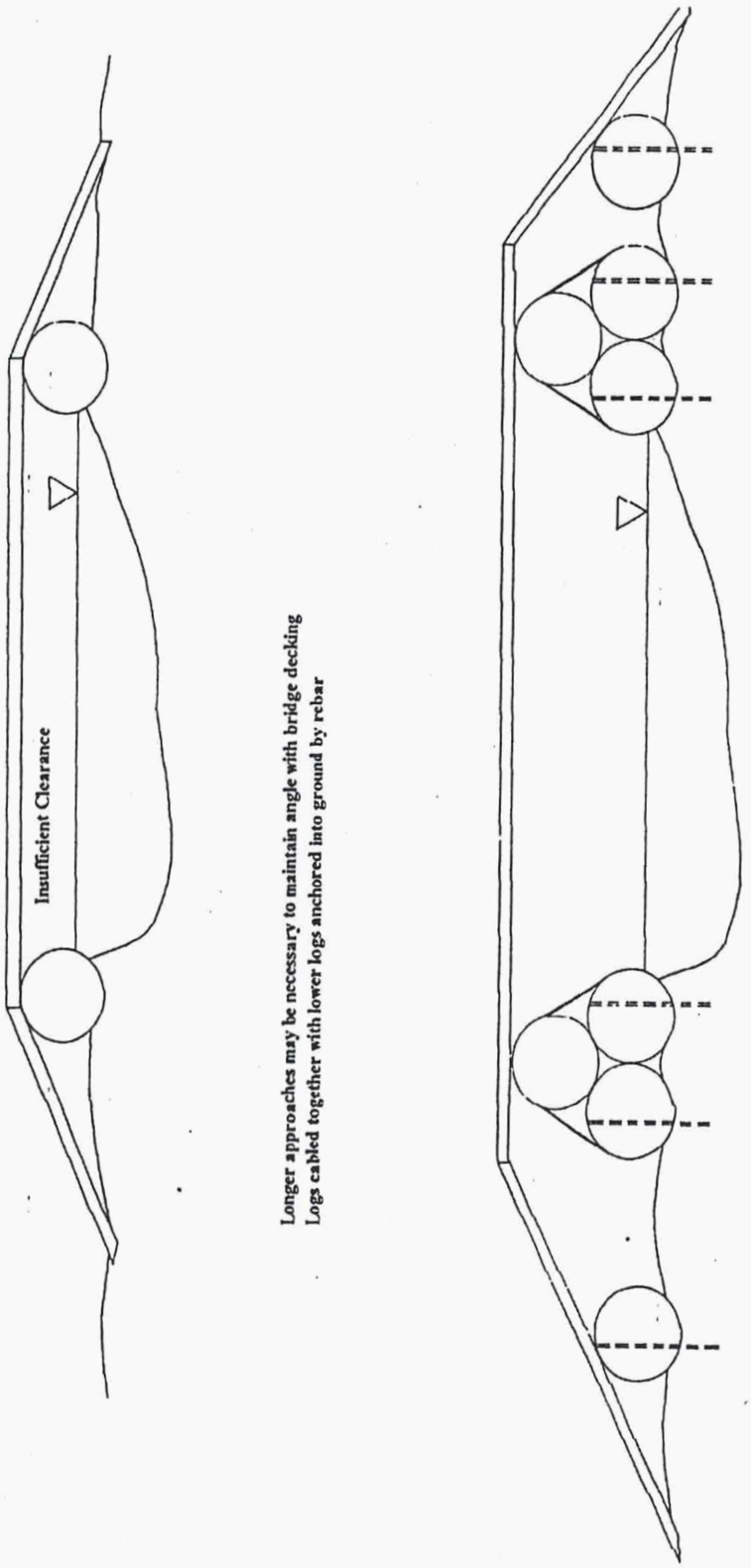


Figure 15: Conceptual diagram of raising bridges over upper Toboggan Creek Survey and Design SD-13

Survey and Design Number: SD-14
Prescription Number: Toboggan 18

LOCATION: Upper Toboggan Creek old bridge crossing of Silvern Lakes road. UTM coordinates 6079600, 611220

IMPACT: Failed bridge has caused great degree of downstream lateral channel movement and aggradation. This has significantly degraded available habitat.

PHOTO(S): TB-14

DESCRIPTION OF PROPOSED WORKS: Removal of remaining in-channel bridge material and debris at bridge site is recommended with appropriate salvaged pieces being used as LWD downstream. A ford (Figure 16) is also recommended for construction as this road is still used for recreation. The works should be combined so the required machinery is on-site to conduct both procedures concurrently.

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ Reduced impacts to substrate in local area and downstream with continued use

SCHEDULE FOR IMPLEMENTATION: The schedule for proposed works is:

1. Acquire approvals
2. Remove bridge & install ford (August)
3. Post-works monitoring (Spring flows 1999)

ESTIMATED COST FOR COMPLETION:

Machinery - Hoe (1.5 days @ $1,000/day)	$ 1,500
Truck (1 day @ $800/day)	$ 800
Materials - Rock/gravel (50m^3 @ $50/$m^3$)	$ 2,500
Labor - 1.5 man-day ($450/man-day)	$ 675
- 1 man-day ($250/man-day)	$ 250
Monitoring - 0.5 man-day (@$450/man-day)	$ 225
Total	**$ 5,950**

APPROVALS REQUIRED: Ministry of Forests, Ministry of Environment, Lands and Parks, Department of Fisheries and Oceans

TOBOGGAN CREEK SURVEY AND DESIGN FIELD PHOTOGRAPH

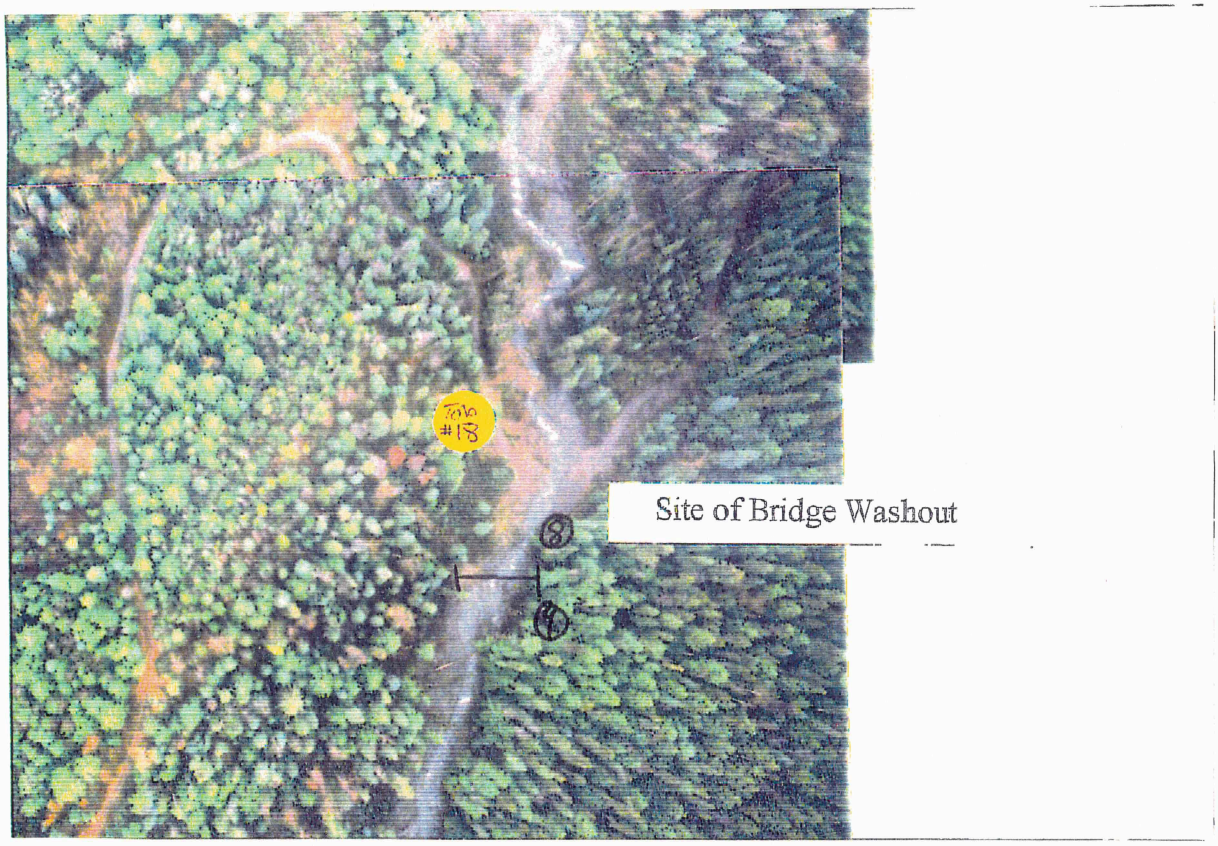


Photo Number: TB-14

Survey & Design/Prescription #: SD-14 / Toboggan 18

Location: Old bridge crossing of Silvern Lakes road over upper Toboggan Creek

Comments: Failed bridge creating downstream impacts. Requires removal of debris and installation of ford for crossing.

Date Taken/Photographer: October 22, 1997 / L. Gibson

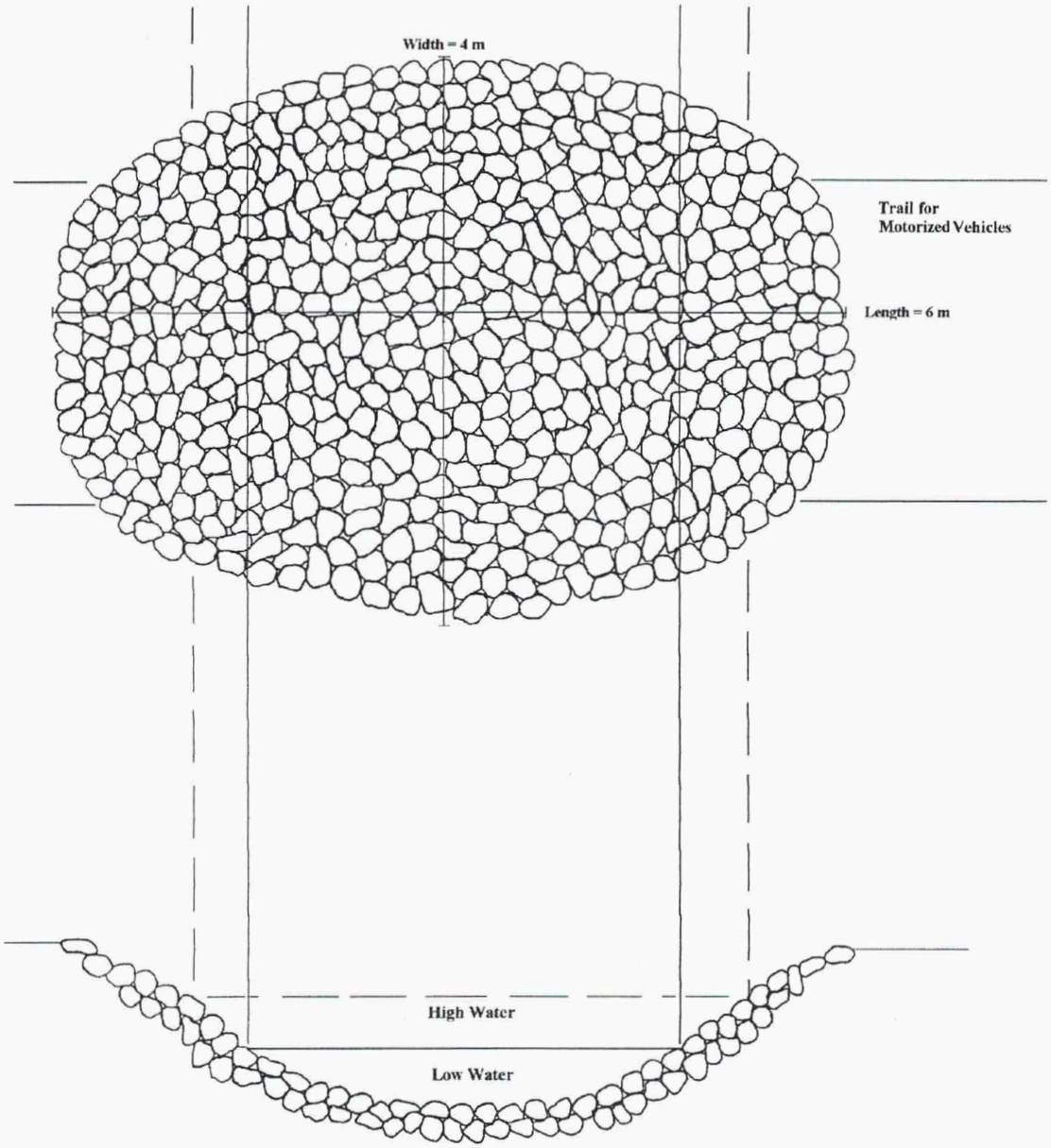


Figure 16: Conceptual diagram of ford for crossing Toboggan Creek at the Silvern lakes road

Survey and Design Number: SD-15
Prescription Number: Toboggan 21

LOCATION: Toboggan Creek mainstem immediately above the Elliot Creek confluence. UTM coordinates 6083620, 611580

IMPACT: Lack of riparian or overstream cover throughout beaver flats. This results in greater temperature extremes due to lack of shading and lack of terrestrial insects and litterfall contribution.

PHOTO(S): TB-15

DESCRIPTION OF PROPOSED WORKS: Construction and placement of five floating platforms (Figure 17 and see Appendix 1). Riparian planting not recommended due to beaver activity (eating stock) and lack of good growing conditions for conifers. Water flow in this area is slow and therefore conducive to placement of platforms. Bench on right bank provides convenient working area for assembly nearby the stream.

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ Local shading and cover for fish
- ❒ Terrestrial vegetation and insect contributions from platforms.
- ❒ Compensation for habitat degradation elsewhere in the system.
- ❒ Local employment for floating platform construction and placement

SCHEDULE FOR IMPLEMENTATION: The schedule for proposed works is:

1. Acquire approvals
2. Construction of platforms (June/July)
3. Placement of platforms (August)
4. Post-Works monitoring (Spring flows 1999)

ESTIMATED COST FOR COMPLETION:

Machinery - Chainsaw/drill rental (2 days @ $50/day)	$ 100
Materials - Lumber (floating platforms)	$ 400
- Cable/Rebar/Hardware	$ 100
Labor - 6 man-day ($250/man-day)	$ 1,500
Monitoring - 0.5 man-day (@$450/man-day)	$ 225
Total	**$ 2,325**

APPROVALS REQUIRED: Mr. T. Storey (Landowner), Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks

TOBOGGAN CREEK SURVEY AND DESIGN FIELD PHOTOGRAPH

Photo Number: TB-15

Survey & Design/Prescription #: SD-15 / Toboggan 21

Location: Toboggan Creek mainstem immediately above the Elliot Creek confluence

Comments: Low velocity water with significant lack of terrestrial cover. Excellent candidate for floating covers.

Date Taken/Photographer: March 17, 1998 / S. Mitchell

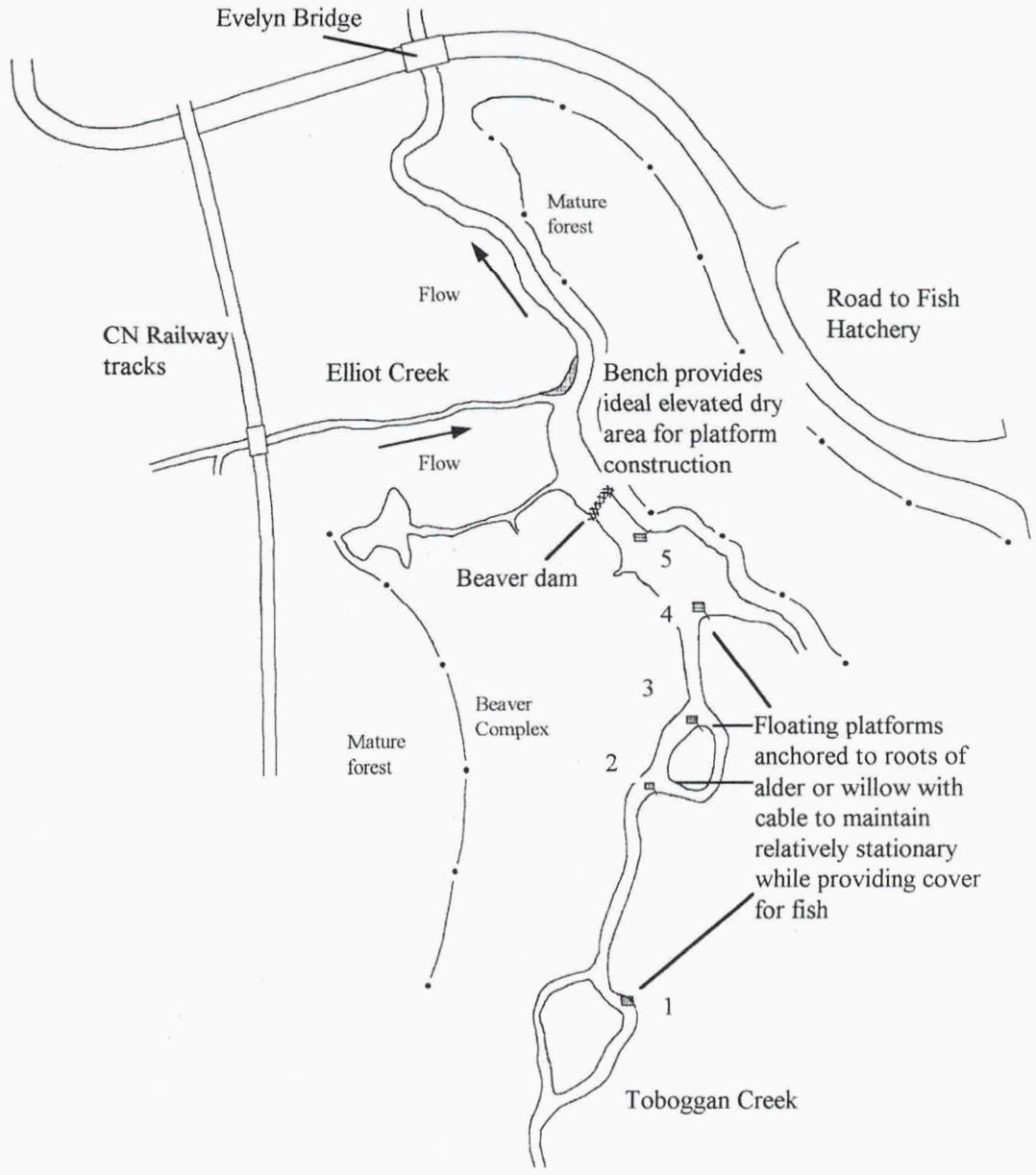


Figure 17: Site map and proposed works for Survey and Design SD-15. See Appendix 1 for details of floating platform construction

Survey and Design Number: SD-16
Prescription Number: Hopps 1

LOCATION: Hopps Brook upstream of road crossing paralleling CN rail tracks along southwest edge of Mr. L. Hopps property. UTM coordinates at road crossing 6087513, 608543.

IMPACT: Extensive riparian land clearing resulting in slumping of unstable banks contributing sediments to the stream. The riparian clearing has removed shade cover and LWD recruitment which has degraded habitat. There is very limited pool presence, channel stability or areas with shade cover for temperature control. Coho salmon are known to use this stream (Gibson, 1997)

PHOTO(S): TB-16 & TB-17

DESCRIPTION OF PROPOSED WORKS: (see Figure 18) Bank stabilization is a priority on this stream. A combination of wattle fences and LWD bank deflectors are required to reduce the extensive erosion in the short term. Riparian planting of a combination of fast growing deciduous species and slow growing conifers is required to stabilize these banks in the long term. Isolated areas would benefit from placement of in-stream LWD to create scour pools as well in order to improve habitat. These areas should also have channel-spanning overhead cover installed to provide shade cover over the newly formed habitat.

Bank Stabilization - Wattle fences should be installed on outside bends with bank heights of less than 1 m. On those banks > 1 m a combination of LWD bank deflectors should be anchored to protect the toe of the slope and wattle fences installed above the deflector. This combination is a scaled down version of SD-6.

Riparian Planting - A 10-15 m wide band should be planted on each side of the creek for 900 m (~2.7 ha). Species should consist primarily of alder (~65%) as cattle are least likely to eat this. Cottonwood, aspen, willow, and red osier dogwood (together accounting for ~25%) should also be planted as fast growing deciduous species to rapidly provide shade and bank stability. A small number (~10%) of the planting stock should consist of spruce and pine as well in order to begin to re-establish conifer presence and LWD recruitment in the long term. Tees should be planted at a relatively low density (~500 stems/ha cottonwood, aspen, spruce and pine combined) to allow the shrubs a rapid foothold and prevent competitive crowding. Negotiations with the landowner to minimize use of this pasture may reduce grazing of planted stock.

In-stream Structures - Judicious placement of angled log deflectors in the stream would create much-needed scour pools for fish use and could be used to subtly direct the current away from eroding banks. Used in conjunction with bank

deflectors such structures would provide diversity to this otherwise homogenous shallow, riffle stream.

Channel-Spanning Overhead Cover - Any habitat created or improved for rearing will require temperature control to prevent large thermal swings during summer days. Channel spanning logs with brush cabled to them will provide isolated areas of shade. On this stream, which is exposed over such a large extent, the minimum length (as measured along the stream) of such cover forming structure should be 20 m. Shorter than this will probably result in passage of water before it has had a chance to cool. A series of eight of these structures may provide two or three years of localized temperature control until the riparian planting has reached a sufficient height to function as shade cover.

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ Short and long-term reduction in sediment contribution to Hopps Brook and subsequently to the Toboggan Creek mainstem
- ❒ Re-establishment of riparian structural and functional integrity
- ❒ Short and long-term shading and cover for fish
- ❒ Provision of habitat for rearing coho
- ❒ Terrestrial vegetation and insect contributions from riparian sources and cross-channel cover.
- ❒ Local employment for bank stabilization, structure placement, cross-channel cover construction and planting.

SCHEDULE FOR IMPLEMENTATION: The schedule for proposed works is:

1. Acquire approvals
2. Order and store planting stock
3. LWD delivery on-site (for deflectors) (July)
4. Bank stabilization - wattles and deflectors (August)
5. Installation of structures and channel-spanning cover (August)
6. Riparian planting (Spring 1999)
7. Post-Works monitoring (Spring flows 1999)

ESTIMATED COST FOR COMPLETION:

Machinery - Hoe (2 days @ $1,000/day)	$ 2,000
- Chainsaw/drill rental (6 days @ $50/day)	$ 300
Materials - LWD (30-40 pieces)	$ 5,000
- Cable/Rebar/Hardware	$ 400
- Planting stock	$ 600 (estimate)
- Whips (for wattle fences)	$ 600 (estimate)
- Geotextile (est. 200 m^2 @ $1.25/$m^2$)	$ 250

Labor - 4 man-day ($450/man-day)		$ 1,800
- 10 man-days ($250/man-day)		$ 2,500
Monitoring - 0.5 man-day (@$450/man-day)		$ 225
	Total	**$ 13,675**

APPROVALS REQUIRED: Mr. L. Hopps (Landowner), Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks

TOBOGGAN CREEK SURVEY AND DESIGN FIELD PHOTOGRAPH

Photo Number: TB-16

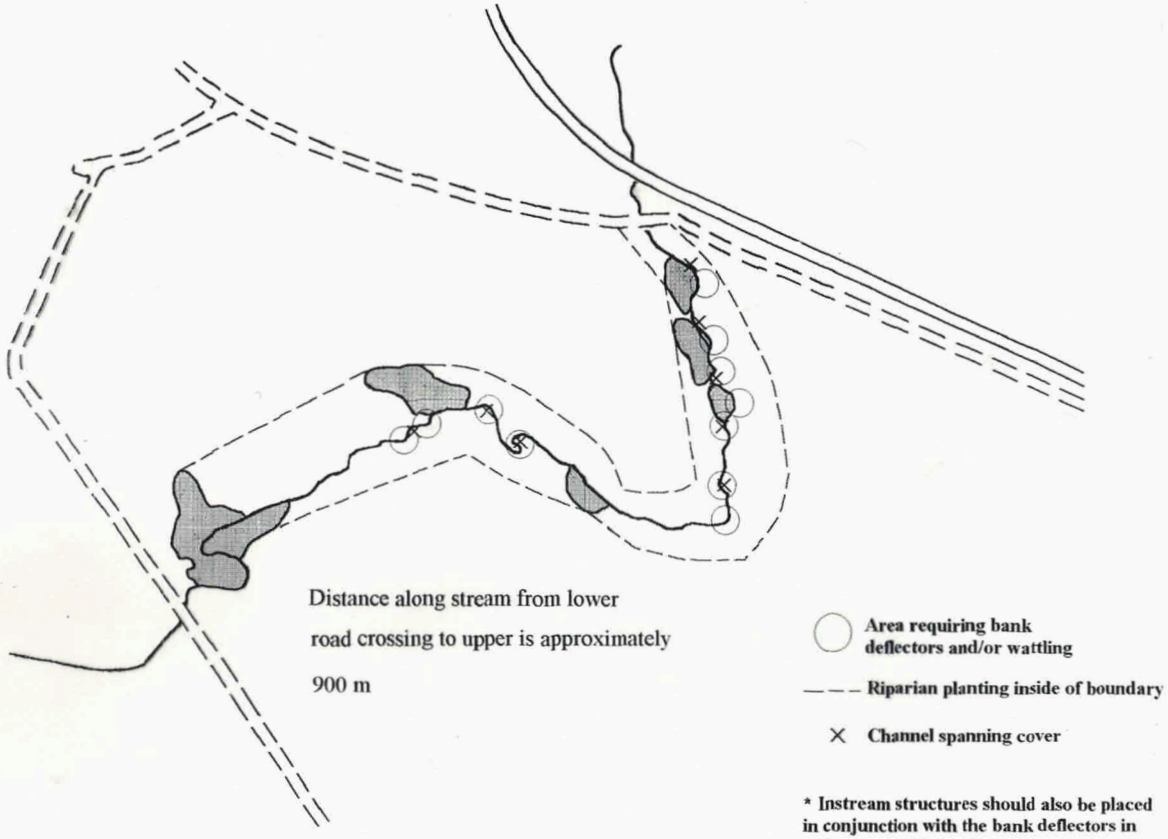
Survey & Design/Prescription #: SD-16 / Hopps 1

Location: Hopps Brook upstream of road crossing

Comments: Stream meandering through pasture illustrating lack of riparian cover, LWD and channel structure. Note the instability of the banks.

Date Taken/Photographer: October 24, 1997 / S. Mitchell

Photo Number: TB-17
Survey & Design/Prescription #: SD-16 / Hopps 1
Location: Hopps Brook upstream of road crossing
Comments: Early Spring condition of Hopps Brook, Note lack of riparian structure (upper photo) and texture of eroding banks (lower photo).
Date Taken/Photographer: March 27, 1998 / S. Mitchell


Distance along stream from lower
road crossing to upper is approximately
900 m
Area requiring bank deflectors and/or wattling
Riparian planting inside of boundary
Channel spanning cover
* Instream structures should also be placed in conjunction with the bank deflectors in order to provide habitat

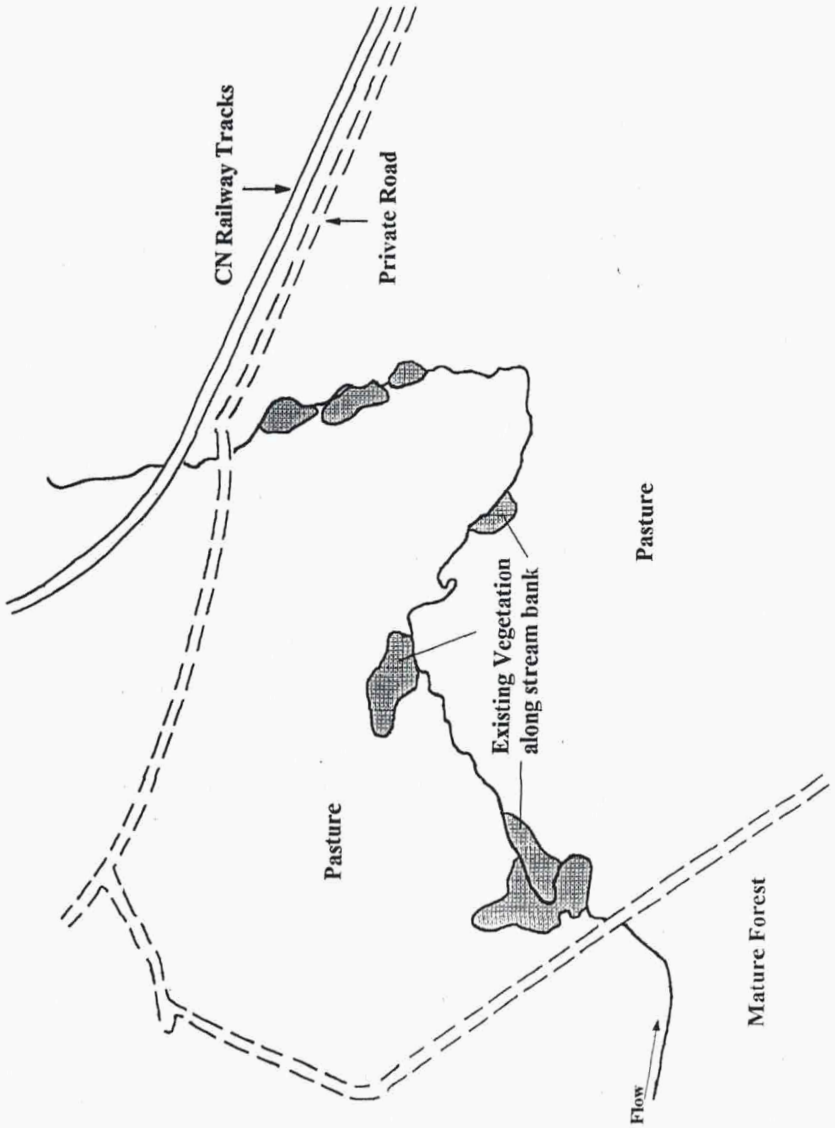


Figure 18: Site map and proposed works for Survey and Design SD-16

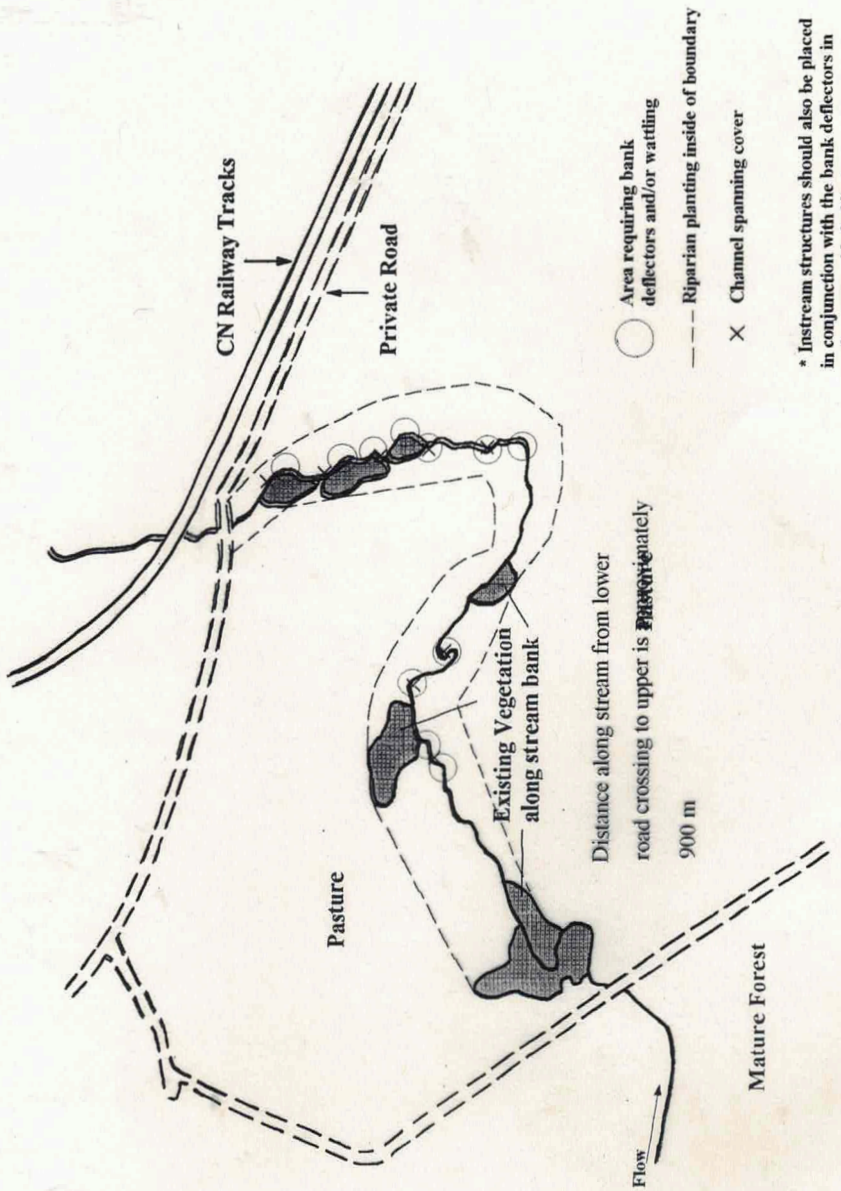


Figure 18: Site map and proposed works for Survey and Design SD-16

Survey and Design Number: SD-17
Prescription Number: Owen 1

LOCATION: Lower 500 m of Owen Creek from confluence with Toboggan Creek. UTM coordinates 6083620, 611580

IMPACT: Isolated areas lacking riparian cover and isolated areas of livestock trampling.

PHOTO(S): None

DESCRIPTION OF PROPOSED WORKS: Riparian fill planting of red-osier dogwood, cottonwood, aspen and spruce to fill in the gaps in the riparian community. Obstacles (i.e. large tree trunks) should be placed to prevent cattle access to these larger newly planted areas and to direct the cattle to the one existing crossing. This work is relatively low priority however, as the riparian area is presently quite well established.

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ Improved riparian structure and function in areas where this has been impacted
- ❒ Prevention of further extensive grazing damage by stock
- ❒ Local employment for riparian planting and obstacle placement

SCHEDULE FOR IMPLEMENTATION: The schedule for proposed works is:

1. Acquire approvals
2. Order and store planting stock
3. Riparian planting and placement of obstacles (Spring 1999)

ESTIMATED COST FOR COMPLETION:

Machinery - Hoe (0.5 day @ $1,000/day) [for obstacle placement]	$ 500
Materials - Stock (whips & trees) - LWD for obstacles (As available)	$ 400
Labor - 2 man-day ($250/man-day)	$ 500
Total	**$ 1,400**

APPROVALS REQUIRED: Mr. L. Hopps (Landowner)

Survey and Design Number: SD-18
Prescription Number: Owen 3

LOCATION: Powerline crossing of Owen Creek approximately 1500 m upstream of Owen Creek-Toboggan Creek confluence. UTM coordinates 6086479, 608568.

IMPACT: Powerline right-of-way has resulted in loss of riparian structure and function over a 70 m length of stream. This has resulted in bank instability/failure contributing sediments, lateral channel movement, loss of shade causing temperature extremes, and lack of habitat (i.e. pool). Downstream transport of sediments is also implicated in downstream lateral channel movement and bank failure (Gibson, 1997)

PHOTO(S): TB-18

DESCRIPTION OF PROPOSED WORKS: Approximately 200 m upstream of this crossing is a very large beaver dam; works done at this crossing must take into account this upstream influence (see Survey and Design - Miscellaneous). The recommended rehabilitation works for the powerline crossing form three components:

1) Bank stabilization - The 55 m long X 2.5 m high bank failure present requires stabilization of the toe and mid-slope. Placement of five large trees as tree revetment anchored into the bank is required. The mid-slope should be pulled back to an angle of repose of 30° from vertical and terraced using wattle fences along the 70 m length of failure. This strategy is similar to SD-6.
2) Planting - The terraces and both banks of the stream through this right-of-way require planting (~0.3 ha) for long term bank stabilization and a return of riparian structure and function. Willow, red-osier dogwood and alder are recommended for planting (see Section 1.1). Large trees, while more ecologically suitable for function and LWD, are not appropriate due to future interference with overhead powerlines.
3) In-stream structures - A series of three downstream angled log deflectors anchored into the bar across from the bank failure are recommended. These would serve to "pull" the stream back toward the centre of the channel and away from the toe of the failing slope. As well, a notched cross stream weir is recommended for installation 25 m downstream of the slope failure to provide pool presence in this area. This is only feasible if the slope failure sediment contribution is decreased. Such a pool should also have channel-spanning cover to provide thermal and protective cover to fish using the pool.

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ Reduction of sediment entry into Owen Creek from this sediment source
- ❒ Prevention of further bank erosion
- ❒ Provision of some habitat for rearing
- ❒ Limited restoration of riparian structure and functional integrity
- ❒ Local employment for bank stabilization, planting and in-stream structure installation

SCHEDULE FOR IMPLEMENTATION: The schedule for proposed works is:

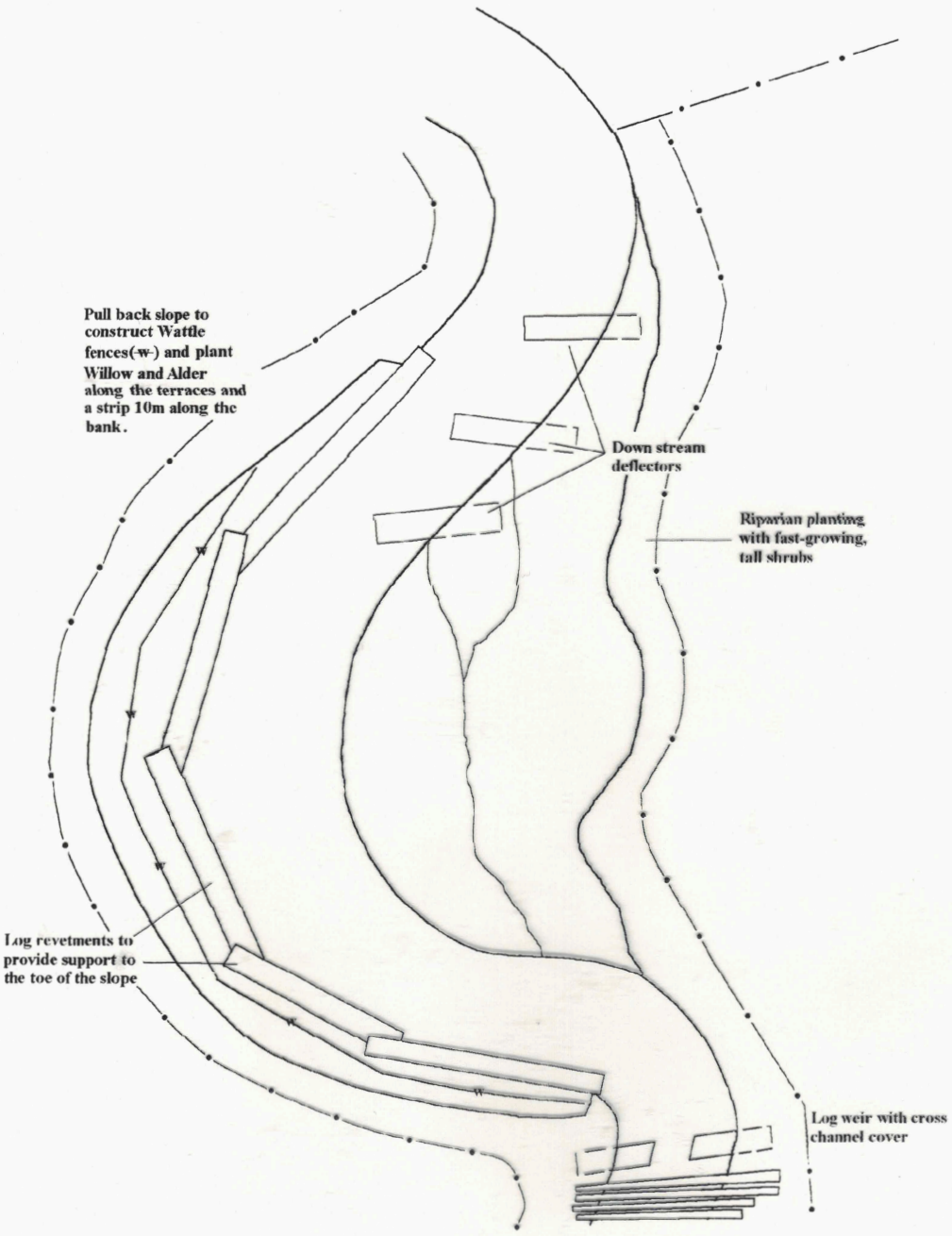
1. Acquire approvals
2. Order and store planting stock
3. LWD delivery on-site (for revetments, deflectors and channel spanning cover) (July)
4. Bank stabilization - wattles and revetment (August)
5. Installation of structures and channel-spanning cover (August)
6. Riparian planting (Spring 1999)
7. Post-Works monitoring (Spring flows 1999)

ESTIMATED COST FOR COMPLETION:

Machinery - Hoe (1 days @ $1,000/day)	$ 1,000
- Chainsaw/drill rental (1 days @ $50/day)	$ 50
Materials - LWD (10-12 pieces)	$ 2,000
- Geotextile (est. 200 m^2 @ $1.25/$m^2$)	$ 250
- Cable/Rebar/Hardware	$ 100
- Planting stock	$ 200 (estimate)
- Whips (for wattle fences)	$ 100 (estimate)
Labor - 2 man-day ($450/man-day)	$ 900
- 4 man-days ($250/man-day)	$ 1,000
Monitoring - 0.5 man-day (@$450/man-day)	$ 225
Total	**$ 5,825**

APPROVALS REQUIRED: Mr. D. Mott (Landowner [for access]), Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks, BC Hydro

Photo Number: TB-18
Survey & Design/Prescription #: SD-18 / Owen 3
Location: Powerline crossing of Owen Creek on the Motts property
Comments: Large bank failure looking upstream (upper photo) and looking downstream (lower photo).
Date Taken/Photographer: March 27, 1998 / S. Mitchell


Pull back slope to construct Wattle fences(-w-) and plant Willow and Alder along the terraces and a strip 10m along the bank.
Down stream deflectors
Riparian planting with fast-growing, tall shrubs
Log revetments to provide support to the toe of the slope
Log weir with cross channel cover

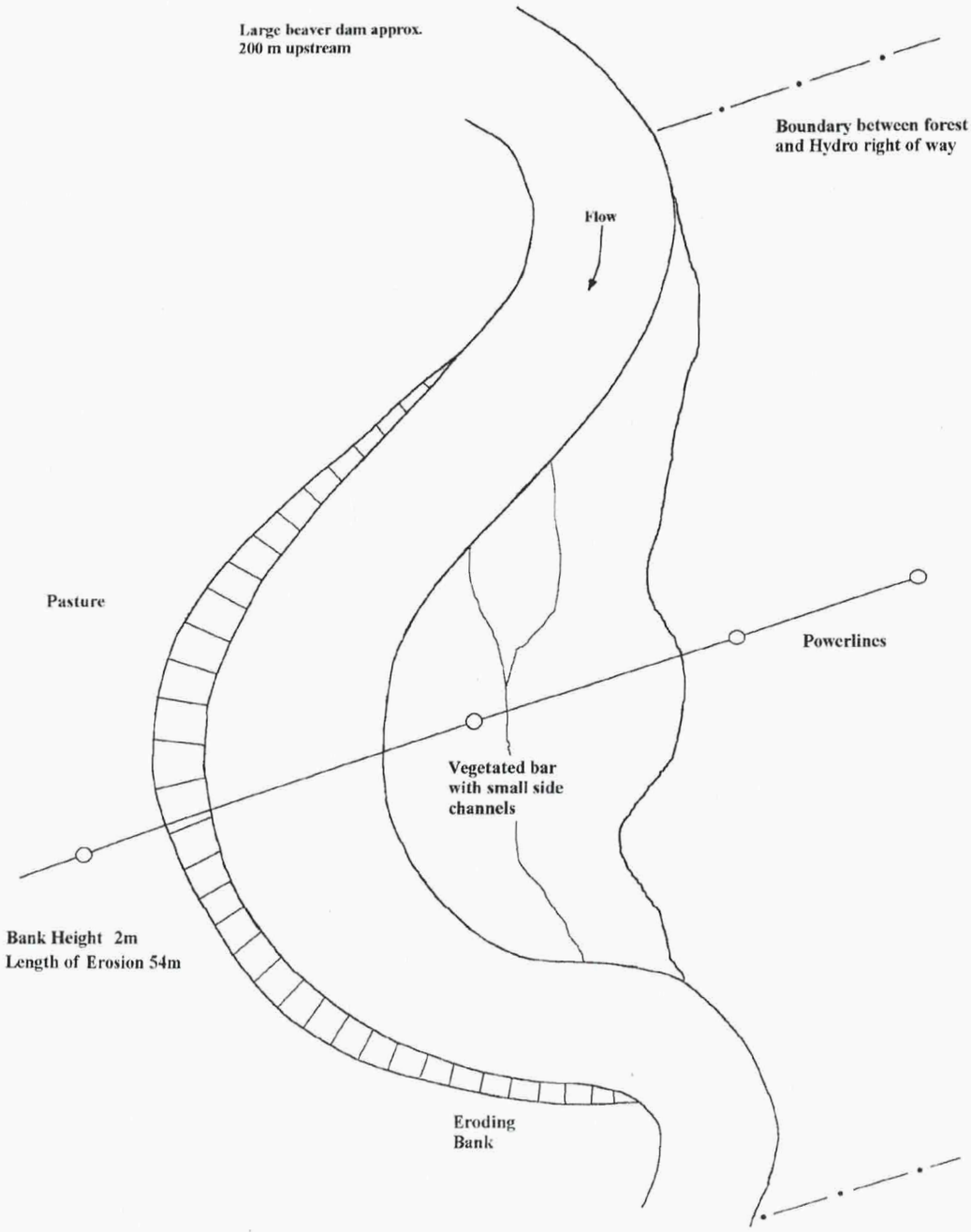


Figure 19: Site map and propose works for Survey and Design SD-18

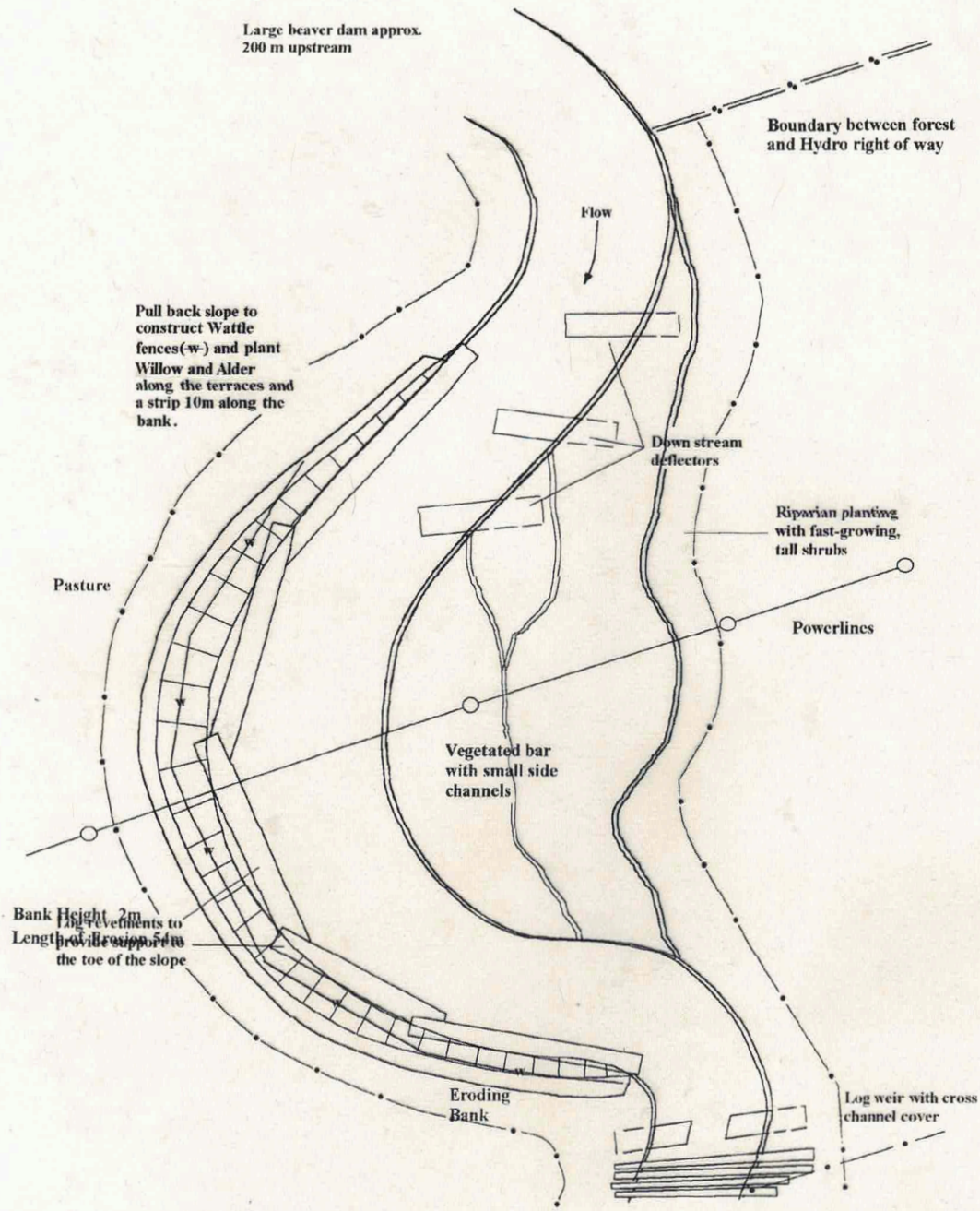


Figure 19: Site map and propose works for Survey and Design SD-18

Survey and Design Number: SD-19
Prescription Number: Owen 5

LOCATION: Approximately 3.5 km upstream from the Owen Creek-Toboggan Creek confluence. UTM coordinates 6086261, 607379.

IMPACT: Failing bridge from past forest harvesting activities is falling into the creek. The potential is high for debris jam formation and resulting catastrophic failure or forcing stream to cut new channel.

PHOTO(S): TB-19

DESCRIPTION OF PROPOSED WORKS: Removal of failing bridge. Bring in hoe, remove bridge and disassemble and salvage timbers for works at powerline site (SD-18) or other sites requiring timber/lumber. Existing bridge abutments (large cottonwoods) should not be disturbed as they are presently offering excellent bank protection.

ANTICIPATED BENEFITS: This project is intended to provide:

- ❒ Reduction in probability of channel movement and downstream aggradation due to lateral channel movement.
- ❒ Removal of obstruction which may become a significant hydraulic concern in the future.
- ❒ Materials for works elsewhere on the Toboggan Creek system

SCHEDULE FOR IMPLEMENTATION: The schedule for proposed works is:

1. Acquire approvals
2. Remove bridge, disassemble, and transport timbers to other sites

ESTIMATED COST FOR COMPLETION:

Machinery - Hoe (1 day @ $1,000/day)	$ 1,000
Labor - 1 man-day ($450/man-day)	$ 450
- 1 man-day ($250/man-day) [for disassembly]	$ 250
Total	**$ 1,700**

APPROVALS REQUIRED: Mr. D. Mott (Landowner [for access]), Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks, Ministry of Forests

Survey and Design Number: Miscellaneous
Prescription Number: Owen 5

Although not part of this survey and design project, beaver control has been identified as being required on the Toboggan Creek system. Beavers are a significant influence in the system, creating, maintaining and destroying habitat as well as creating isolated, temporary access problems.

DESCRIPTION OF PROPOSED WORKS:

An overview helicopter flight with habitat personnel from Ministry of Environment, Lands and Parks and Department of Fisheries and Oceans to pinpoint and highlight beaver complex issues is strongly recommended. This is intended to provide an overview of the extent and magnitudde of beaver effects and to establish which beaver complexes require works. Such a flight should include upper Toboggan, Glacier Gulch and Owen Creeks.

The beaver dam near the outlet of Toboggan lake has been a chronic problem and concern. Recent trapping has removed several of the beavers in the area and at this time the dam should be lowered by 0.5 - 1.0 m to decrease the volume of water stored and resultant catastrophic downstream effects in the event of dam failure. Continued beaver control (trapping and/or shooting) is required at this location.

Beaver control in the form of trapping/shooting should also be conducted at the large dam on Owen Creek above the powerline, and this dam breached prior to works being conducted at the powerline crossing. This area is very attractive to beavers and an ongoing control program is recommended until either beavers leave the area or proven alternative techniques may be employed. It is recognized that the killing of beavers is only treating the symptom and not the cause of the problem; however until more effective non-lethal control techniques are developed, lethal beaver control is required on the Toboggan Creek system.

Mr. R. Grebliunas (Landowner) has mentioned that he does not want any beaver control on the stream through his property. He presently has beavers on the upper extent of his property and wishes to maintain them; his property may provide an experimental "control" with which to compare the success of beaver control practices.

SCHEDULE FOR IMPLEMENTATION: An overview flight is recommended for August or September. By this time the beavers will have rebuilt any structures destroyed by Spring flows and will provide distribution and impact information. Beaver control (trapping/shooting) should be pursued in either Spring or late Fall and the lowering of the Toboggan Lake beaver dam conducted in August/September (to coincide with salmon migration).

ESTIMATED COST FOR COMPLETION:

OVERVIEW FLIGHT	
Helicopter time (2 hours @ $800/hr)	$ 1,600
Mapping/documentation (1 man-day @ $450/day)	$ 450
BEAVER CONTROL	
$2,500/complex/year * 2 complexes	$ 5,000/year
LOWERING OF TOBOGGAN LAKE DAM	
2 man-days @ $250/day	$ 500
Total	**$ 7,550 in 1998**
	$ 5,000/year after 1998

APPROVALS REQUIRED: Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks, Mr. D. Mott (Landowner on Owen Creek), Mr. E. Johnson and Mr. T. Storey (Landowners at Toboggan Lake beaver dam) CN Rail, local trappers.

3.0 RECOMMENDATIONS

The following are recommendations regarding the required rehabilitation works on the Toboggan Creek system.

Recommendation 1: With the exception of SD-3, the previous designs must be completed in a comprehensive manner. That is, completion of only part of the design will almost certainly fail, rehabilitation works must address all of the present problems, including in-stream requirements. For example, SD-6 requires works at the toe, mid and upper slope of the failing bank. Failure to address all of these areas will result in continued bank failure. A comprehensive approach is necessary.

Recommendation 2: Plans must be flexible. The preceding designs are based on best professional judgement at the time of survey and based on 1997 field work. However, Spring flows through May and June may change conditions requiring site assessment and decisions. Flexibility to modify designs to meet changing field conditions must be built into any contracts for these works. The professional knowledge and judgement of the field staff must be respected to increase the probability of success for these rehabilitation works.

Recommendation 3: Monitoring of the success/failure of the rehabilitation works following Spring flows 1999 is necessary. This is not only to assess state of structures/works but also as part of the learning process to determine what rehabilitation works are most succesful under what conditions. With an increasing knowledge base, future works may be done more efficiently and successfully.

Recommendation 4: In addition to the previous rehabilitation works, beaver control in key areas should be strongly considered. The activities, and consequences of the activities of these animals are of great concern to many of the local landowners and sincere attempts at addressing this problem would improve Agency credibility with landowners and assist in Agency/landowner negotiations.

In an attempt to priorize all of these surveys and designs, taking into account budgets as well as impacts and likelihood of success, a score for each site was determined. Following is this semi-quantified priority list of works to be conducted. Each column is "subjectively" estimated and assigned a ranking to develop a total score. The greater the value of the total score, the higher the priority of the works.

S & D Site	Cost	Success	Value	Impact	Total Score	Priority
SD-1 (Option 1)	1	12	4	12	576	5
(Option 2)	5	12	1	12	720	3
SD-2	3	4	5.5	4	264	9
SD3 (slope 1)	1	2	4	6	48	20
SD-3 (slope 2)	6	3	1.5	1	27	21
SD-3 (slope 3)	6	12	1	1	72	17
SD-3 (slope 4)	5	12	1	1	60	18
SD-3 (slope 5)	3	2	4	4	96	15
SD-4	5	3	4	4	240	11
SD-5	3	9	5.5	6	891	1
SD-6	2	4	4	12	192	12
SD-7	3	4	5.5	9	594	4
SD-8	4	6	4	3	288	8
SD-9	3	4	5.5	12	792	2
SD-10	5	4	1.5	3	90	16
SD-11 & 12	1	4	6.5	12	312	7
SD-13	6	9	2.5	1	135	14
SD-14	4	9	3.5	2	252	10
SD-15	5	4	1.5	3	90	16
SD-16	1	1	10	16	160	13
SD-17	6	6	1	2	72	17
SD-18	4	4	3.5	9	504	6
SD-19	6	9	1	1	54	19
SD-Miscellaneous	3	4	5	4	240	11

The top five priority sites are:

1. SD-5 Bank stabilization of Mr. Hopps small bank failure
2. SD-9 Improvement of CN ditchline
3. SD-1 Monitoring PK migration past Highway 16 culvert and pool development
4. SD-7 Riparian planting & bank stabilization of Mr. Booths property
5. SD-18 Owen Creek powerline crossing

Estimated total cost for the works prescribed for these five highest priority sites is $47,725.

BOX 1: RANKING METHOD FOR DETERMINING SCORING AND PRIORITY OF SURVEY AND DESIGN SITES

Cost = Ranked as >$10,000 (=1), $8,000-$10,000 (=2), $6,000-$8,000 (=3) $4,000-$6,000 (=4), $2,000-$4,000 (=5), <$2,000 (=6)

Success = *Rough approximation of chance of success based on experience and area to be worked on (Experience ranking * Area ranking)*

Years of experience	Ranking	Size of area	Ranking
0-2	1	<20 m^2	4
2-5	2	20-50 m^2	3
5-10	3	50-100 m^2	2
10+	4	>100 m^2	1

Value = *Rough approximation of "value of enhancement" based on % of system affected and sum of life stages and uses targeted.*

% of system affected	Ranking	Life stage/use	Ranking
0-25	1	Adult access	1.0
25-50	2	Adult spawning	2.0
50-75	3	egg/alevin	2.0
75-100	4	Rearing	1.5

Impact = *Rough approximation of impact based on area and "magnitude"*

Area of Impact	Ranking	"magnitude"	Ranking
<20 m^2	1	No impact	0
20-50 m^2	2	Loss of rearing	1
50-100 m^2	3	Loss of spawning	2
>100 m^2	4	Loss of spawning & rearing	3
		Extensive damage	4

Total Score = *Cost ranking * Success ranking * Value ranking * Impact ranking*

LITERATURE CITED

Alberta Environmental Protection. 1996. Fish habitat enhancement designs - typical structures. Water Resources Management Services, Technical Services and Monitoring Division, River Engineering Branch. 44p.

Anonymous. 1994. Correlated guidelines for tree species selection and stocking standards for the ecosystems of British Columbia. Prepared by Silviculture Interpretations Working Group. Canada-British Columbia Partnership Agreement on Forest Resource Development: FRDA II. 328 p.

Donat, M. 1995. Bioengineering techniques for streambank restoration - a review of Central European practices. Province of British Columbia. Ministry of Environment, Lands and Parks and Ministry of Forests. Watershed Restoration Project Report No. 2. 86p.

Gibson, L. 1997. Toboggan Creek watershed restoration project - level 1 and 2 detailed assessment. Prepared by Nortec Consulting for Watershed Restoration Program, Ministry of Environment, Lands and Parks, Skeena Region. Contract #CSK 3087.

Koning, C.W., and E.R. Keeley. 1997. Salmonid biostandards for estimating production benefits of fish habitat rehabilitation techniques. *In*. Slaney, P.A., and D. Zaldokas (eds.) Fish Habitat Rehabilitation Procedures. Watershed Restoration Technical Circular No. 9 3-1 to 3-21.

Newbury, R., M. Gaboury, and D. Bates. 1997. Restoring habitats in channelized or uniform streams using riffle and pool sequences. *In*. Slaney, P.A., and D. Zaldokas (eds.) Fish Habitat Rehabilitation Procedures. Watershed Restoration Technical Circular No. 9 12-1 to 12-22.

Personal Communications

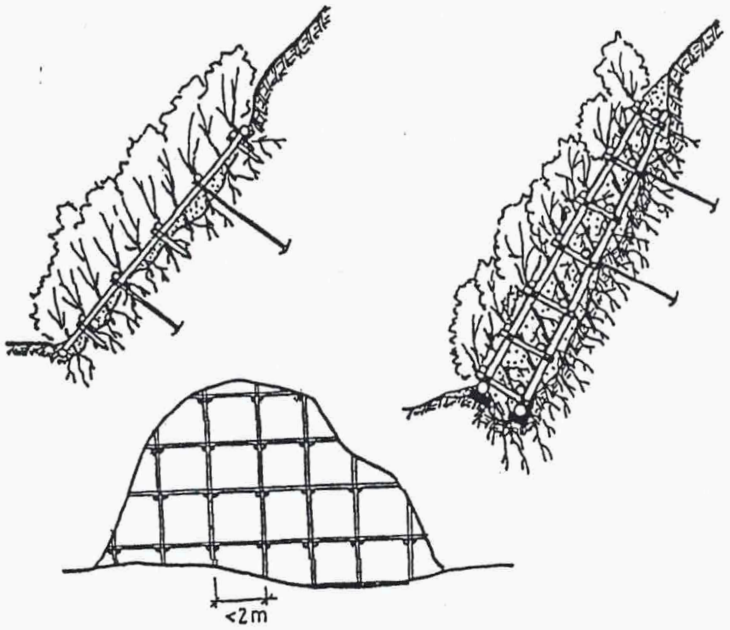
Mr. R. Grebliunas, Toboggan Creek Landowner

Mr. P. Lemiuex, Habitat Officer, Department of Fisheries and Oceans, Smithers, B.C.

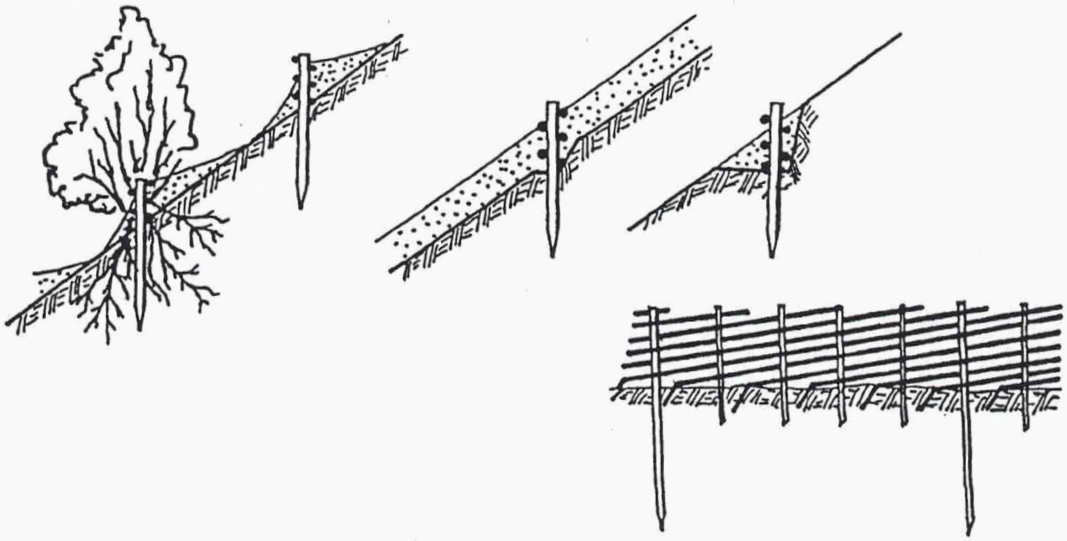
Mr. P. Lychak, Toboggan Creek Landowner

APPENDIX 1

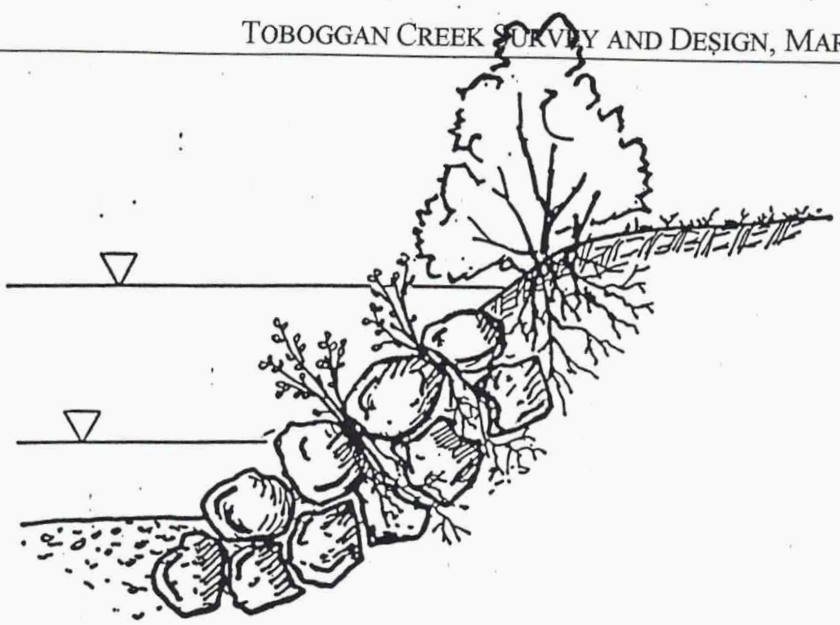
Diagrams of Proposed Structures for Toboggan Creek
Survey and Design, 1998

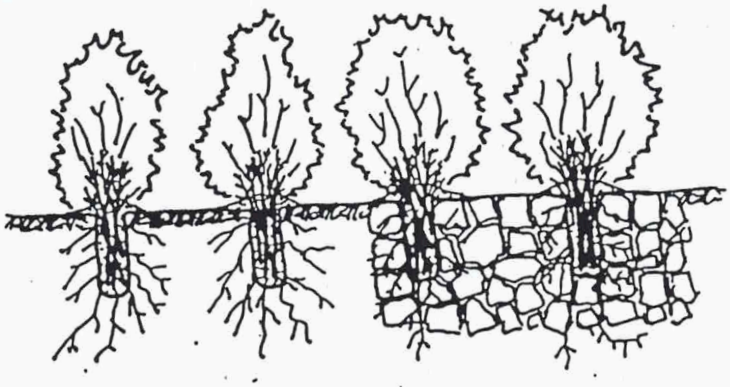


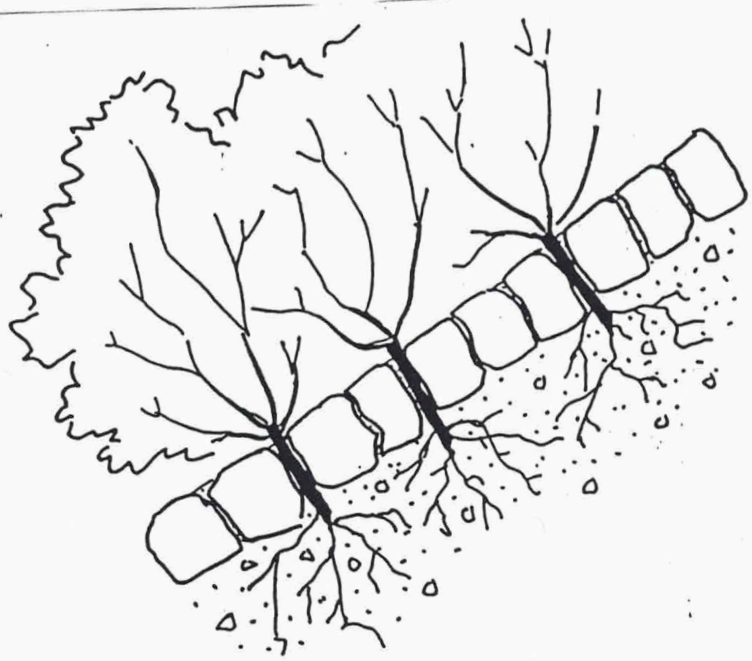
Conceptual diagram of live slope grating construction (from Donat, 1995)



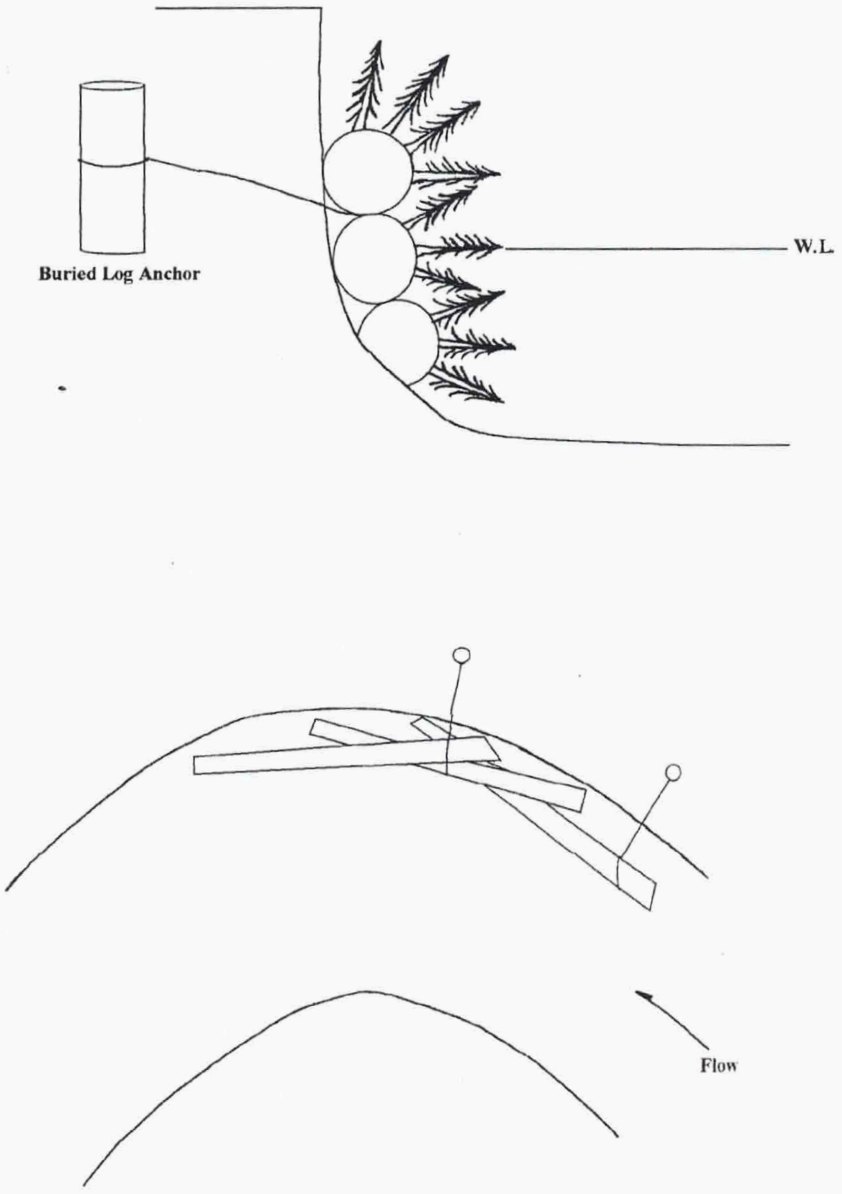
Conceptual diagram of wattle fence construction (from Donat, 1995)



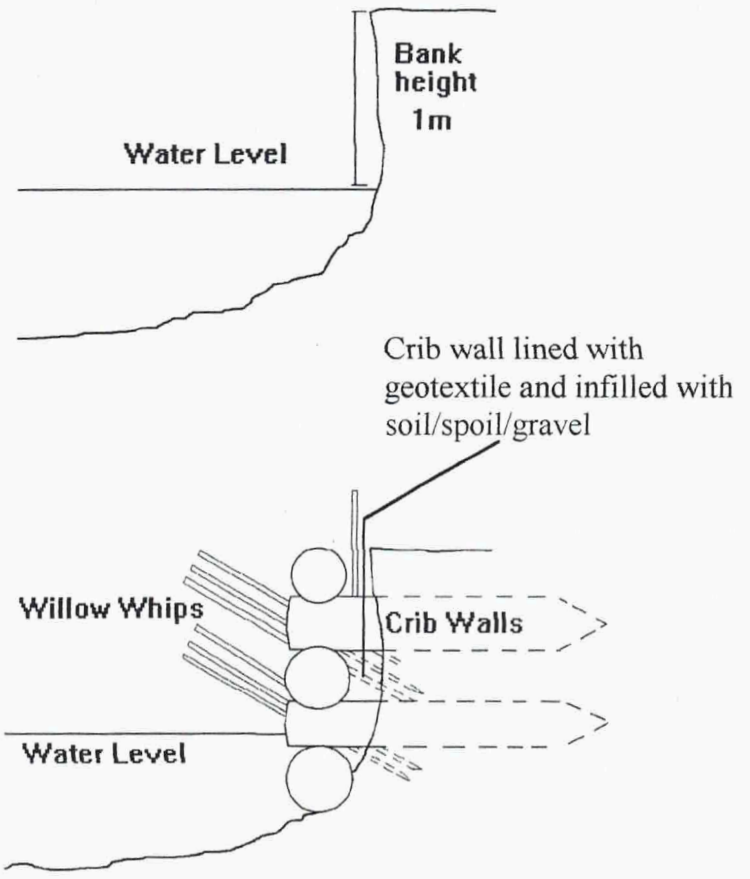




Conceptual diagram of joint planting of rip-rap (from Donat, 1995)

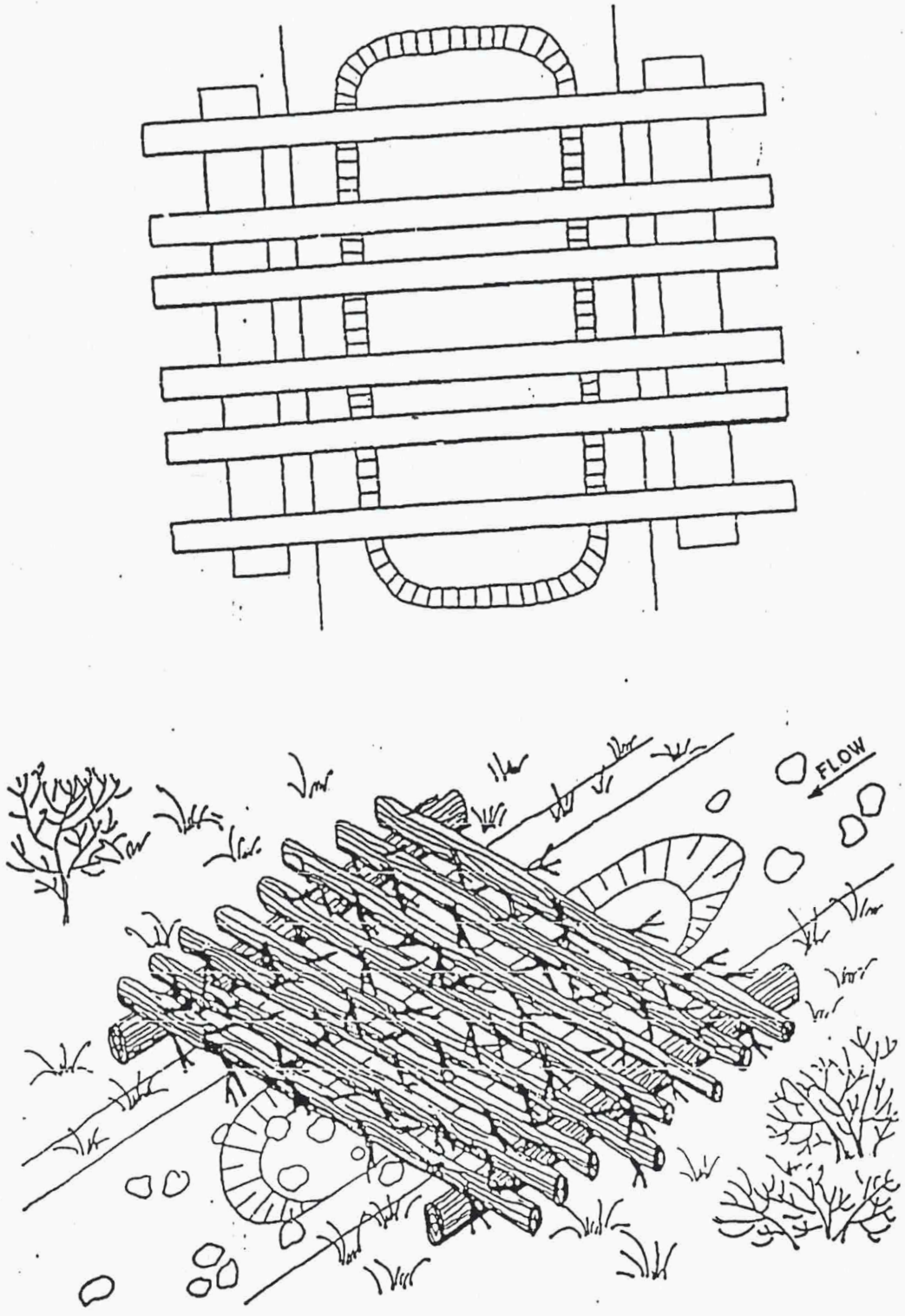


Conceptual diagram of tree revetment for bank stabilization

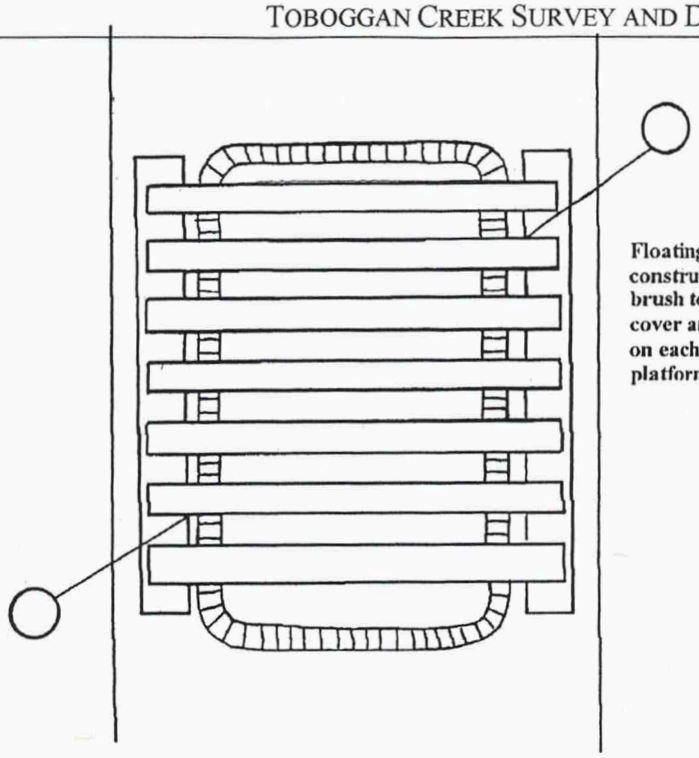


Conceptual diagram of live crib wall construction

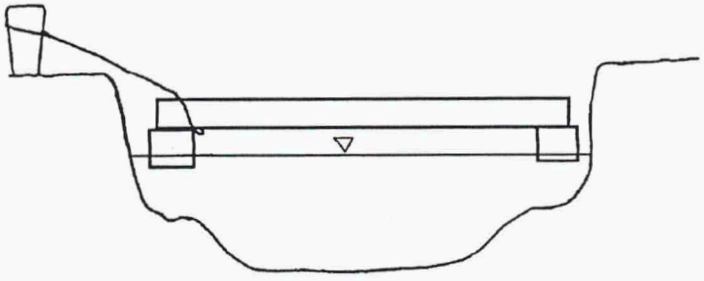
Photo Number: TB-19
Survey & Design/Prescription #: SD-19 / Owen 5
Location: Failing bridge crossing of Owen Creek approximately 600 m upstream of powerline crossing
Comments: Bridge failing into stream forming jam and consequent hydraulic and channel alterations. Looking upstream (upper photo) and looking downstream (lower photo).
Date Taken/Photographer: March 27, 1998 / S. Mitchell



Conceptual diagram of overstream (cross channel) cover using lumber (upper diagram) and trees (lower diagram; from Alberta Environmental Protection, 1996)



Floating platform to provide constructed from wood. Fasten brush to the top to provide added cover and fasten platform to banks on each side to prevent damage to platform or channel.



Conceptual diagram of floating cover