REGIONAL EXAMPLES OF FISH HABITAT PROJECTS OF THE WATERSHED RESTORATION PROGRAM 1994 - 1996

Fish Habitat Assessment and Prescriptions Course Participants in the Field at the Keogh River Model Training Watershed. WestLand Television Photo 1996

BC Environment

November 1996

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LOWER MAINLAND REGION

VANCOUVER ISLAND REGION

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Compiled by D. Zaldokas, AScT
Ministry of Environment, Lands and Parks
Watershed Restoration Program

LOWER MAINLAND REGION

CHILLIWACK RIVER WATERSHED

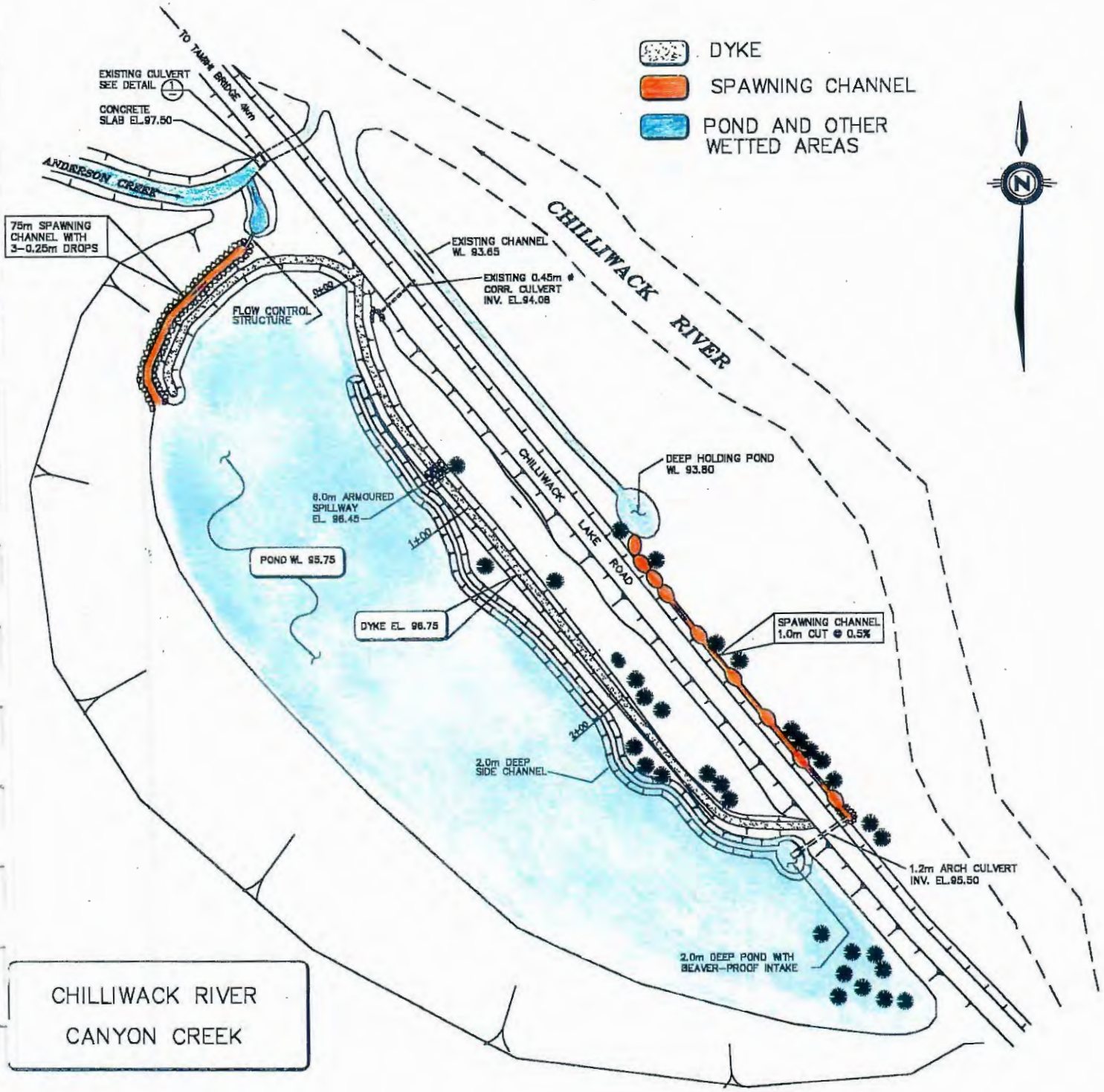

DYKE
SPAWNING CHANNEL
POND AND OTHER WETTED AREAS
N
TO TAMIHI BRIDGE 4km
EXISTING CULVERT SEE DETAIL 1
CONCRETE SLAB EL.97.50
ANDERSON CREEK
75m SPAWNING CHANNEL WITH 3-0.25m DROPS
CHILLIWACK RIVER
EXISTING CHANNEL WL. 93.65
EXISTING 0.45m ø CORR. CULVERT INV. EL.94.08
FLOW CONTROL STRUCTURE
DEEP HOLDING POND WL 93.80
CHILLIWACK LAKE ROAD
8.0m ARMOURED SPILLWAY EL. 96.45
POND WL. 95.75
DYKE EL. 96.75
SPAWNING CHANNEL 1.0m CUT @ 0.5%
2.0m DEEP SIDE CHANNEL
1.2m ARCH CULVERT INV. EL.95.50
2.0m DEEP POND WITH BEAVER-PROOF INTAKE
CHILLIWACK RIVER
CANYON CREEK

Photo 1. Excavation of deep channel along the side of the dyke in order to prevent beaver dam construction. Large woody debris was left in this channel for cover.

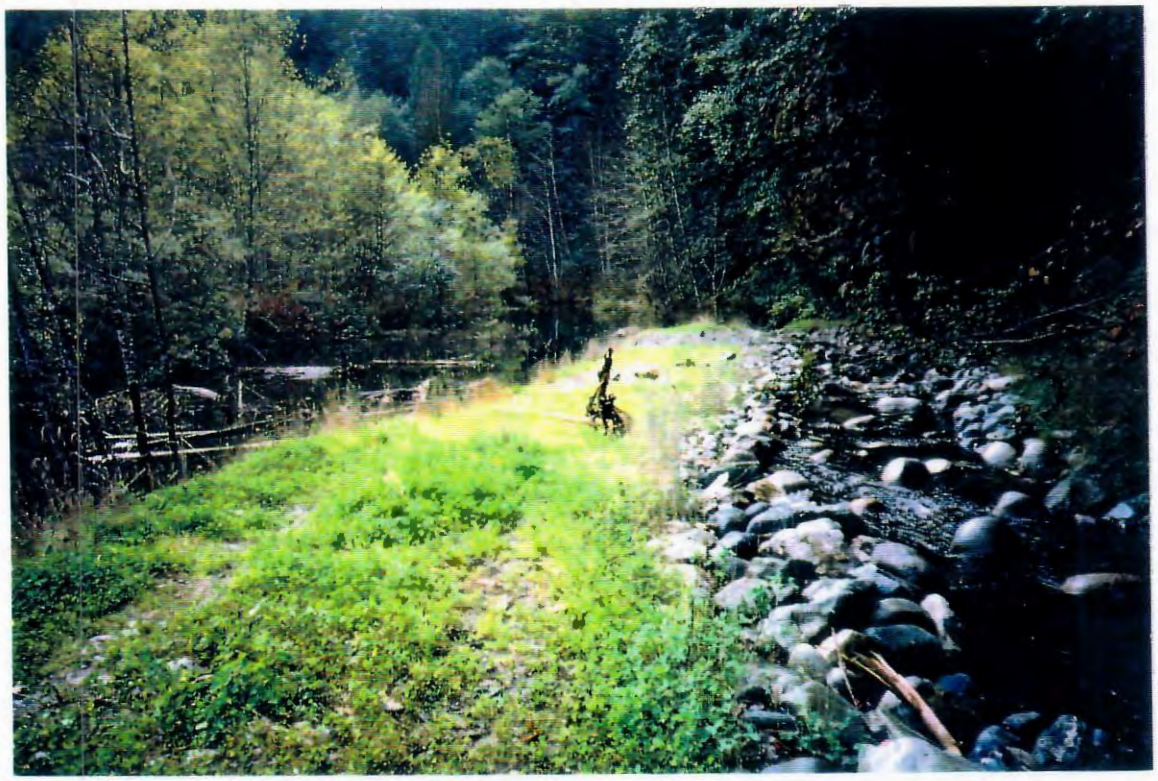


Photo 2. Completed pond and side channel with woody debris and dressed and seeded berm.

Photo 3. Flooded pond with beaver box and culvert at pond outlet.

Photo 4. Fishway connecting downstream spawning channel to Chilliwack River.

Photo 5. Downstream spawning and rearing channel below culvert.

Photo 6. Upper spawning channel delivering water from Anderson Creek to rearing pond.

Photo 7. Flow control / fishway between Anderson Creek and upper spawning channel.

Photo 8. Sheer boom at Anderson Creek.

CHILLIWACK RIVER

Centennial Trail Spawning/Rearing Channel

May - November, 1996

From Department of Fisheries & Oceans

Location: Located between Centre Creek and Middle Creek on the south side of the Chilliwack River.

Proponent: Resource Restoration Division, Department of Fisheries & Oceans (DFO).

Introduction:

Coastal streams such as the Chilliwack River with braided and unstable channels that are re-arranged after each winter flood provide poor salmonid habitat during the winter months. Off-channel habitats, in contrast provide secure refuges for salmonids throughout their life cycles during extreme flood events common to coastal British Columbia. These habitats are within the flood plain, that are either partially or fully protected from the river floodwaters except during extreme high water events. They may be marshes, ponds, wall-based channels or river side channels that receive flow either directly from the river, moderated by log jams at their heads, or from groundwater sources or stable sidehill creeks. The Centennial Trail channel was constructed to provide chum, coho and sockeye spawning and coho and steelhead rearing habitats.

Project Description:

The work included:

a) Excavation and sloping of the channel, rip-rap armouring, complexing (large woody debris, rootwads, boulders and weirs) and excavation of a small off-channel lake.
b) Placement of spawning gravel in the channel. A 1% grade was set for boulder-riffle sections and 0.1% and 0.3% grades were set in the main spawning sections.
c) Construction of the head pond, the channel intake and the spillway at the top end of the channel. Excavated material was used to build the dam across a natural back channel and the dyke that runs along the length of the channel at its top end.
d) Installation of a river intake, similar in design to the channel intake.
e) Excavation of three rearing ponds on the south side of the main road including a small connector channel that will permit fish passage between the main channel and the south ponds. Each pond is controlled by a side channel that travels around the ponds dam. These three side channels were lined with rip-rap and spawning gravel was placed at the apex of each channel. Each dam has a spillway to bypass water if beavers decide to block the ponds outlet.
f) Excavation of a channel from the river intake to the head pond.
g) Construction of a large sill just above the outlet to permit implementation of a downstream trap in the spring and an adult counting fence in the fall of 1997.
h) A shear boom was set 30 cm above low water at the river intake to deflect debris from the river.
i) "Wildlife poles" were scattered throughout the site to provide habitat for birds.

Photo 1. Centennial Trail spawning/rearing channel prior to construction.

Photo 2: Land clearing and slash burning.

Photo 3. Excavation of channel.

Photo 4. Sloping of channel.

Photo 5. Armouring the channel with boulders.

Photo 6. Gravel placement and channel complexing.

Photo 7. Gravel placement and channel complexing.

Photo 8. Centennial Trail spawning/rearing channel after construction and hand seeding.

Photo 9. Centennial Trail spawning/rearing channel after construction and hand seeding (prior to hand planting of shrubs and trees by First Nations planters).

Photo 10. Water intake structure at Chilliwack River.

CHILLIWACK RIVER

Chilliwack Lake Gravel Placement

August, 1995

From Department of Fisheries & Oceans

Location: Located at the outlet of Chilliwack Lake.

Proponent: Resource Restoration Division, Department of Fisheries & Oceans (DFO).

Introduction:

The gravel placement at the outlet of Chilliwack Lake was designed to take advantage of the stable flow and high water quality in this section of the Chilliwack River. All species of salmonids found in the watershed are expected to spawn in the lake outlet area. A modest quantity of gravel was placed at this location in 1978 and has been well utilized for spawning by coho, pink and chum salmon and steelhead trout.

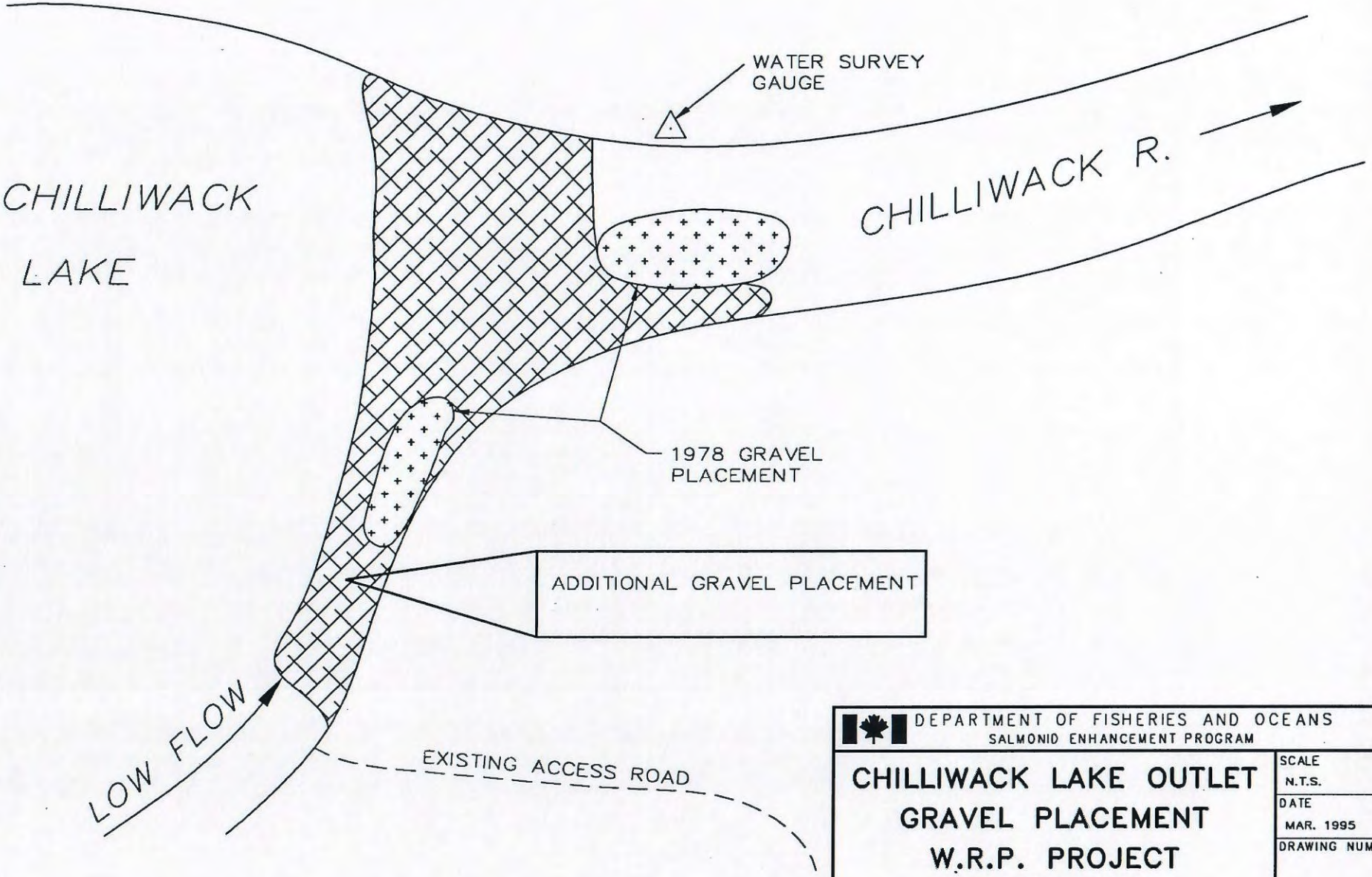
Project Description:

The work included:

a) Hauling approximately 2000 m^3 of screened and washed gravel from a stockpile near Centre Creek.
b) Dumping of gravel at the lake and construction of a road by a large tracked excavator across the lake outlet using the spawning gravel.
c) Leveling of the road to below the water surface to an elevation to ensure adequate velocity across the gravel at low flows and gravel stability at higher flows.

Estimated Production:

This project created approximately 2500 m^2 of high quality spawning habitat at the outlet of Chilliwack Lake. This area has the potential to produce 625,000 salmonid fry annually. In the fall of 1995, approximately 1000 pink, 100 chum and 50 coho salmon were observed spawning at this location. This spawning habitat will produce approximately 6250 adult salmon each year when it becomes fully utilized.



DEPARTMENT OF FISHERIES AND OCEANS
SALMONID ENHANCEMENT PROGRAM

CHILLIWACK LAKE OUTLET GRAVEL PLACEMENT W.R.P. PROJECT PROJECT 1A

SCALE	N.T.S.
DATE	MAR. 1995
DRAWING NUMBER	
REVISION	

Photo 1. Volvo trucks transporting spawning gravel to lake outlet.

Photo 2. Gravel placed across lake outlet prior to levelling.

Photo 3. Excavator levelling gravel to final grade.

Photo 4. Lake outlet prior to gravel placement.

Photo 5. Lake outlet at completion.

Photo 6. Spawning gravel at lake outlet during September low flows.

CHILLIWACK RIVER

Slesse Creek (R4) Off-channel Habitat Development

September, 1995 and October, 1996

From Jan Den Dulk, SSHRC

Location: Approximately 2 km upstream from the confluence of Slesse Creek and the Chilliwack River.

Proponent: Steelhead Society Habitat Restoration Corporation (SSHRC).

Introduction:

To mitigate for some of the losses of steelhead trout and coho salmon spawning, incubation and rearing areas in the mainstem of Slesse Creek, off-channel habitat was developed. The work consisted of developing an infiltration gallery to capture groundwater to be directed into excavated old flood channels that were cut off by the construction of a logging road.

Project Description:

The work included:

a) Development of a groundwater infiltration gallery to provide 0.75 $m^3 \cdot sec^{-1}$ of flow to the channel. This was accomplished by burying 80 m of 20 cm drainage pipe along the base of the valley wall bordering the site. This water is throttled into a 'weeping bed' to provide 75 m^2 of spawning gravel with up-welling flows.

b) Excavation of an abandoned side channel, approximately 800 m in length, to provide spawning and rearing habitat for steelhead trout and coho and chum salmon. Habitat complexing within this channel included the development of riffles, runs, glides and in-stream pools by using a variety of boulder and woody debris structures. The techniques utilized were chosen for their applicability to the specific hydraulic conditions of each reach and for purposes of demonstration and training for future projects.

c) Excavation of six (connected) off-channel ponds throughout the site. Complexing was accomplished through the use of large woody debris. Wherever possible, root wads were employed to maximize total usable habitat.

d) Construction of a berm from spoiled material during channel excavation, to ensure that all created habitat will survive a 1:50 year flow event in the Slesse Creek mainstem.

Estimated Production:

This project created approximately 2700 m^2 of in-channel spawning and incubation habitat. An additional about 1500 m^2 of pond rearing habitat were also created. This area has the potential to produce an estimated 200 adult coho salmon and 20 steelhead annually. To determine the success of the developed habitat, a long-term monitoring program will be implemented. This program will measure fish production and habitat use in the channel.

Photo 1. Aerial view of Slesse Creek prior to creation of off-channel habitat.

Photo 2. Slesse Creek. Note lack of habitat complexity and logged riparian zone.

Photo 3. Constructed groundwater channel with large woody debris and boulder placements.

Photo 4. Constructed overwintering pond with large woody debris and rootwad placements.

Photo 5. Constructed pond with large woody debris and rootwad placements for a juvenile overwintering refuge for coho.

Photo 6. Constructed pool with large woody debris placements for juvenile coho and steelhead summer and overwinter rearing.

COQUIHALLA RIVER WATERSHED

COQUIHALLA RIVER

Off-channel Habitat Development and Fish Habitat Rehabilitation

1995 - September, 1996

From Chris Picard, B.C. Conservation Foundation

Location: Hope, B.C.

Proponents: Ministry of Environment, Lands and Parks (MoELP) and Steelhead Society Habitat Restoration Corporation (SSHRC).

Introduction:

The Coquihalla River is a major tributary to the Fraser River and is located near Hope, B.C. in the Chilliwack Forest District. Summer steelhead (*Oncorhynchus mykiss*) is the only anadromous species that accesses most of the river because of a partial migration barrier within the lower Coquihalla Canyon. Resident rainbow trout and Dolly Varden (*Salvelinus malma*) are also present in the watershed. This summer-run stock is considered "at risk" and warrants urgent attention.

The river has been adversely impacted by past logging practices and more recently by a major highway that severely intrudes on the floodplain. This is a very dynamic river characterized by steep gradients and severe floods associated with rain-on-snow events. Natural channel instability and bedload movement have been exacerbated by recent floodplain development. Consequently, off-channel habitat and small tributary restoration were considered the only strategies viable to pursue in the watershed. However, suitable sites for restoration are very limited because of the intrusive highway, pipelines and associated dykes.

Karen and Spring Creeks, two small tributaries to the Coquihalla, were historically important spawning habitat for summer steelhead. Floods in Karen Creek had scoured out spawning gravel in the lower section which was not being recruited from the headwaters. Recent severe floods in the mainstem Coquihalla, resulted in the deposition of large volumes of porous sediment in the lower portions of Spring Creek, thus causing water in the tributary to flow sub-surface, eliminating critical steelhead habitat.

Project Description:

In Karen Creek, two off-channel habitat areas were developed to mitigate for lost steelhead spawning and rearing habitat in Karen Creek and the mainstem Coquihalla. Initial work on the first, upstream off-channel habitat began in 1995. An infiltration gallery was constructed to provide stable flows into an excavated rearing pond which was connected to Karen Creek. This upper off-channel habitat was extended in September 1996. Additional stream-type habitat was constructed incorporating pool/riffle sequences, spawning gravel, and large woody debris. A large pond was also excavated, complexed with large woody debris and connected to the stream-type habitat. Overall, the upper off-channel habitat is 150 m in length.

The lower off-channel habitat in Karen Creek was entirely constructed in September, 1996. This stream-type off-channel habitat runs parallel to Karen Creek for 320 m before joining it approximately 50 m upstream from the confluence with the Coquihalla. The water source is seepage from the Coquihalla,

therefore, channel flows will fluctuate with the river. It was complexed with pool/riffle sequences, large woody debris, and two large alcoves at the upper end.

Spring Creek restoration also occurred entirely in September 1996. Large volumes of sediment were removed from the lower end of the tributary (deposited during large floods in the Coquihalla River). This excavation exposed approximately 400 m of Spring Creek that previously flowed sub-surface, which facilitated access of adult and juvenile steelhead and resident fish to Spring creek. The newly exposed section was complexed with pool/riffle sequences, spawning gravel, and large woody debris. However, restoration works at Spring Creek were still at risk to flooding and sediment inundation from the Coquihalla River. Previous flood events had damaged the large dyke constructed to protect the highway from flooding, and two large gaps placed Spring Creek at particular risk. Rather than repairing the dykes with more rip-rap, the decision was made to construct two large log-jams along the bank of the Coquihalla to fill the dyke gaps. The concept was that boulder-secured log-jams would collect debris during flood events which would enlarge and stabilize the structure to prevent flooding as well as provide severely limited mainstem rearing habitat for juvenile salmonids.

Two different designs for the jams were used to test the effectiveness of each approach. For the upstream jam, very large cedar logs (i.e., 1-1.5 m dbh, 10-20 m long) and large boulders (i.e., >1 m diameter) were placed alternately for the base of the jam, and secured in place by cabling them together and to existing rip-rap. The base logs were placed with stems on the bank and rootwads facing upstream at approximately 30 degrees to catch incoming debris. Another layer of boulders and primarily cedar logs (perpendicular to the base logs) were placed on the base logs to add additional mass to the structure.

At the downstream location, a much less robust jam design was implemented because the flood risk was less and fewer large cedar logs were readily available. Base-logs and boulders were again placed alternately and cabled together. This time, rootwads were placed high on the bank and stems were placed in the water facing upstream.

Estimated Production:

The total amount of stream-type habitat restored in Karen and Spring Creeks is approximately 2200 m^2, and log-jam habitat restored in the Coquihalla River is approximately 150 m^2. Total expected annual steelhead smolt production from these restoration projects is 50-100, depending on nutrient status.

Photo 1. Coquihalla River jam construction.

Photo 2. Coquihalla River log jam from gravel bar.

COQUITLAM RIVER WATERSHED

COQUITLAM RIVER

Or Creek Habitat Improvements - Phase II

September - October, 1995

From Department of Fisheries & Oceans

Location: Coquitlam, B.C.

Proponent: Resource Restoration Division, Department of Fisheries & Oceans (DFO).

Introduction:

A fish habitat complex was constructed at this site, with the creation of a series of ponds and channels as well as the provision of a stable water supply. It was decided to expand this complex by expanding habitat improvements immediately downstream of this existing complex.

Project Description:

The work included:

a) Improvements to the previously constructed complex included the addition of spawning gravel to the lower reach of the channel, previously back-watered by the Or Creek pond. The original dam was built up and re-faced with well graded gravel to seal leakage and to increase the freeboard.

b) The new complex included the construction of rearing and spawning channels totaling 1350 m^2 and the creation of 8100 m^2 of rearing pond. The existing water supply to the original complex is now split such that half is flowing out of the original complex and the other half diverted into the newly developed complex. Trees and stumps yielded from clearing of the site were used to complex the channel and pond habitat. Channels were lined with gravel and armoured with rip-rap. Filter cloth was installed in the sub-grade of the channel immediately downstream of the original dam site to minimize water loss through the base of this earth filled elevated channel. An old rail grade was used as a dam to contain the largest pond, and was cut in two locations for the inlet and outlet channels to pass through.

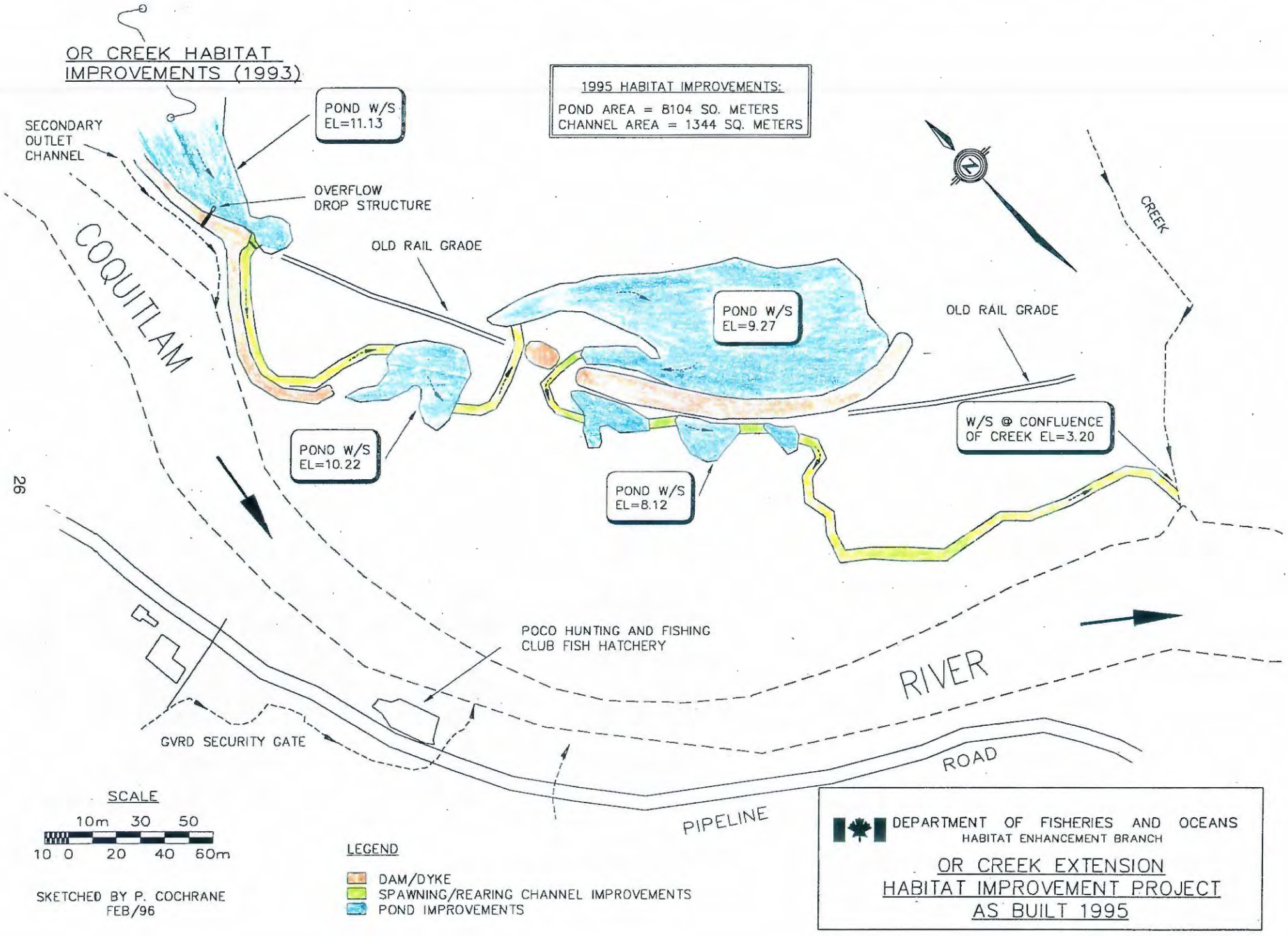

OR CREEK HABITAT IMPROVEMENTS (1993)
1995 HABITAT IMPROVEMENTS:
POND AREA = 8104 SQ. METERS
CHANNEL AREA = 1344 SQ. METERS
POND W/S EL=11.13
SECONDARY OUTLET CHANNEL
OVERFLOW DROP STRUCTURE
OLD RAIL GRADE
COQUITLAM
POND W/S EL=9.27
OLD RAIL GRADE
CREEK
W/S @ CONFLUENCE OF CREEK EL=3.20
POND W/S EL=10.22
POND W/S EL=8.12
POCO HUNTING AND FISHING CLUB FISH HATCHERY
RIVER
GVRD SECURITY GATE
ROAD
PIPELINE
SCALE
10m 30 50
10 0 20 40 60m
SKETCHED BY P. COCHRANE FEB/96
LEGEND
DAM/DYKE
SPAWNING/REARING CHANNEL IMPROVEMENTS
POND IMPROVEMENTS
DEPARTMENT OF FISHERIES AND OCEANS
HABITAT ENHANCEMENT BRANCH
OR CREEK EXTENSION
HABITAT IMPROVEMENT PROJECT
AS BUILT 1995

Photo 1 Loader taking material from borrow pit which will become part of pond complex and form entrance pond for channel leading water to new complex. Original pond is contained above dyke in centre right of photo.

Photo 2 Photo taken immediately after flooding borrow area (lower centre of photo) and from same angle as above photo. Dam was topped and re-faced with well graded back fill to add freeboard and to seal small leaks. Log debris deflector in centre left of photo forms entrance to new channel.

Photo 3 Excavator loading rock sorted from borrow area at start of new complex, into loader, for placement along slope of the new channel. The channel was lined with filter cloth to minimize seepage. The filter cloth was covered with 0.5 metres of clean gravel borrowed from an inactive gravel bar and hauled to channel with the loader.

Photo 4 Photo taken from same angle as above immediately after construction. Logs, stumps, and rocks were used to complex channel.

Photo 5 Channel was cut through unsuitable glacial till which had to be over excavated and filled with 0.5 meters of clean gravel hauled from upstream borrow area with front end loader. As this portion of the channel and pond complex meanders through coniferous forest, trees that had to be removed were utilized as complex material throughout project.

Photo 6 Completed channel as viewed from nearly same angle as above. Note all disturbed areas were seeded with a costal re-vegetation mix and stabilized with a straw covering.

Photo 7 Excavator piling cleared debris (logs, stumps, etc.) into impoundment which will become pond.

Photo 8 Same pond as above photo taken from a different angle, immediately after back flooding .

Photo 9 Main pond prior to flooding is just left of centre. Old railway grade was used as dam, is between trees just right of centre.

Photo 10 This photo taken from same angle as above immediately after back flooding of the pond.

Photo 11 Excavator digging channel at lowermost end of habitat complex.

Photo 12 Completed channel taken from same angle as above photo, with outflow.

PITT RIVER WATERSHED

PITT RIVER (Upper)

Mosquito Creek and Corbold Creek Channels

August, 1995

From Department of Fisheries & Oceans

Location: Maple Ridge, B.C.

Proponent: Resource Restoration Division, Department of Fisheries & Oceans (DFO).

Introduction:

To mitigate for some of the losses of spawning, incubation and rearing areas in the mainstem of the upper Pitt River and Corbold Creek, off-channel habitat was developed. The work consisted of excavating old flood channels that were cut off by the construction of the main logging road.

Project Description:

The work included:

a) Excavation of the Mosquito Creek channels (approximately 1 km). Silty material was removed from the channels and the excavated material was spread along one side of the channels. Culverts were installed. Gravel was added and the channels were complexed with large woody debris.
b) Excavation of the Corbold Creek sidechannel and test pits along the proposed route.

Estimated Production:

This project provided an additional 5900 m^2 of rearing area.

Photo 1. Overgrown channel prior to improvements.

Photo 2. Dry channel prior to improvements.

Photo 3. Excavation of overgrown channel.

Photo 4. Excavated channel.

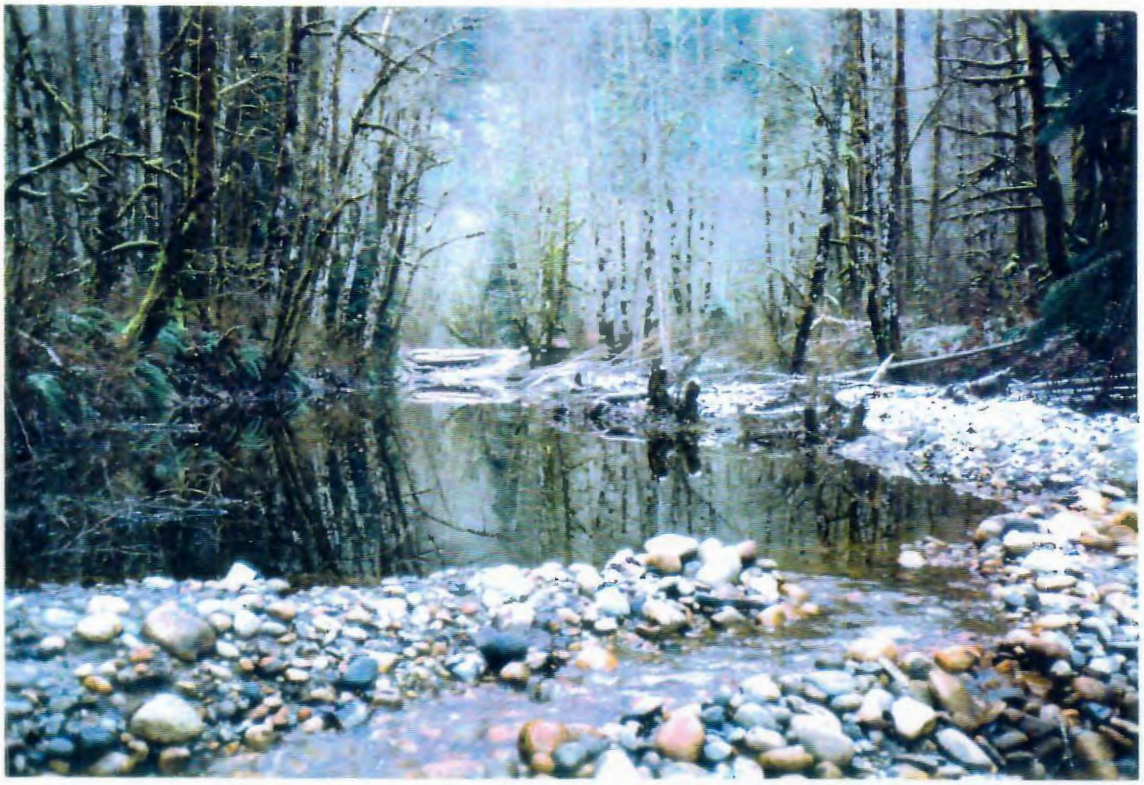
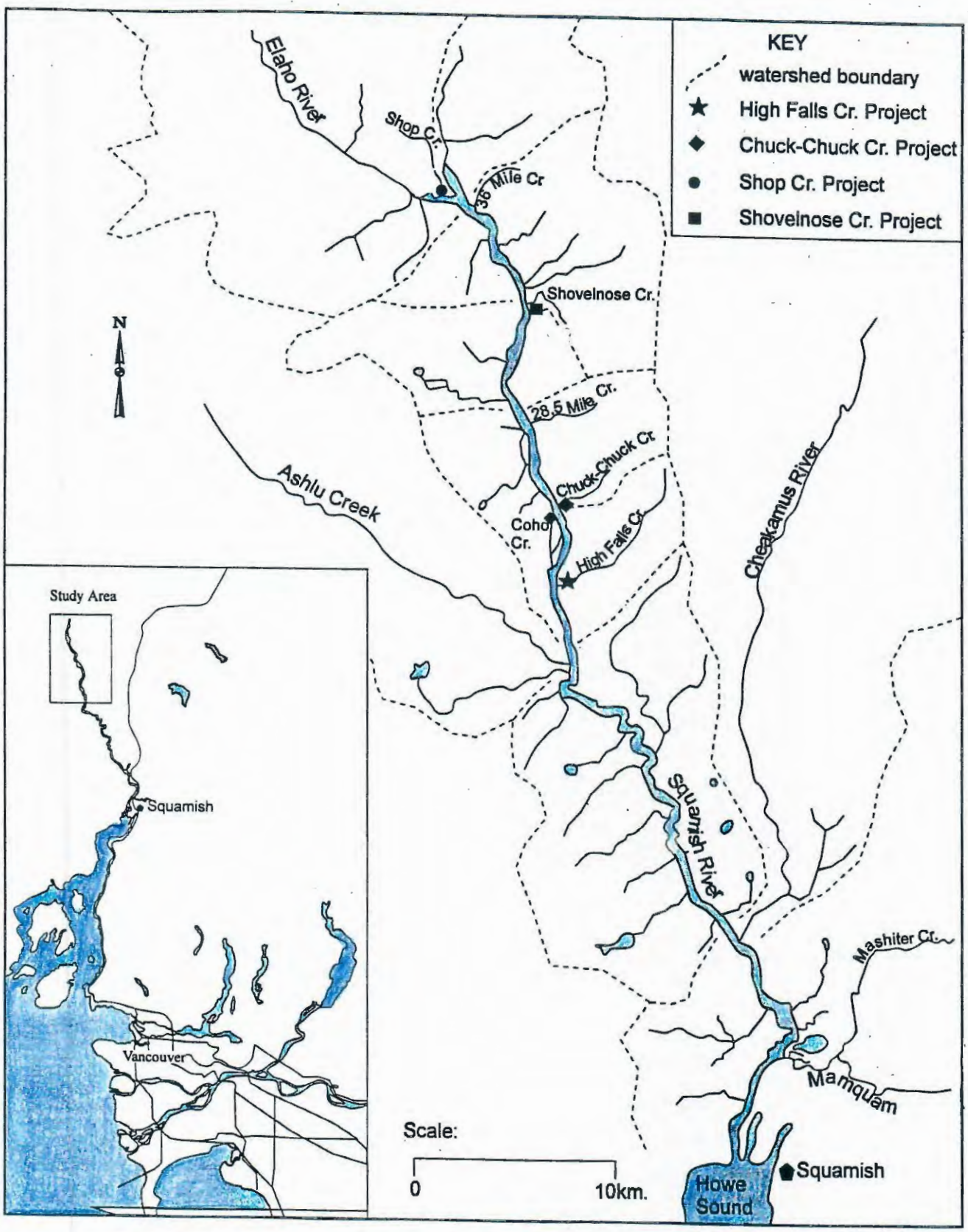


Photo 5. Excavated channel at riffle.

Photo 6. View upstream of forest service road.

SQUAMISH RIVER WATERSHED

Figure of the Squamish River Watershed Showing Rehabilitation Sites



SQUAMISH RIVER

Shop Creek Overwintering Pond, Groundwater Channels and Fish Habitat Rehabilitation

1993 - 1995

From Pat Slaney, MoELP - WRP

Location: Access is at Mile 37 on Interfor's (Empire Logging Division) Main Branch Road north along the Squamish River.

Proponent: Squamish River Habitat Task Force.

Introduction:

The old-growth forest surrounding Shop Creek was logged to the stream banks about 30 years ago; little structure remained in the channel (less than 50 pieces of large woody debris per km versus 200-300 pieces in an old-growth condition). Rehabilitation of 1.2 km of the mainstem (channel width, 5-6 m) and development of off-channel habitat was undertaken in two phases.

Project Description:

The work included:

- Phase 1: establishment of log v-weirs to deepen wide shallow pools, secured floating log cover in shallow runs, and boulder clusters in riffles (via BC-21 in 1993); construction of an overwintering pond (2000 m^2), mainly for coho salmon (Interfor and DFO in 1993).
- Phase 2a: construction of groundwater channels (3 channels via WRP in 1994 and 1995) to provide rearing and overwintering habitat for juvenile coho salmon and to augment low minimum flows in Shop Creek (80-300 m in length and 4.2 m in average width).
- Phase 2b: restoration of large woody debris and additional larger boulder clusters to rehabilitate salmonid habitat (1994 and 1995 via WRP). Smolt traps have been used to evaluate off-channel benefits.

Estimated Production:

Smolt yield in 1996 was 7150 coho salmon and 210 steelhead trout (pond 778 coho smolts, or 10.6%; channels, 1093 coho and a small number of steelhead smolts, or 14.9%). Such yield represents substantial improvement compared to standard production values in coastal B.C. streams (about 2-fold), and indicates the utility of stream restoration techniques in small nursery tributaries within larger, glacial watersheds.

Photo 1. Shop Creek prior to fish habitat rehabilitation. Only poor to marginal salmonid habitat remained in extremely shallow riffles and shallow monotypic pools after logging and clearing since the mid-1960s.

Photo 2. As a result of past logging of the flood plain, 90% of the large logs providing fish habitat in the stream were removed. Although the streambanks are reforested with 30-40 year-old alders, these provide only a very limited supply of natural windfalls.

Photo 3. Shop Creek prior to fish habitat rehabilitation. Note lack of natural boulder groups which are prime rearing and overwintering habitat for steelhead fry and parr in stream riffles.

Photo 4. Shop Creek prior to fish habitat rehabilitation. Note lack of large coniferous windfall logs which are required as cover for juvenile fish for both overwintering and summer rearing in stream channels.

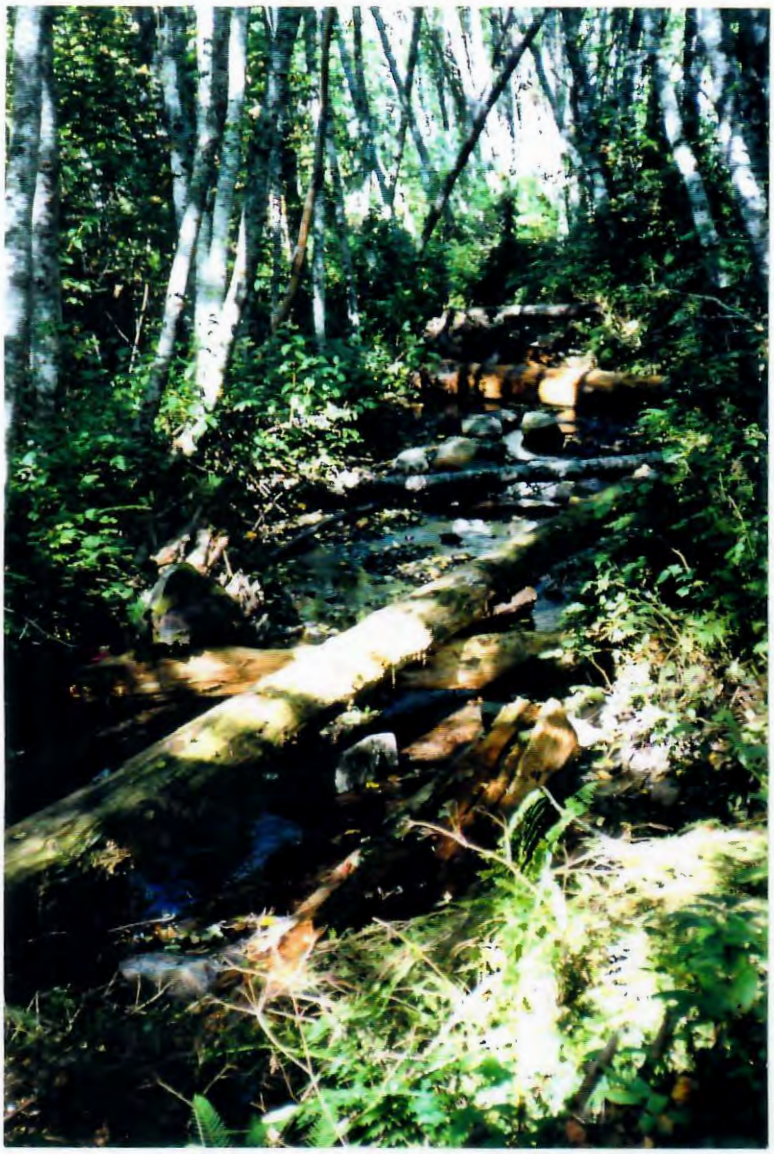


Photo 5. Note rearing (coho salmon and steelhead trout) complex created by a combination of boulder clusters and large woody debris (of the type that would have fallen - as windfalls - into the stream to provide in-stream habitat and cover for fish).

Photo 6. After excavating (deepening) a "run" for fish holding (adult coho and steelhead) and attaching surface (chained) log cover

Photo 7. Juvenile steelhead habitat was created by placing "boulder clusters" with a backhoe.

Photo 8. This corner pool was restored by pre-excavating the pool to provide greater depth (0.6 m) for holding of adults and of overwintering juvenile salmonids.

Photo 9. Two-log rafts were chained to large alders on the bank at several sites to provide overhead cover and to induce scour in winter freshets.

Photo 10. V-log weirs were installed by loading excavated bed materials on logs keyed into banks, and a log cover was attached to increase habitat complexity.

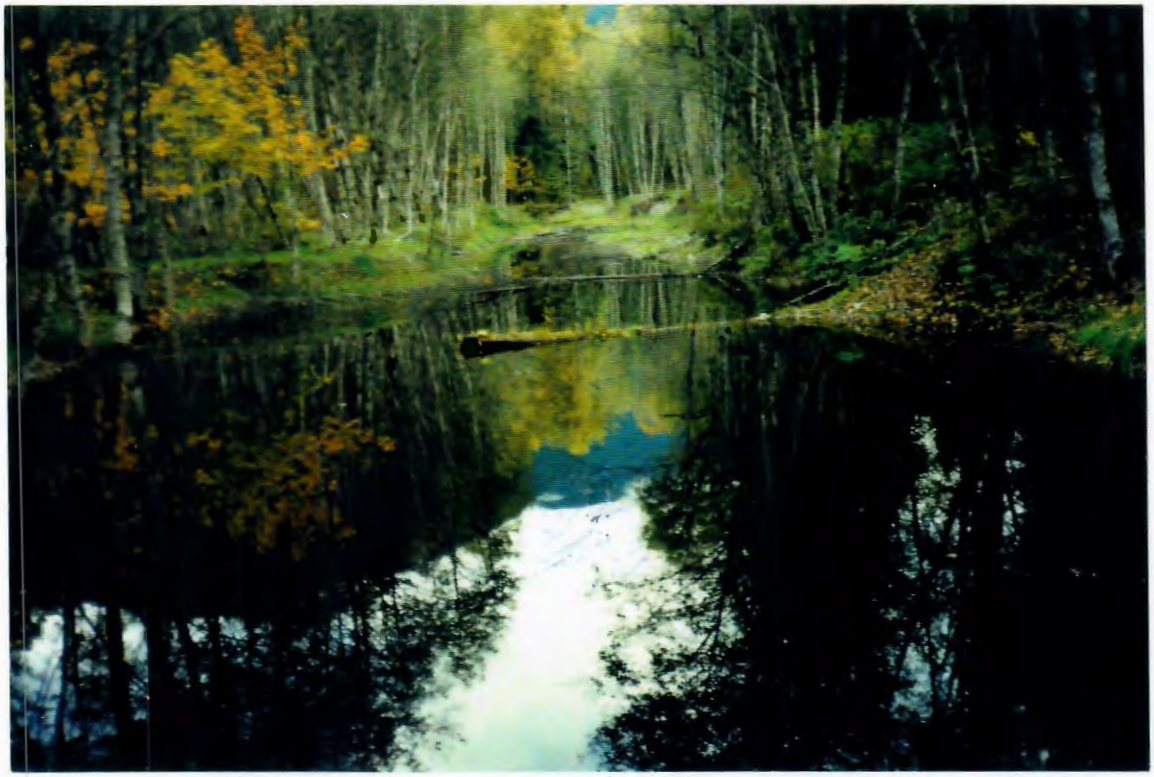


Photo 11. Overwintering pond-channel complex for maximizing over-winter survival of coho. The outlet provides passage for smolts in spring, and the pond-channel complex facilitates multi-species use.

Photo 12. Groundwater channels (3) were excavated to provide additional overwintering habitat and to augment minimum flows. Such channels attract large numbers of coho fry.

Photo 13. Horizontal screen trap. In 1996, 26% of coho smolts produced from Shop Creek (7150 in total) originated from two constructed groundwater channels and the overwintering pond.

SQUAMISH RIVER

28.5 Mile Creek "Working With Beavers"

August - October, 1996

From Pat Slaney, MoELP - WRP

Location: Access is at Mile 28.5 on Interfor's (Empire Logging Division) Main Branch Road north along the Squamish River.

Proponent: Steelhead Society Habitat Restoration Corporation (SSHRC).

Introduction:

A 1996 autumn project, "Working With Beavers" was designed to recover fish habitat impacted by beaver colonization of a deciduous forest on the Squamish River valley bottom that replaced the conifer forest after logging about 30 years ago. Beaver activity has also directed the stream onto the mainline logging road resulting in salmon spawning in ditches that are dry after storm events. Approximately 1 km of channel and pond habitat for rearing salmonids has been restored and improved while also maintaining beaver habitat within the lower section of the project.

Project Description:

Low-level, earth-filled dikes have been constructed to increase the wetted area of an existing beaver dam. Discharge from nearby mountain watercourses and groundwater flow through the newly created pond and then downstream via a spawning/rearing channel constructed adjacent to the hillslope. The channel-pond outlet is provided with excessive woody debris and a beaver fence to prevent the beavers from building a dam across the outlet stream. Woody debris in the channel pools is designed as cover for fish and to discourage beaver dams. Large wood augmentation and riparian restoration will be required in the lower reach (0.6 km) located downstream of the old inaccessible beaver dam area.

Estimated Production:

Production benefits proposed for evaluation under FRBC research program; expected benefits are about 3000 coho smolts (300 adults) as well as significant numbers of steelhead trout, cutthroat trout, char and some chum salmon.

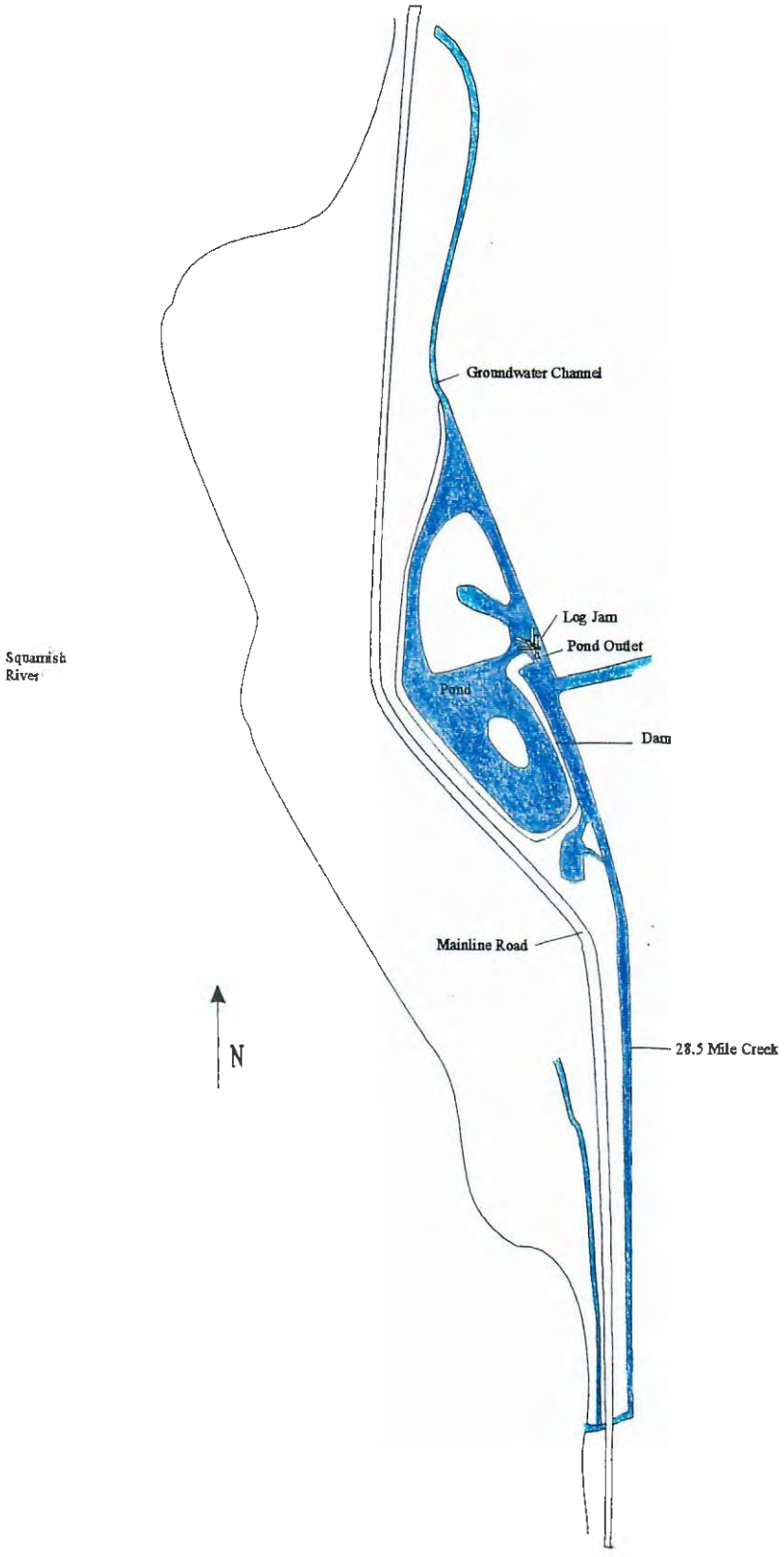

Groundwater Channel
Log Jam
Pond Outlet
Squamish River
Pond
Dam
Mainline Road
N
28.5 Mile Creek

Photo 1. A dam under construction to create a large pond to provide winter refuge habitat.

Photo 2. Completed groundwater channel on 28.5 Mile Creek, prior to revegetation.

SQUAMISH RIVER

Chuck-Chuck Creek Off-channel Habitat Development

August - October, 1996

From Pat Slaney, MoELP - WRP

Location: Access is at Mile 24 on Interfor's (Empire Logging Division) Main Branch Road north along the Squamish River.

Proponent: Steelhead Society Habitat Restoration Corporation (SSHRC).

Introduction:

Chuck-Chuck Creek is a tributary to the Squamish River with a length of 850 m that is available to salmonids downstream of an impassable falls. A natural groundwater channel 400 m in length enters Chuck-Chuck Creek 50 m upstream from the confluence with the Squamish River. The total area available to salmonids is 6500 m^2. Most of Chuck-Chuck Creek is of low gradient (1%) except for a short 100 m steeper section directly below the falls. A shallow pool (1 m in depth by 100 m in length) is located off the main channel at the upper end of the low gradient portion of the creek, and probably receives groundwater. Coho salmon, steelhead trout and Dolly Varden char inhabit Chuck-Chuck Creek (from 1993 tributary surveys and 1979 surveys by B. Clark, MoELP) with coho being dominant. Estimated steelhead production (from intensive electrofishing surveys in 1979) is 45 smolts equivalent to 5 adults.

Summer rearing habitat and overwinter refuge habitat (especially for coho) were assessed as limited. Large woody debris was near lacking throughout, which was probably a result of streambank logging operations 30-40 years ago. An excessively large log jam (approximately 100 m x 10 m) at the lower end of the creek provides cover habitat, but owing to its large size may act as a barrier to migrating adult spawners except at peak flows. As a result of beaver use, primarily within the groundwater channel, the lower reach of the creek had developed wide shallow pools eliminating much of the riffle habitat and potential spawning areas. During freshet conditions water behind the dam spilled over into the surrounding flats resulting in large amounts of fine sediment to be washed into the creek, covering the larger substrate of the creek to several centimeters.

Project Description:

To provide overwinter refuge in the upper reach, the shallow long pond (1885 m^2) was excavated to a depth of 2-3 m and large woody debris placed along the margins. Groundwater, augmented by intermittent surface flow ensures high dissolved oxygen levels in the main pond, although a small alcove is poorly oxygenated because of organic materials. Subsequent restoration will involve riparian treatments to provide future large wood debris (LWD) from conifers (cedars) and LWD placements in the channel, along with removal of excessive debris at the stream mouth.

Estimated Production:

Production benefits proposed for evaluation; expected benefits similar to Shop Creek.

Photo 1. A shallow remnant beaver pond that is too shallow to supply adequate winter refuge habitat on Chuck-Chuck Creek.

Photo 2. Completed Chuck-Chuck Creek pond with large woody debris added to provide cover.

SQUAMISH RIVER

Shovelnose Creek Flood Protective Dyke and Fish Habitat Rehabilitation

March, 1994 - October, 1996

From Pat Slaney, MoELP - WRP

Location: Access is at Mile 31 on Interfor's (Empire Logging Division) Main Branch Road north along the Squamish River.

Proponent: Squamish River Habitat Task Force.

Introduction:

Shovelnose Creek was seriously impacted by a series of natural events in the 1980s, i.e. a mud-flow from Mt. Cayley into the Squamish River and natural slides in upper Shovelnose, plus a combination of past logging impacts including logging of the flood plain to the stream bank throughout its accessible length to salmon and steelhead, and augmented sedimentation from a gully failure and logging roads.

Project Description:

The work included:

- Road upgrading: cross-ditches, water bars and re-vegetation of slopes (Weldwood/Interfor 1993-1994).
- Shovelnose dyke: this WRP project was assisted by Weldwood of Canada (now Interfor), and was designed to restore vital fish habitat seriously impacted by encroachment of cold, silty waters of the Squamish River. The dyke was constructed in March - April as the inaugural project of the Watershed Restoration Program at the inception of the Forest Renewal Plan in the spring of 1994.
- Construction of pilot stream reefs and slow release fertilization: pilots initiated during 1995.
- Extension of Shovelnose side-channel: late-summer, 1995; project recovered 800 m (20%) of prime salmon and steelhead habitat in a relic channel, partially offsetting habitat losses (2 km) in the highly de-stabilized upper reach (logging to banks in 1980s has resulted in considerable channel widening and lateral scour).
- Construction of groundwater channels (3; 1.5 km) and restoration of off-channel habitat (0.3 km - isolated by Main Branch Road).
- Construction of opposing wing deflectors (6) and excavation of pools in the mainstem.

Estimated Production:

A research proposal has been submitted to FRBC to evaluate salmonid production benefits (pre-smolts - smolts) of salmonids and to enumerate adult utilization of restored and mitigative habitats. The channels and alcove ponds should produce about 6000 coho smolts or 600 coho adults on average plus significant numbers of chum salmon, steelhead trout and char. Mainstem channel (pool-riffle) re-construction is designed to benefit chinook salmon, steelhead trout, coho salmon and chum salmon.

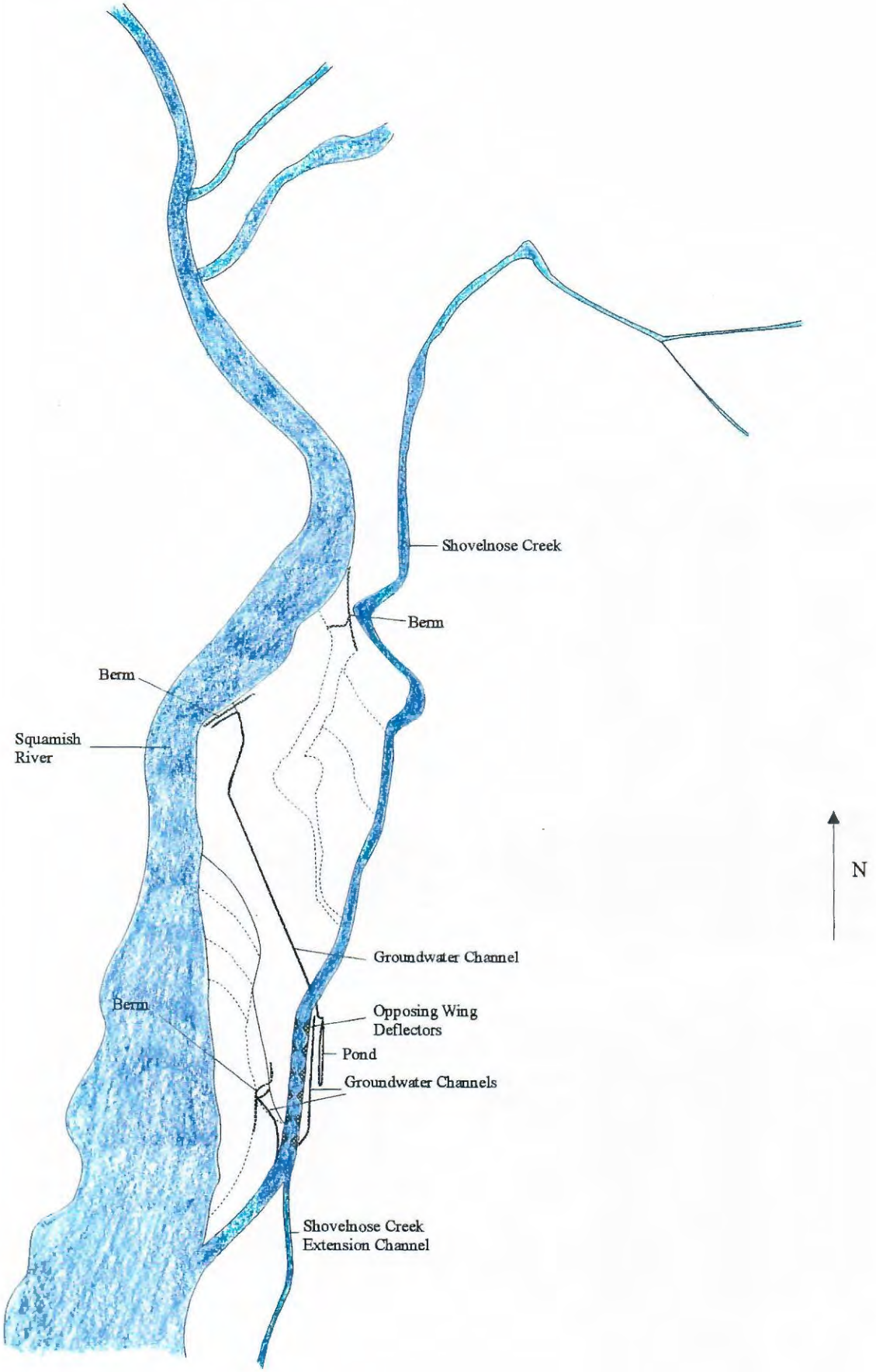

Shovelnose Creek
Berm
Berm
Squamish River
N
Groundwater Channel
Berm
Opposing Wing Deflectors
Pond
Groundwater Channels
Shovelnose Creek Extension Channel

Photo 1. 1984 breakout of the high water channel (left) of the Squamish River (right at low flow), thus degrading Shovelnose Creek (not shown) in spring-summer with silty waters.

Photo 2. Restored clear waters of Shovelnose Creek with berm in background, after construction in May 1994.

Photo 5. Rock armour placement Shovelnose Creek side.

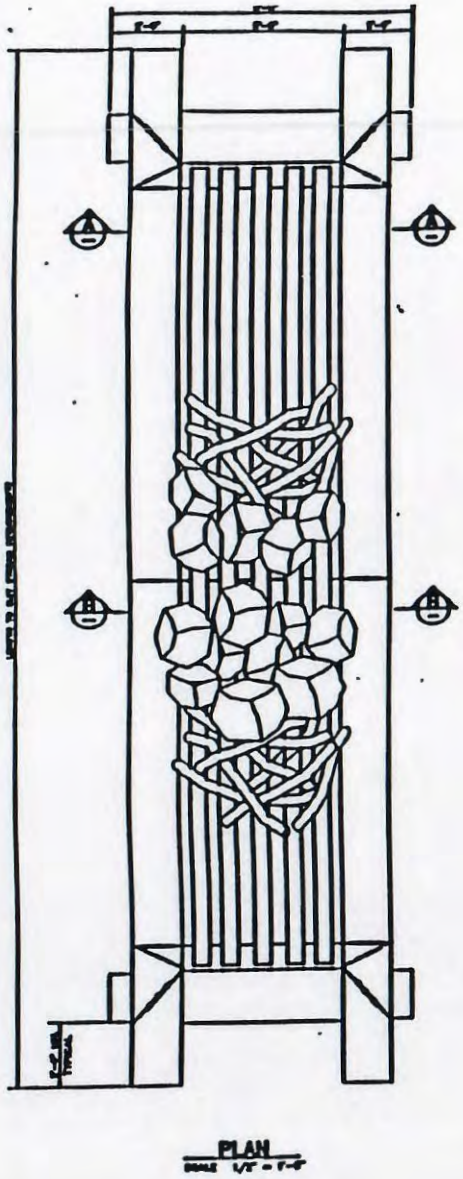
Photo 6. Hydro-seeding after construction.

Photo 7. Shallow monotypic section of Shovelnose Creek. During summer low flows this 500 m section was a barrier to adult chinook salmon.

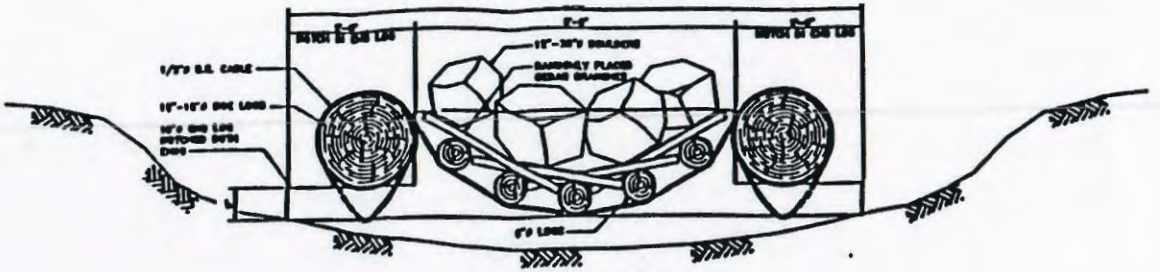
Photo 8. Six opposing wing deflectors were constructed to create deep pools and a meander pattern within the channel. During summer/fall 1996 chinook and chum salmon were seen spawning throughout this section of creek.

Photo 9. A large gravel bar at the edge of the lowermost section of Shovelnose Creek. A groundwater channel is to be constructed on the right hand side.

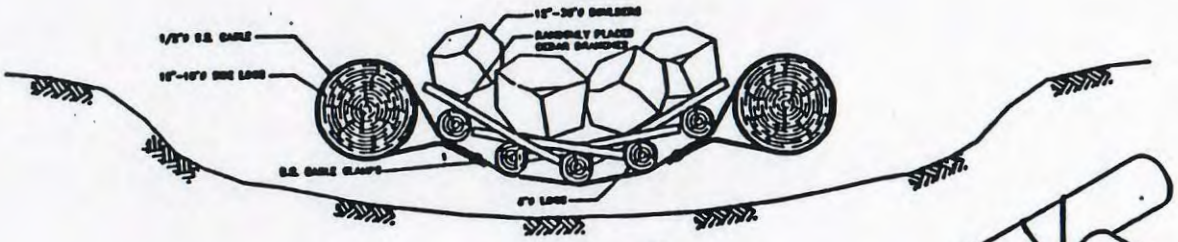
Photo 10. After construction large woody debris was added to the groundwater channel to provide cover.



PLAN



SECTION A



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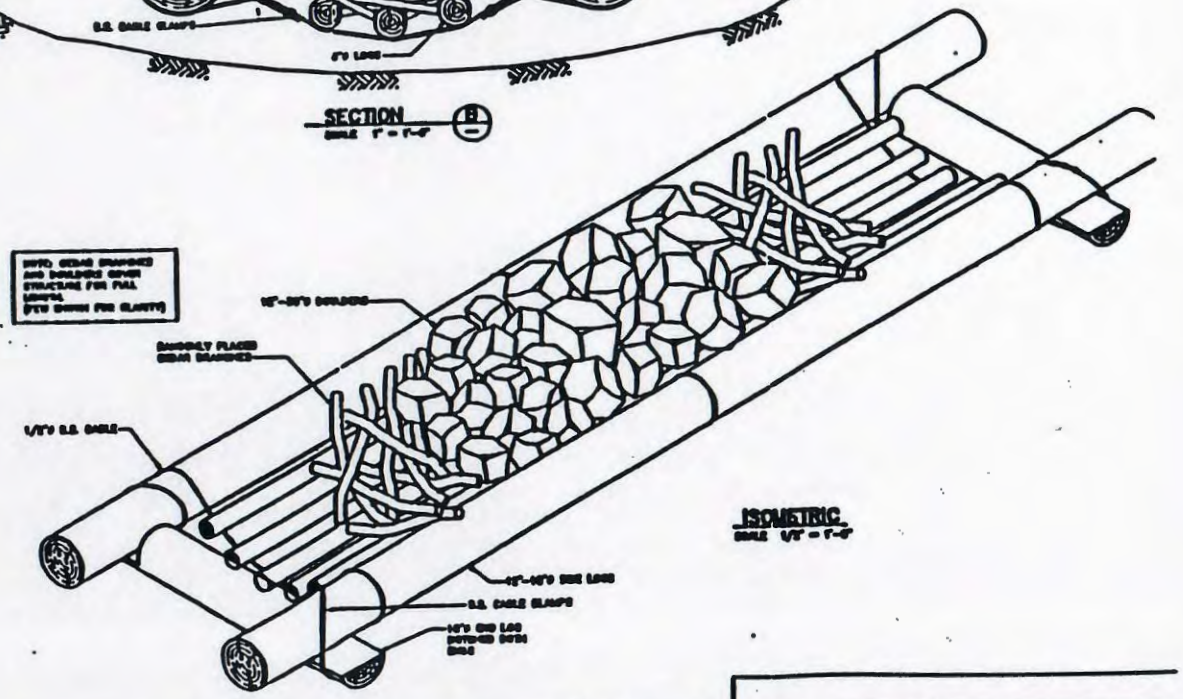


ISOMETRIC

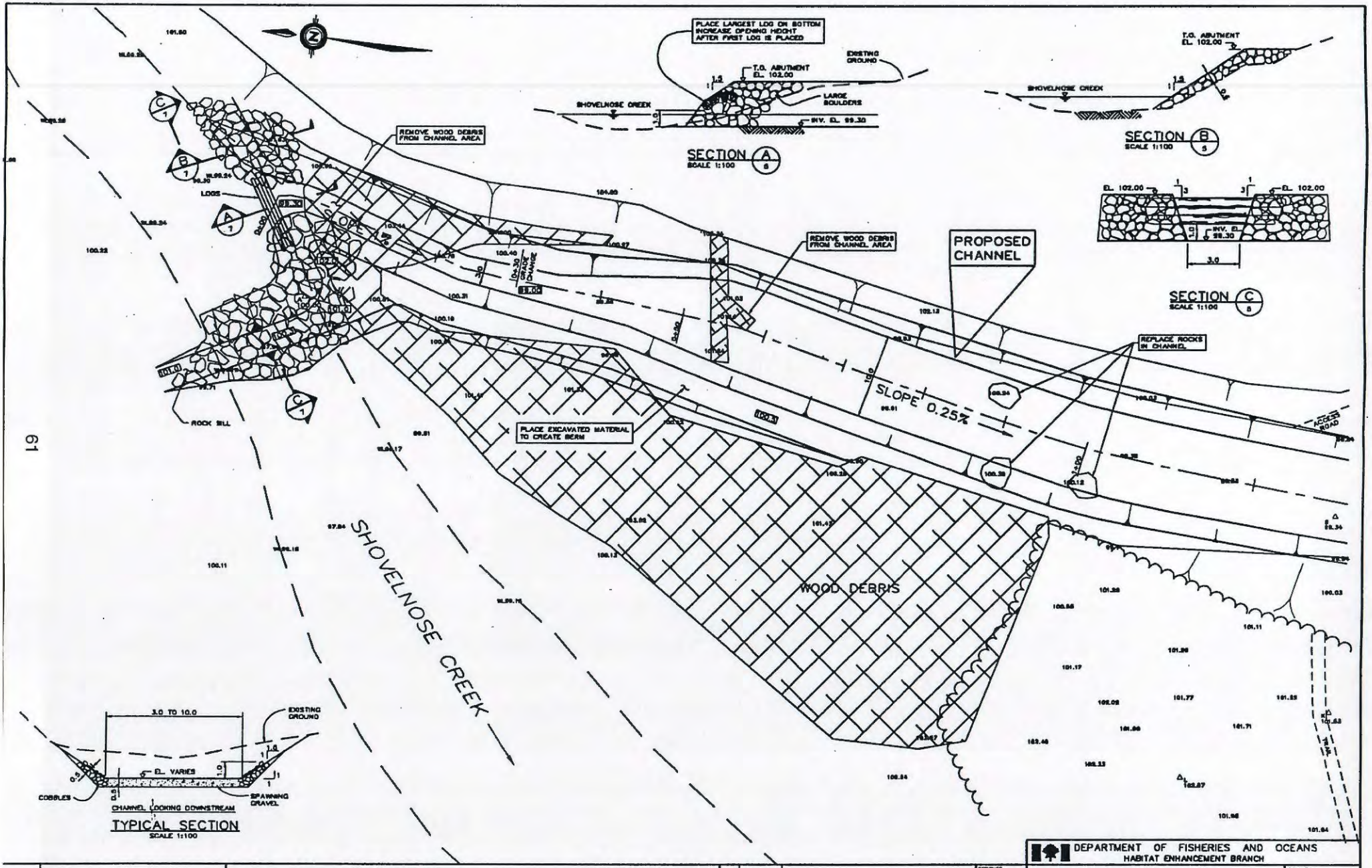
NOT TO SCALE

ROCK & LOG CRIB REEF
PLAN, SECTION, AND
ISOMETRIC VIEW

11-115

Photos 11 & 12. Artificial log reef is under construction and one is installed below. Reefs comprised of boulders and logs are well inhabited by juvenile salmon, steelhead and char and restore critical fish habitat as they are similar to (mimic) large old growth trees.

Photos 13 & 14. Depressed fish abundance resulting from logging impacts (often combined with overfishing) depresses the availability of nutrients (phosphorus and nitrogen) crucial to the salmonid food chain. Nutrients can be restored by the use of pellets that release at extremely low target levels (<5 ppb).



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DEPARTMENT OF FISHERIES AND OCEANS
HABITAT ENHANCEMENT BRANCH

11-115-7	SECTIONS	1. ALL UNITS ARE IN METRES UNLESS OTHERWISE SPECIFIED. 2. SURVEYED MAY 19-28, 1984 BY E. NICKEL.				DESIGNED A.M.	SHOVELNOSE CREEK MILE 31 SPAWNING CHANNEL INTAKE PLAN	SCALE N.T.S. - REDUCED
						DRAWN E.N./D.T.		DATE JUNE 1984
						RECOMMENDED		DRAWING NUMBER 11-115-5
						APPROVED		
DWG. NO.	REFERENCE DRAWINGS	NOTES	NO.	DATE	REVISIONS	APPROVED		REVISION

Photo 15. Lower Shovelnose Creek side channel (pre-construction, spring 1995). About 1 km of channel, isolated and dry by past storm events, was re-opened, offsetting channel instability in the upper 1-2 km reach.

Photo 16. Extension of Shovelnose Creek side channel . Photo taken August 1995, a few days after rewatering the channel. Large chinook salmon moved rapidly into the reach and spawned.

Photo 17. A controlled-flow intake and the placement of large logs across the head of Shovelnose Creek side channel to deflect floating debris.

Photo 18. Chinook salmon holding in a deep pool constructed in the previously isolated channel.

Photos 19 & 20. Selective placements of boulder clusters and holding pools in the side channel also offset habitat losses in the upper unstable reach of Shovelnose Creek.

VANCOUVER ISLAND REGION

KEOGH RIVER WATERSHED

KEOGH RIVER

Fish Habitat Rehabilitation

June - August, 1996

From Bruce Ward, MoELP, Fisheries Research

Location: Approximately 20 km southeast of Port Hardy, B.C.

Proponent: Ministry of Environment, Lands and Parks (MoELP).

Introduction:

Habitat assessment continues at the Keogh in co-operation with stakeholders, and follows from twenty years of habitat and salmonid life history research by the Ministry of Environment, Lands and Parks (MoELP). *Stream habitat rehabilitation structures* (120) placed in 1996, as well as experimental habitat structures (boulder weirs and clusters) installed previously (1979 to 1981), will augment the smolt yield from this coastal stream and *provide demonstration and training opportunities* to restoration practitioners, forest workers, resource-based interest groups, and community residents, through field-oriented workshops and displays.

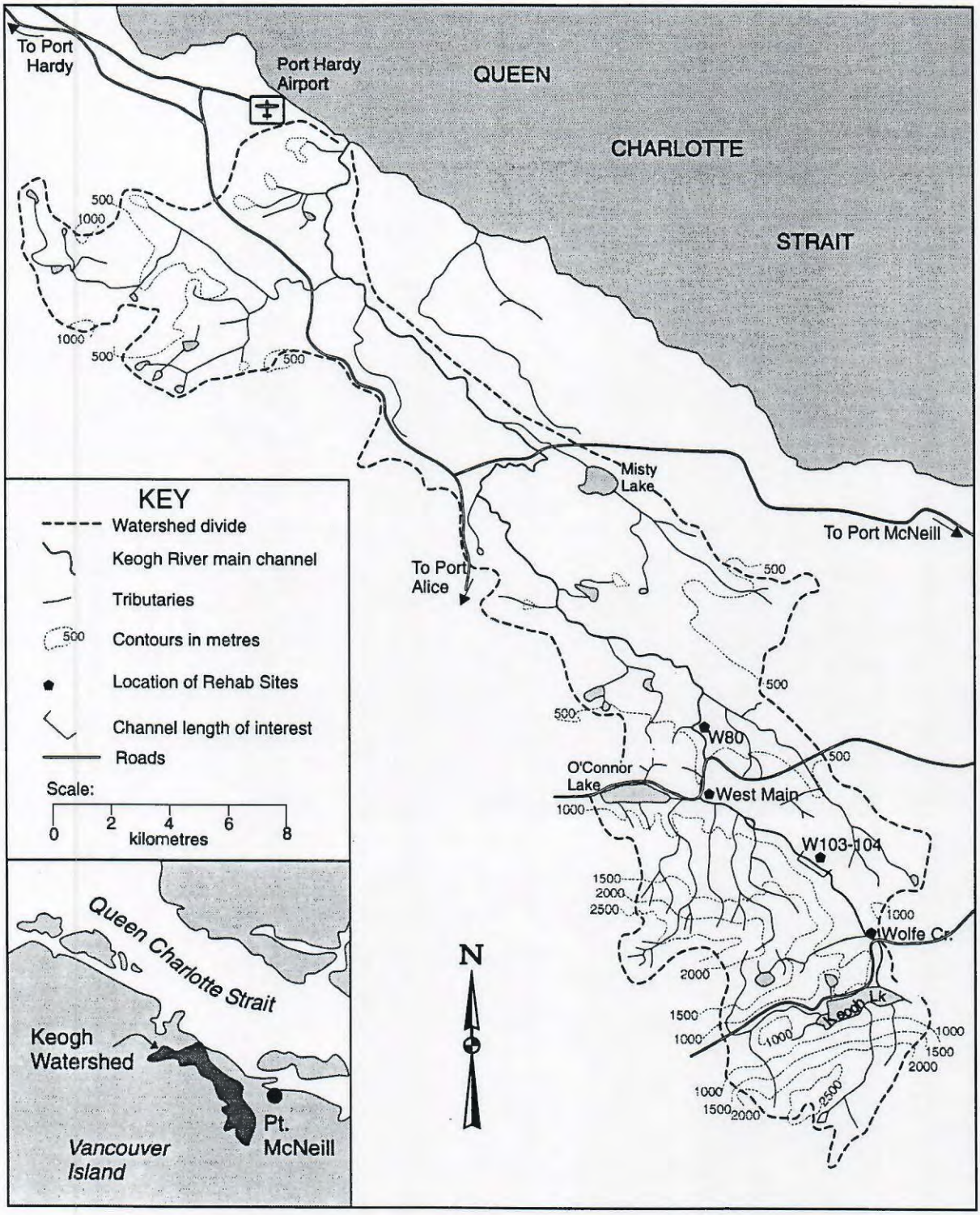
Project Description:

Stream restoration activities, over 3 km, included the development of a groundwater-fed side channel (300 m) near the river mouth, off-channel pond and woody-debris alcoves, in-stream large-woody debris and boulder cluster placements, pool-riffle re-constructions, and slow-release nutrient augmentation in prescribed sites, while other sections and tributaries are further assessed for prescriptions.

Estimated Production:

The predicted improvement in salmonid smolt yield, upon whole-river completion over four years, is towards at least a doubling in coho and steelhead smolt numbers, which will be documented as part of MoELP fisheries and FRBC research, proposed WRP evaluation, and proposed effectiveness assessment of rehabilitation techniques.

Figure of the Keogh River Watershed Showing Rehabilitation Sites



Photos 1 & 2. Streambank log jams were created at W80 sites which also capture large woody debris along the stream margin during high flows: key logs were secured by attaching large boulders. Prime juvenile salmonid rearing and overwintering habitat is provided, as well as cover for spawners.

Photo 3. W80 site prior to placements of boulder clusters combined with large woody debris.

Photo 4. W80 site after placements of boulder clusters combined with large woody debris (LWD) at the head of shallow pools or runs to create prime habitat for rearing salmonids, as well as overwinter refugia (at minimum flow).

Photo 5. W80 bridge, site 18 before fish habitat rehabilitation.

Photo 6. 80 bridge, site 18 after fish habitat rehabilitation.

Photo 7. Placements of boulder clusters at W80 site to provide prime habitat for rearing and overwintering of steelhead fry and parr. When scour pockets form small pools, these boulder sites will also be utilized by coho salmon fry.

Photo 8. Streambank log jams were created at W103 to W104 sites to capture large woody debris along the stream margin during high flows: key logs were secured by attaching large boulders.

Photo 9. V-log weirs were installed at West Main site by loading excavated bed materials on logs keyed into banks, and a log cover was attached to increase habitat complexity.

Photo 10. Streambank stabilization and provision of overhead cover with large woody debris secured to boulders at West Main site.

Photo 11. West Main, site 1 before fish habitat rehabilitation.

Photo 12. West Main, site 1 after fish habitat rehabilitation.

Photo 13. West Main, site 2 before fish habitat rehabilitation.

Photo 14. West Main, site 2 after fish habitat rehabilitation.

Photo 15. West Main, site 3 before fish habitat rehabilitation.

Photo 16. West Main, site 3 after fish habitat rehabilitation.

Photo 17. West Main, site 5 before fish habitat rehabilitation.

Photo 18. West Main, site 5 after fish habitat rehabilitation.

Photo 19. West Main, site 11 before fish habitat rehabilitation.

Photo 20. West Main, site 11 after fish habitat rehabilitation; designed to trap debris.

Photo 21. Re-establishment of pools and riffles can restore habitats in streams which have become more uniform as a result of increased peak flows, higher sediment loads and loss of large wood.

Photo 22. At this site a pool was deepened and a riffle constructed from the largest boulders available on the streambed. Future floods will help maintain this natural pool and riffle profile.

Photos 23 & 24. The Schaeff Superhoe™ spider is highly functional and versatile for instream work.

MALKSOPE RIVER WATERSHED

MALKSOPE RIVER

Fish Habitat Rehabilitation

August, 1996

From Marc Gaboury, MoELP - WRP

Location: South of Brooks Peninsula on west coast of Vancouver Island.

Proponents: Kyuquot Management Board (primary) in conjunction with Interfor.

Introduction:

Logging began in the Malksope River in 1968 and 46% of the total watershed has currently been harvested. The resulting impacts of forest harvesting to the main channel and tributaries include an accelerated rate of coarse sediment loading from slope failures in the upper watershed and increased peak flows during rain on snow events. Accelerated coarse sediment transport has reduced the natural configuration of pool/riffle habitats in the mainstem and tributaries. Increased bedload has infilled the lower reaches of Tributary 1.37, forcing the stream to be diverted down an abandoned road ditch into the adjacent tributary. Loss of old growth timber on the riparian zone, as a result of past logging, has resulted in a reduction of LWD in the mainstem and tributaries. As a consequence, channel morphology and complexity has been reduced as has juvenile fish rearing habitat.

Project Description:

The objectives of instream works in 1996 were to:

a) restore juvenile rearing habitats by re-creating natural pool and riffle habitats,
b) re-connect watercourses to their historic channels and re-establishing historic drainage patterns,
c) increase the amount of functional large woody debris to provide pool complexity and cover for juveniles and adults, and
d) develop overwintering and summer rearing habitat in off-channel ponds.

In Tributary 1.37, the lower reach of the stream was re-connected to its historic channel. The aggraded channel was excavated and a series of rock riffle structures were constructed. Pools were also excavated through the reconstructed reach and complexed with LWD. Further LWD placements are planned for 1997 after the channel has re-adjusted and the pools have scoured fully. In the upper reach of the tributary, aggraded pools were excavated and rock riffles constructed to re-establish a natural pool/riffle frequency.

Rock riffle structures were constructed in Tributaries 1.18 and 1.22. Tributary 1.18 had been subject to the diverted flows from Tributary 1.22 and some channel reconstruction involving channel narrowing to the appropriate bankfull width and the creation of pool and riffle habitats was undertaken. Tributary 1.22 was aggraded with large bed material and its uniform bed profile was adjusted to a stepped pool and riffle profile by constructing rock riffles by hand. Large woody debris was anchored into a large bedrock-controlled pool in the mainstem to provide cover for adult fish.

Approximately 1000 m^3 of material was excavated to create a groundwater pond adjacent to the mainstem. A berm was constructed to protect the pond from high flows in the Malksope River. Mature alders and other LWD salvaged during clearing of the site were placed in the pond to provide cover for fish. Groundwater-fed side channel pools in Tributary 4.37 were excavated by hand to restore 50 m^3 of overwintering habitat for juvenile salmon. The pools were previously infilled with organic sediments.

Photo 1. Historic channel (Trib. 1.37) prior to reconnection and reconstruction.

Photo 2. Historic channel (Trib. 1.37) after reconnection and reconstruction.

Photo 3. Channel restoration using hand labour and chainsaw winch.

Photo 4. Trib. 1.37 after reconstruction.

Photo 5. Malksope River pool-riffle construction.

Photo 6. Malksope River backwater pond.

SKEENA REGION

GINULAK CREEK (NASS RIVER WATERSHED)

GINULAK CREEK

Fish Habitat Rehabilitation

August, 1996

From Jeff Lough, MoELP - WRP

Location: 40 km west of New Aiyansh in the Nass Watershed, north of Terrace.

Proponents: Nisga'a Tribal Council (NTC) and Skeena Cellulose (partner).

Introduction:

Logging activities in the Ginulak Watershed occurred between 1954 and 1973 where 37% of the watershed was harvested. As for most of the tributaries to the Nass, the logged area of this watershed is on an alluvial fan which, even prior to development, was naturally unstable.

Project Description:

Assessment and Analysis

An Overview and Level I Assessment was completed for the Ginulak between late 1995 and early 1996. An analysis of the Level I detailed habitat assessment measurements, along with professional field observations revealed:

a) The Ginulak Watershed has a considerable amount of summer and winter rearing habitat for coho and resident species but was replete in suitable (stable) spawning habitat. The majority of suitable spawning habitat was historically located in the logged part of the alluvial fan. The spawning habitat has now aggraded causing dewatering, avulsions, and channel braiding.

b) A productive, unimpacted tributary (Trib 7c) to Ginulak Cr. was being threatened by avulsions which would potentially introduce high flows down an old logging road depositing uncontrolled flows and road material in the tributary stream.

Survey and Design

A survey and design contract for rehabilitation and protection the aforementioned fish habitat was let to the NTC in the summer of 1996 (refer to site map). Future sediment sources upstream of the site were considered to be minimal and had run their course (stabilized). A survey and design report with drawings was submitted to us with a Section 7 Approval application in early July.

Rehabilitation Work

Works began in mid-August in the reaches of concern on the upper Ginulak (work site) when most of the flows were sub-surface and almost all works were completed in the **dry** (prior to fall freshettes). In order to protect the valuable existing spawning habitat two berms were constructed (see photos 7, 8, 9, 10). In addition, the stream channel was redefined by removing aggraded gravels and protecting banks with anchored root wads (see photo 11). Some stream complexing was completed with logs, root wads, and boulder clusters. All disturbed soil was seeded with grasses and planted with Sitka spruce (*Picea sitchensis*) and western redcedar (*Thuja plicata*).

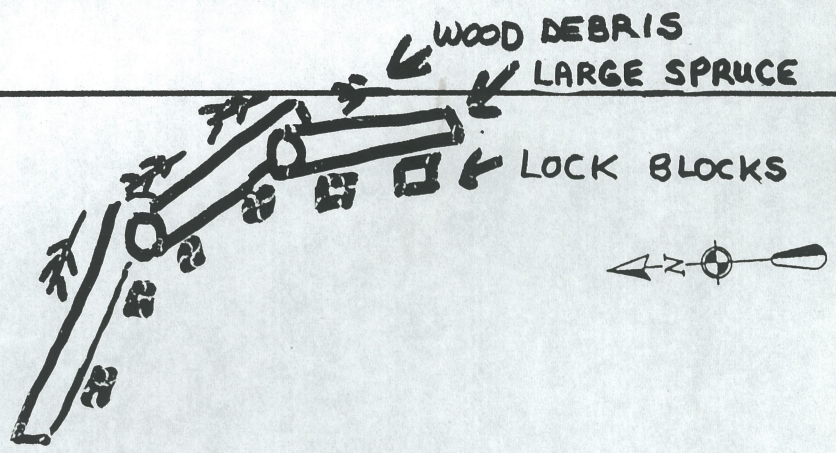
Proposed Work 1997

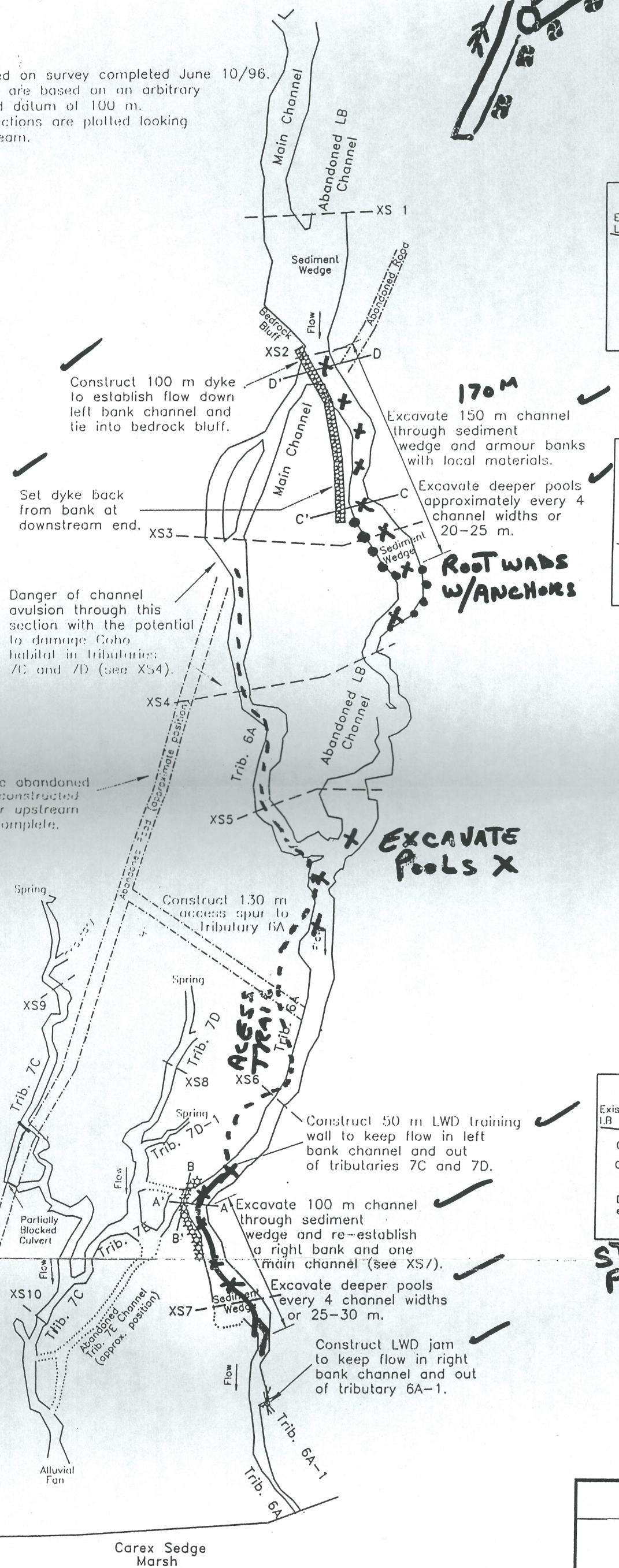
Although the stream channels (0.7 km in length and 10 m in average width) were completed as designed, more complexing, some armoring and an assessment of the berm stability will be required next spring/summer. In addition we will be completing some routine "operational" monitoring this summer looking for fry and at the durability of the structures after a fall and spring freshet.

Production Estimates

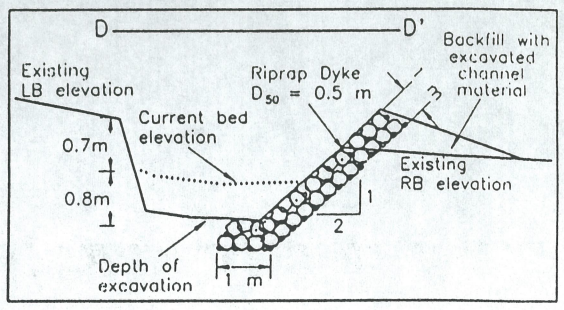
It will be very difficult to estimate the potential smolt production from the reach at this time. Habitat capability estimates can be completed once the channel complexing work is completed. A temporary fence at the lower end of the reach would indicate annual smolt emigration numbers, but may be difficult to operate because of high flows during smolt migration.

Notes:
1) Plan based on survey completed June 10/96.
2) Elevations are based on an arbitrary surveyed datum of 100 m.
3) Typical sections are plotted looking downstream.





Typical Section D to D'



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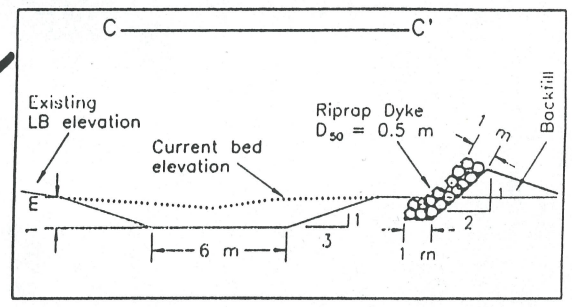
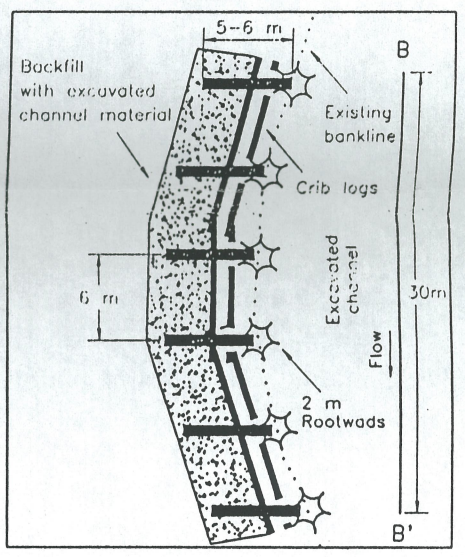
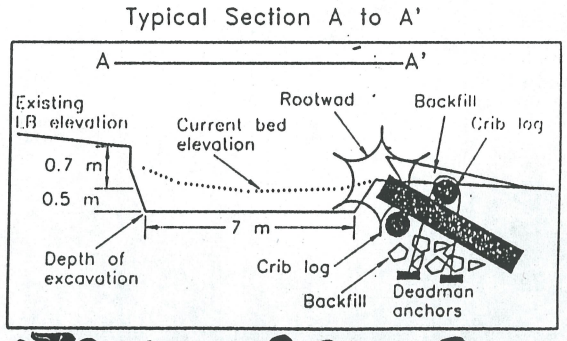


Typical Section B to B'



Typical Section A to A'



STREAM & BERM BANK PLANTED W/GRASS + SPRUCE

Legend
- Bank
- Cross Section
- Road

NHCV 2343-109

Nass River WRP

Ginulak Tributary Creeks

6A, 7C, 7D, and 7E

Proposed Works for Year 1

northwest hydraulic consultants

Photo 1. Preparing for bank stabilization (pits for anchor blocks).

Photo 2. Anchor blocks for rootwad armouring.

Photo 3. Anchor blocks placed in pits.

Photo 4. Cabling down large woody debris and rootwad to blocks.

Photo 5. Backfill over tree stem and anchor block.

Photo 6. Final armoured bank constructed during low flows.

Photo 7. Ginulak avulsion berm (before).

Photo 8. Construction of berm to protect avulsion channel which enters an old road creating a new channel impacting fish habitat.

Photo 9. Armouring bank.

Photo 10. Completed berm - more large woody debris and boulder complexing to be installed.

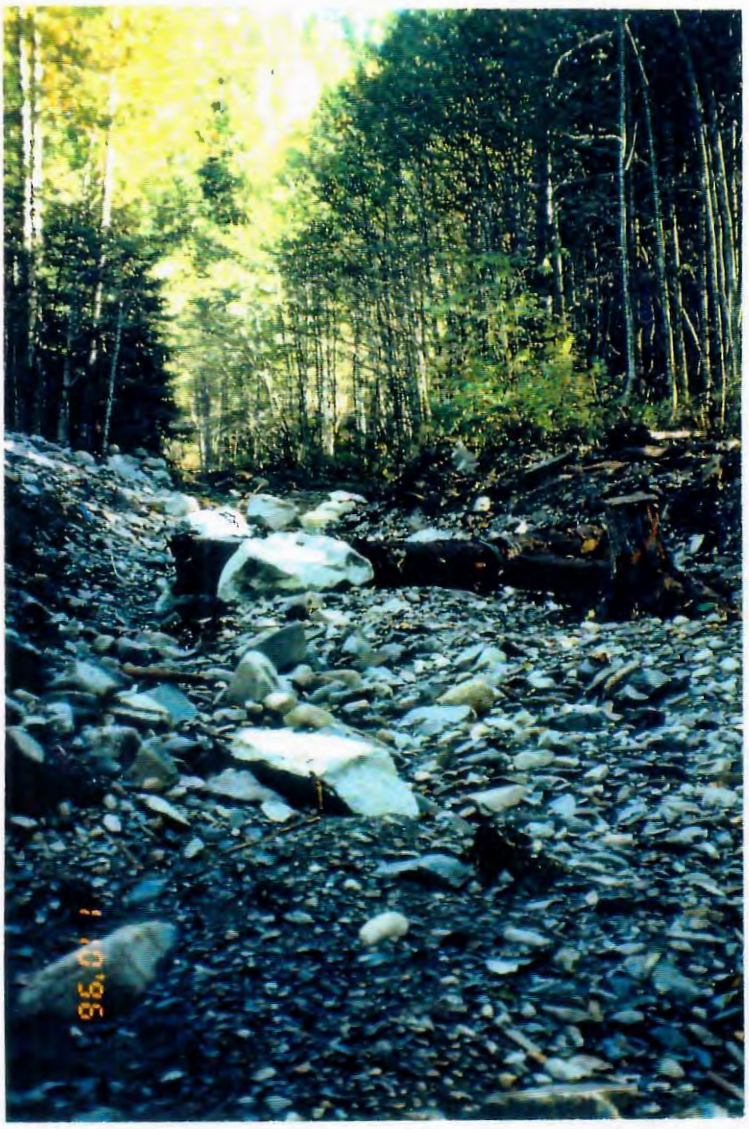


Photo 11. Aggraded gravels removed and some complexing initiated.

LITTLE GOOSE CREEK WATERSHED

Note: The primary goal of this WRP project was to stabilize the channel to protect and restore fish habitat in a highly valued downstream reach. A second phase is planned for 1998 for completion of fish habitat features of the project in this reach. These would typically involve restoration of pool habitat and large woody debris (LWD) attachments at suitable locations to provide rearing habitat for juvenile salmonids.

LITTLE GOOSE CREEK

Fish Habitat Rehabilitation

August, 1996

From Northwest Hydraulic Consultants

Location: Drains into Selwyn Inlet, Queen Charlotte Island.

Proponent: Western Forest Products Limited (WFP).

Introduction:

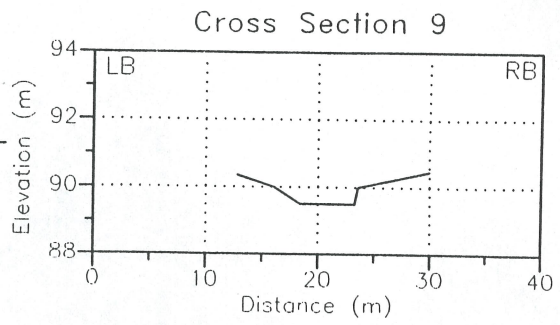
Reach 2 of Little Goose Creek is moderately steep and confined, with valley wall failures directly contributing coarse sediment and debris to the channel. A debris flow traveled down the main channel leaving a debris jam with a sediment wedge that extended up about 300 m of the lower reach. Little Goose Creek breached the right side of the log jam and degraded through the sediment wedge, carrying this material downstream. Flow percolated into the deposit and surface flow only occurred during floods. The purpose of the works was to 1) remove gravels so that they are not transported downstream to Reach 1, and 2) restore the channel (and surface flow) through the debris torrent deposit in Reach 2. Northwest Hydraulic Consultants provided technical guidance pertaining to the hydrotechnical aspects of the project, and Shawn Hamilton and Associates provided environmental monitoring services.

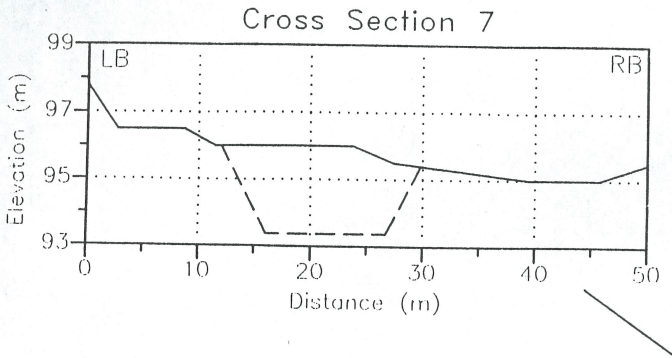
Project Description:

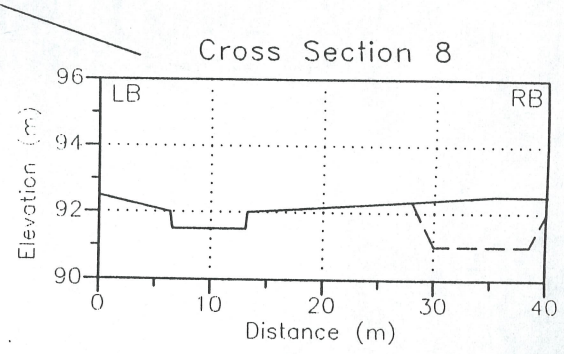
The work included:

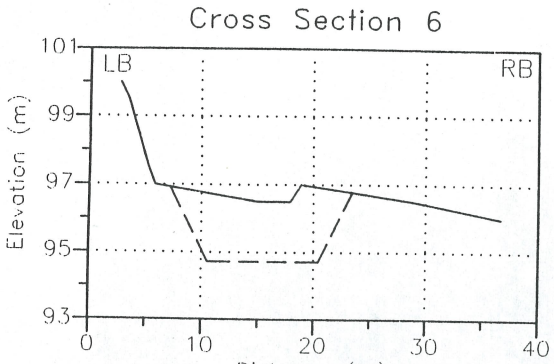
a) A new channel was excavated through the torrent deposit, upstream of Cross-section 7.
b) Rip-rap was used to protect 95 m of bank along the entire right side of the excavated diversion channel.
c) The last 20 m of a small tributary was channelized across the upper right bank and directed towards a slightly lowered section in the right bank armour to prevent the tributary from flowing along the upper right bank behind the bank armour.
d) Riffles were constructed using angular rock. Each riffle was keyed into the bed about 0.3 m, extended 12.5 to 15 m across the width of the channel and was keyed into each bank. The length of the riffles ranged between 3 to 5 m.
e) The channel between Cross-section 6 and Cross-section 8 was lined with a protective layer of rock.
f) The four upstream bends were protected with logs laid along the bank.
g) Logs in each jam were cabled together to provide additional stability, if feasible.
h) Two rootwads were added to Log Jam 4.
i) A rootwad was anchored near Cross-section 8 adjacent to the left bank.
j) At Riffle 5, cross-channel logs exposed during excavation were removed and replaced with a sill log buried along the upstream edge of the riffle.

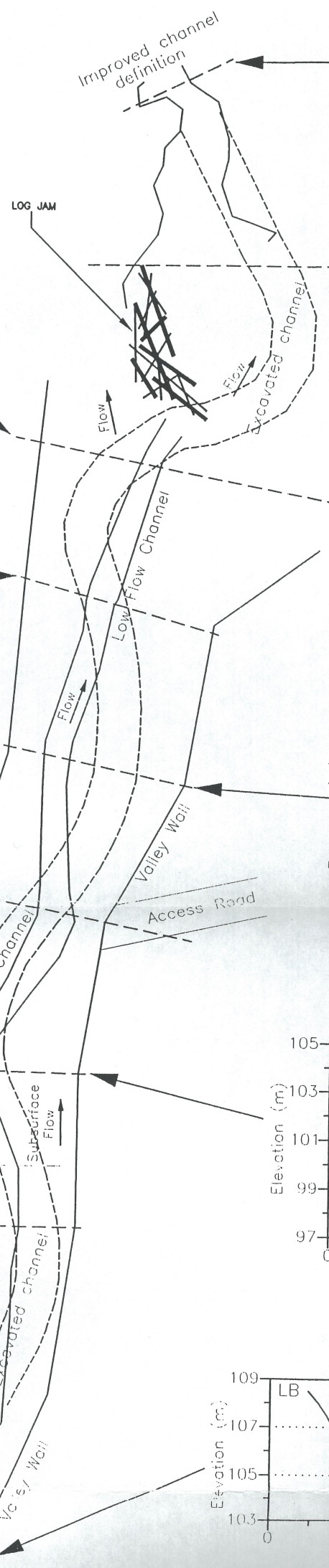
An off-channel, high flow refuge was created on the left bank at Log Jam 1 near Cross-section 2.

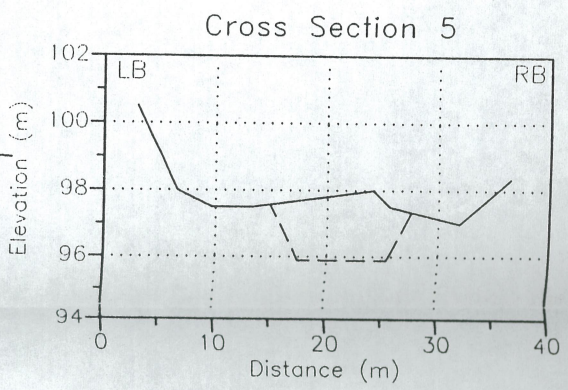


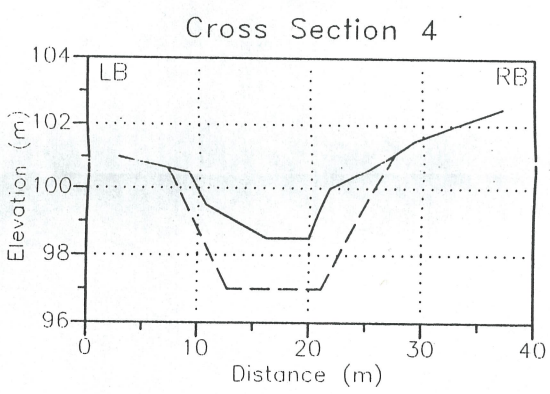


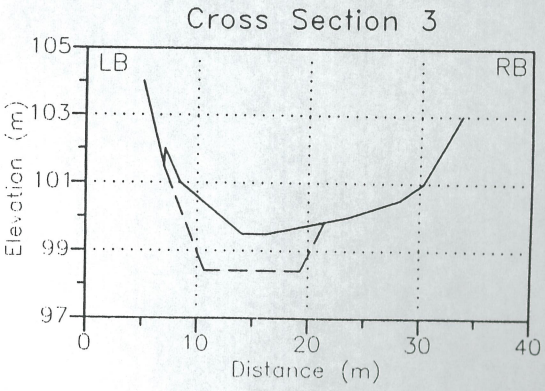


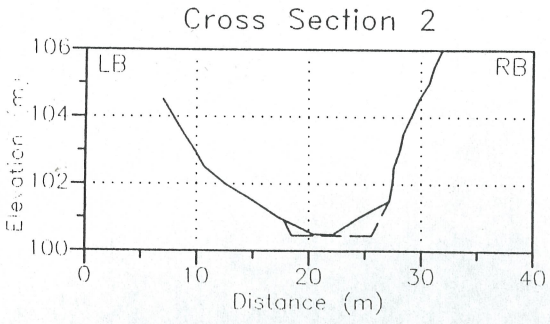


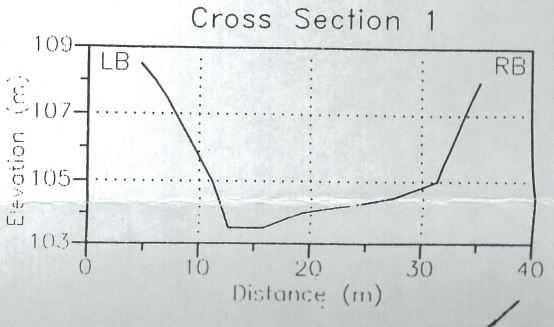












Notes:

1) Plan based on survey completed July 31/96.
2) Elevations are based on a arbitrarily surveyed datum of 100 m.
3) Vertical exageration in the cross sections is 3:1.
4) Cross sections are plotted looking downstream.

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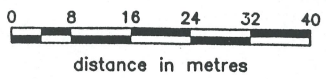
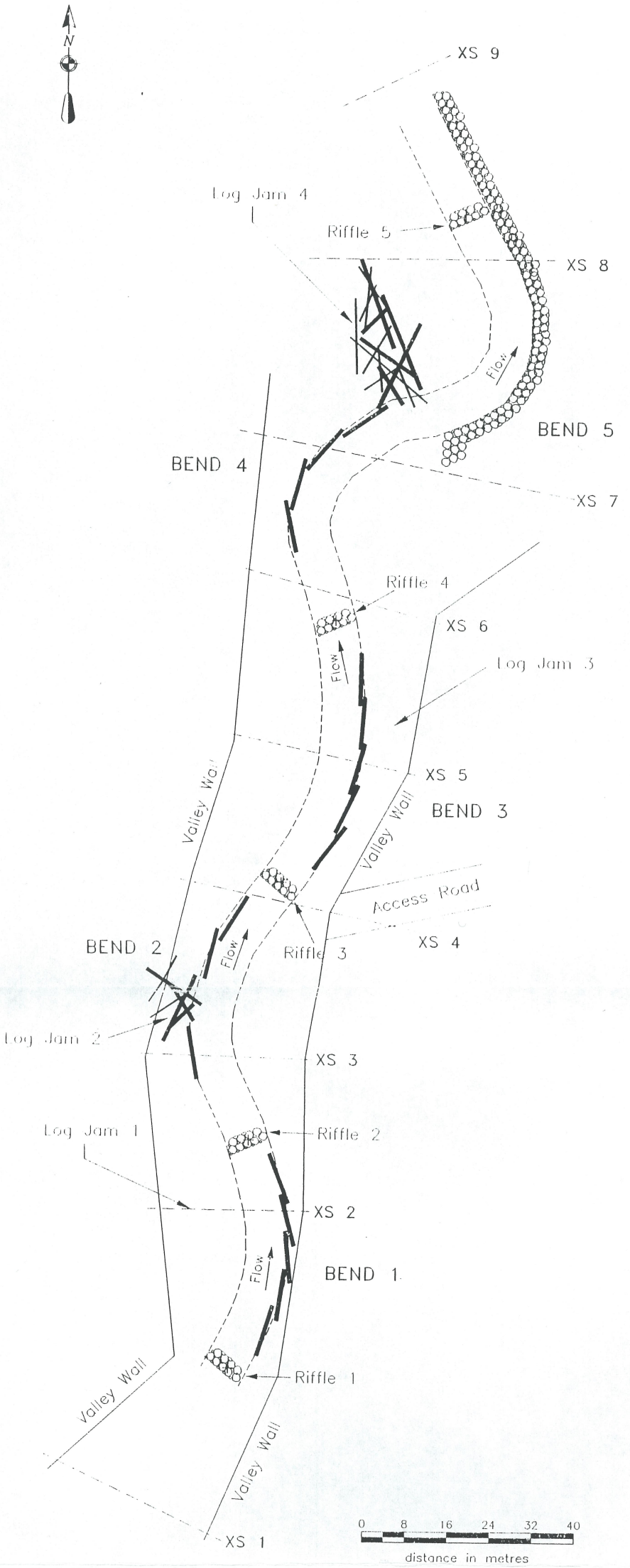
PROVINCE OF BRITISH COLUMBIA
K. M. ROOD
GEOSCIENTIST



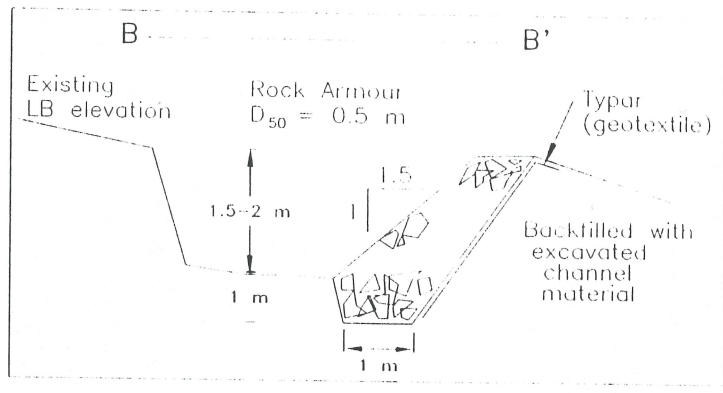
Little Goose WRP
Little Goose Sediment Wedge Plan View
northwest hydraulic consultants

NHCV2394 - 100

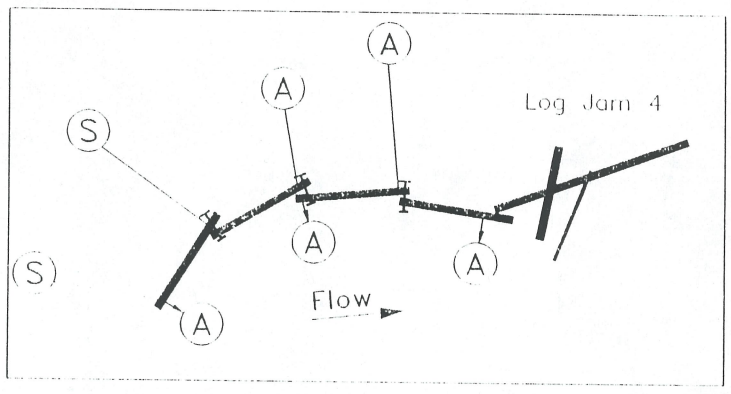
Figure 1



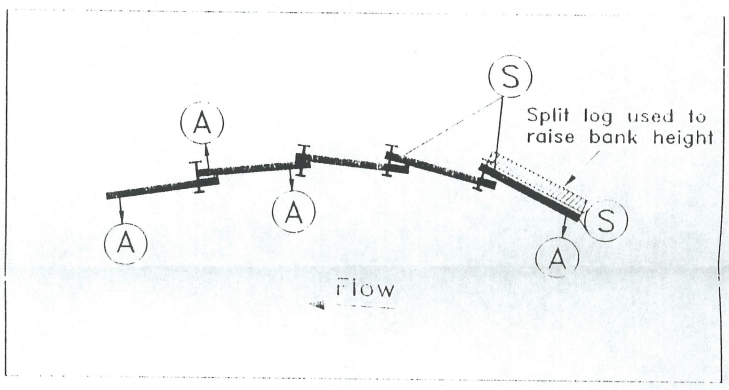
Typical Rock Armour Bank Protection



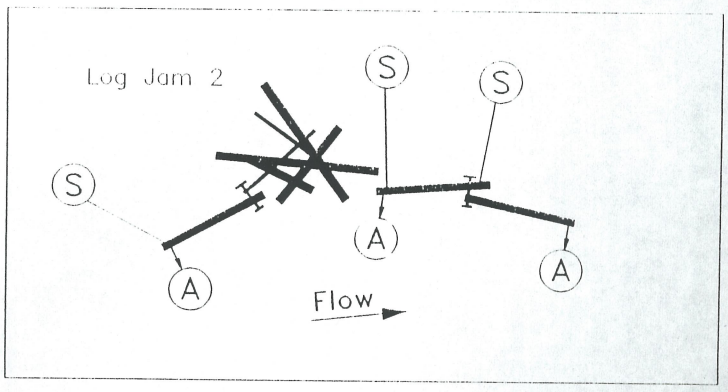
BEND 4 – Log Bank Protection



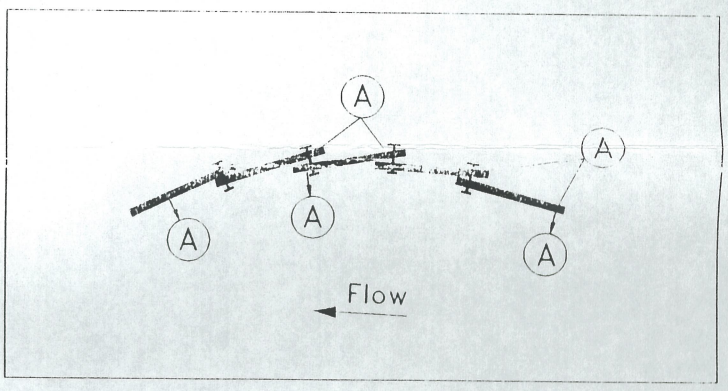
BEND 3 – Log Bank Protection



BEND 2 – Log Bank Protection



BEND 1 – Log Bank Protection



Legend

- Riprap
- Log
- (S) Stump bank anchor
- (A) Rock bank anchor
- (A) Rock bed anchor
- Cabled logs

Notes

1) Plan based on pre-construction survey completed July 31/96.
2) Elevations are based on a arbitrarily surveyed datum of 100 m.
3) Schematics for log bank protection are not to scale.

NHCV2394-113

Little Goose WRP

Little Goose Creek
As-built – Instream Works

northwest hydraulic consultants

Figure 2

Photo 1. Instream construction of new channel between Cross-section 5 and Cross-section 7 viewed downstream from Cross-section 4. Excavation began at Cross-section 2 and worked downstream towards Cross-section 7.

Photo 2. Excavation of the new channel ended at Cross-section 7. Sediment generated from upstream work settled in the pond upstream of Log Jam 3.

Photo 3. Construction of log bank protection at Bend 4 viewed upstream. Logs are being cabled together and have been anchored to notched stumps above the creek (note cables extending into the bush).

Photo 4. Construction of log bank protection at Bend 4 viewed from right bank. Logs are cabled together and have been anchored to anchor rocks buried at the base of the adjacent slope (note cables extending into the bush).

Photo 5. Completed instream work showing upstream view of Riffle 2 in the foreground.

Photo 6. Completed instream work showing downstream view of log bank protection at Bend 1.

MORICE RIVER WATERSHED

MORICE RIVER

Kilometer 29 Fish Habitat Improvements

August - October, 1996

From Department of Fisheries & Oceans

Location: Approx. 30 km southwest of Houston, B.C. on Morice West Forest Service Road.

Proponent: Resource Restoration Division, Department of Fisheries & Oceans (DFO).

Introduction:

This project was constructed to investigate a technique for improving overwintering rearing habitat for juvenile coho salmon in a northern interior stream. The middle Morice River (from Gosnell Creek to Fenton Creek) contains its highest habitat diversity and has been shown to support a high proportion of the rearing juvenile salmonids (particularly coho) in the area upstream of Smithers. Production is limited, however, by the effects of drying and freezing in off-channel habitats during winter. The purpose of this project was to increase the quality and quantity of overwintering habitat in an off-channel pond complex and to improve access to it.

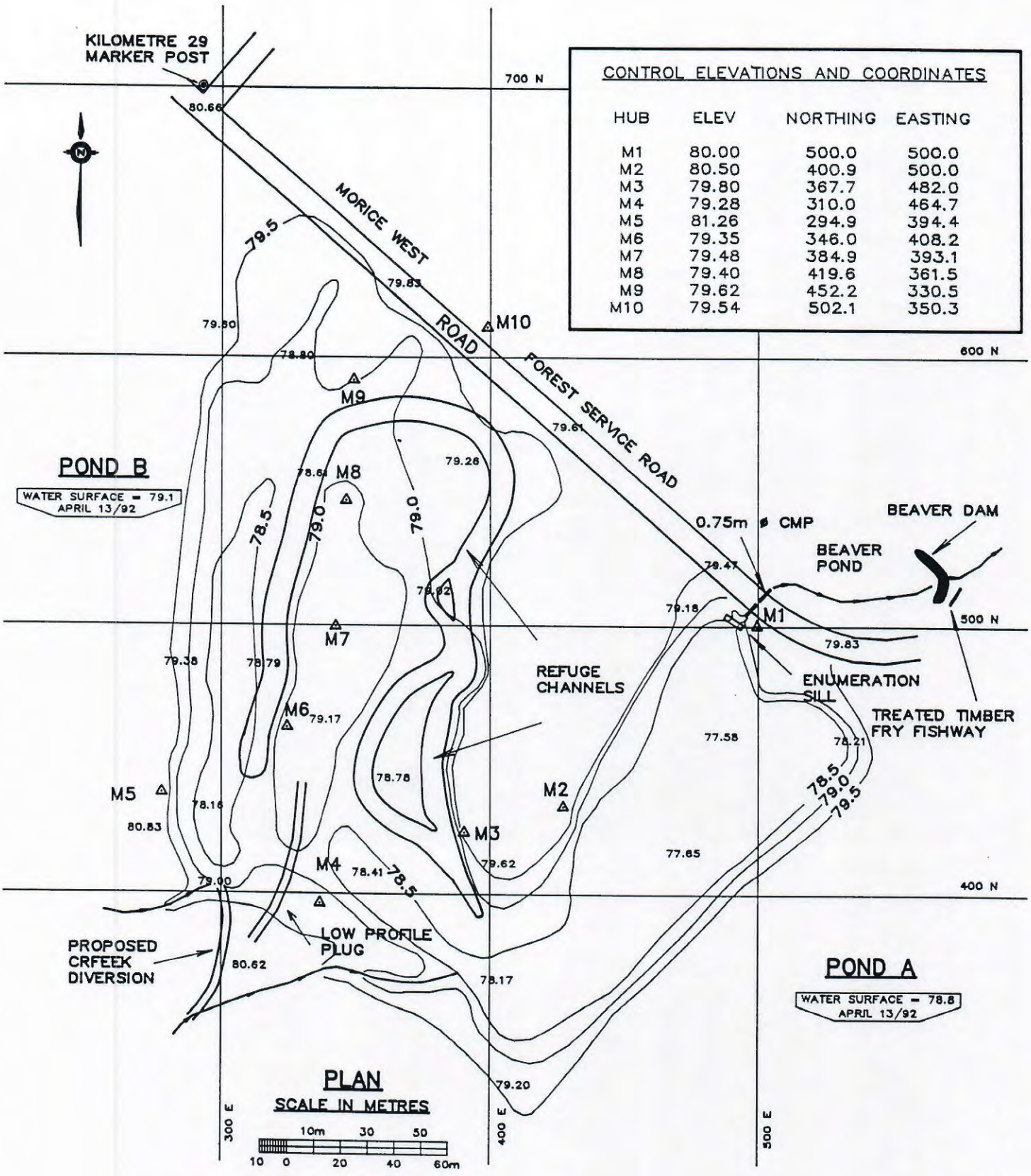
Project Description:

The work included:

a) Excavation of 320 lineal m of channel between two existing ponds to provide cooler water refuge in summer and deeper unfrozen refuge in winter. Spoil material was side cast and leveled adjacent to the channel. Artificial undercut banks were created using backfill over logs placed over notches excavated in channel slope.

b) Installation of a laminated 5 cm x 10 cm treated timber enumeration sill at the outlet of the pond complex to allow for installation of traps for ongoing assessment.

c) Installation of a treated timber fry fishway adjacent to a 0.7 m high beaver dam approximately 100 m below the pond outlet providing upstream migrant fry passage to the pond complex, while having negligible impact on the beaver pond.



CONTROL ELEVATIONS AND COORDINATES

HUB	ELEV	NORTHING	EASTING
M1	80.00	500.0	500.0
M2	80.50	400.9	500.0
M3	79.80	367.7	482.0
M4	79.28	310.0	464.7
M5	81.26	294.9	394.4
M6	79.35	346.0	408.2
M7	79.48	384.9	393.1
M8	79.40	419.6	361.5
M9	79.62	452.2	330.5
M10	79.54	502.1	350.3

ELEVATION IN METRES
M1 = 80.00 METRES ASSUMED ELEVATION

SURVEYED AND PLOTTED BY P.R. COCHRANE APR/92
DRAFTED BY P.R.C. / I.M. MAY/92
REVISED JAN/93 FOR AS BUILT SUMMER/92 INFO

MORICE RIVER
KILOMETRE 29 PONDS
HABITAT IMPROVEMENT PROJECT

Photo 1. Excavating refuge channel within dried pond area.

Photo 2. Excavating refuge channel between two ponds.

Photo 3. Artificial undercut bank (center) made by excavating notch in side slope of channel and covering with logs and then backfilling.

Photo 4. Laminated treated timber enumeration sill at outlet of pond complex. Culvert through road is in center of photo.

Photo 5 (Above)
Treated timber fry fishway prior to backfilling. Beaver pond and dam is just left of excavator bucket.

Photo 6. Inside view of baffle/port detail of fry fishway. Aluminum deflectors are screwed into plywood baffle at port. The port is 3.75 in x 8 in. high.