

3-4195

November 4th, 2005

Fraser Valley Regional District
45950 Cheam Avenue
Chilliwack, BC
V2P 1N6

Attention: Mr. Graham Daneluz, Long Range Planner

**Re: 2005 As-Built Flood Damage Recovery Works, Lagace Creek, Hatzic Valley
Final Report**

We have finalised the above-named report. An electronic copy in PDF format has been placed on our ftp site. Based on our phone conversation of two days ago, there is no need for me to prepare a paper copy of the report.

Please do not hesitate to contact me should you have any questions or concerns regarding this matter.

Yours truly,

northwest hydraulic consultants



Derek Ray P. Geo.
Geomorphologist

cc. Andrew Walter, Scott Resources Services, 31856 Silverdale Avenue, Mission,
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FRASER VALLEY REGIONAL DISTRICT



2005 AS-BUILT FLOOD DAMAGE RECOVERY WORKS LAGACE CREEK, HATZIC VALLEY FINAL REPORT

OCTOBER 2005



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2005 As-BUILT FLOOD DAMAGE RECOVERY WORKS LAGACE CREEK, HATZIC VALLEY FINAL REPORT

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October 2005

nhc 3-4195

EXECUTIVE SUMMARY

The 2005 channel recovery works have returned Lagace Creek to approximately pre-event conditions within the fisheries window and with a minimum of environmental disturbance. The following table summarises the completed works and the volume of sediment that was moved.

Reach	Completed Works	Estimate of Sediment Removed (m ³)	
		Net	Total
Lower R 1	Excavation of sand from bars downstream of Farms Road Bridge	-	6,700
R 1	Excavation of sand from channel	-	13,200
R 2	Excavation of sand and gravel from channel	-	9,600
R 3	Excavation of gravel from lower portion of reach, recontouring bed in upper portion of reach and armouring banks with available large bed material	16,300	28,300
R 4	Limited channel contouring and armouring	0	9,000
R 5	Excavation of gravel and armouring banks with available bed material	13,000	28,000
R 6	Excavation of gravel and armouring banks with available bed material	8,300	15,200

The budget included below summarises the direct construction costs of the works and does not include GST or consulting services. The per-cubic-meter cost of removing this material ranges from \$2.40 to \$9.13, with an average of \$5.22.

Lower Reach 1	\$20,800
Reach 1	\$62,300
Reach 2	\$87,600
Reach 3	\$88,300
Reach 4	\$4,500
Reach 5	\$67,400
Reach 6	\$134,400
Total	\$465,300

We recommend that the installation and ongoing maintenance of sediment traps be considered as part of the long-term sediment management strategy for Lagace Creek.

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1 INTRODUCTION

1.1 BACKGROUND

Lagace Creek is one of several flood-prone creeks that drain into Hatzic Slough immediately east of Mission, BC. Fed by its major tributary, Pattison Creek, this creek system is very active, carrying significant bed material load that deposits in the lower valley bottom, causing avulsion and flooding hazards. Glacial history, historic land-use, settlement, and physical processes in the watershed result in sediment and debris events that are typically associated with high precipitation and runoff. Flood events associated with large rainstorms that occurred in October 2003 and November 2004 resulted in significant damage to the creek channel, caused primarily by a debris flood emanating from Pattison Creek. The damage caused in the creek ranged from infilling of coarse sediment and woody debris, and bank erosion on the upper reaches occupying the Pattison/Lagace Alluvial Fan, to overbank flooding, loss of drainage capacity and channel infilling by finer gravel and sand in the lower reaches occupying the floodplain lands of Hatzic Prairie.

Based on these high-flow events, Northwest Hydraulic Consultants (**nhc**) and Scott Resources Services (SRS) were contracted by the Fraser Valley Regional District (FVRD) to prepare a report quantifying the damage to the channel and to make recommendations for recovery works. This report was submitted by the FVRD to the Provincial Emergency Program (PEP) in support of an application for funding to implement flood damage recovery works.

Construction activities for channel recovery of Lagace Creek began on August 16th, 2005 and were completed on September 12th, 2005. This report provides details of the construction activities and completed works. Appendix A contains the pre- and post-construction cross-section surveys. Appendices B and C of this report contain details of the environmental monitoring and fish salvage operations.

1.2 DOCUMENTATION

The initial flood damage study culminated in the report ***Flood Damage Recovery Plan, Lagace Creek, Hatzic Valley (2005)***, prepared by **nhc** and SRS. This report formed the basis for the application to PEP for funding and provided the focus for preliminary discussions with Fisheries

and Oceans Canada (DFO). Based on this report and through ongoing discussions, the following documents were prepared in support of the FVRD application to complete works during the 2005 instream window:

- ***Lagace Creek – 2005 Proposed Work Plan*** (nhc)
- ***Construction Mitigation Plan*** (SRS)

Additional memos were prepared by **nhc** in response to specific questions or concerns regarding various aspects of the project. These include:

- ***Lagace Creek – 2005 Proposed Work Plan – Additional Information, August 3rd, 2005***
- ***2005 Lagace Creek Channel Excavations – Potential Fish Habitat Compensation, August 10th, 2005***
- ***Lagace Creek Reach 4 – Huxley Property d/s of Lagace/Pattison Confluence, August 23rd, 2005***
- ***Lagace Creek Lower Reach 1 – Additional Sediment Removal, August 25th, 2005***

1.3 WORKS

An ***Authorization For Works Or Undertakings Affecting Fish Habitat*** was issued by DFO permitting works to proceed in Reaches 1, 2, 3, 5, and 6, as outlined in the application, and to be completed by September 15, 2005. For the purposes of the Authorization, the reaches are described as follows:

- Reach 1 – downstream of Dale Road bridge for approximately 750 m
- Reach 2 – upstream of the Dale Road crossing to Schroots' Corner
- Reach 3 – upstream of Farms Road to Seux Road (Farms Reach)
- Reach 4 – upstream of Seux Road to Pattison Confluence
- Reach 5 – Pattison confluence upstream to Sylvester Road (Pattison Creek)
- Reach 6 – upstream of Sylvester Road for approximately 600 m (Pattison Creek)

All works described in the Authorization were completed. In addition, permission was granted to complete limited works in the upstream end of Reach 4, and additional works in Lower Reach 1,

immediately downstream of the lower Farms Road Bridge crossing. Table 1-1 summarises the works completed in each reach and includes an estimate of the volume of sediment removed. A detailed account of the completed works is contained in Sections 1 to 8.

Table 1-1. Summary of completed works by reach.

Reach	Completed Works	Estimate of Sediment Removed (m ³)	
		Net	Total
Lower R 1	Excavation of sand from bars downstream of Farms Road Bridge	-	6,700
R 1	Excavation of sand from channel	-	13,200
R 2	Excavation of sand and gravel from channel	-	9,600
R 3	Excavation of gravel from lower portion of reach, recontouring bed in upper portion of reach and armouring banks with available large bed material	16,300	28,300
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R 6	Excavation of gravel and armouring banks with available bed material	8,300	15,200

The volume of sediment removed from Lagace Creek is estimated through comparison of surveys completed prior to construction and the post-construction surveys, as well as from truck counts as per the daily time sheets. Net sediment removed refers to the volume of material that was removed from the channel. Total sediment removed includes material that was used to fill eroding banks and other low spots, and although is still present within the channel, will not generally be available for sediment transportation.

1.4 PROJECT TEAM

Northwest Hydraulic Consultants (**nhc**) took lead responsibility in coordinating the various contractors and overseeing the construction works. Mr. Bruce Walsh, P.Eng. acted as project manager and Mr. Derek Ray, P.Geo. acted as overall on-site construction supervisor. Mr. Peter Kokoska acted as construction foreman and supervisor for Reaches 5 and 6. Additional construction supervision was performed by various **nhc** personnel as required. Scott Resource Service Inc. provided environmental monitoring and fish salvage services, with Mr. Andrew Walter, R.P.Bio, acting as site supervisor. Mr. Graham Daneluz, Long Range Planner for the FVRD, managed the project on behalf of the District. Table 1-2 provides a summary, by reach, of the contractors that completed works in Lagace Creek.

Table 1-2. Summary of contractors completing works by reach.

Reach	Contractor	Equipment Supplied / Service Provided
Lower Reach 1	Anderson Excavating	Hitachi ZX200LC Excavator
	Davies Sand & Gravel	Hitachi ZX200LC Excavator Sand trucks
	4N Holdings Ltd	Sand truck
Reaches 1&2	Aurum Contracting	Samsung SE 350 Excavator
	Dan Connel Contracting	Hitachi EX 350 Excavator
Reach 3	Anderson Excavating	Hitachi ZX200LC Excavator
	Doug Anderson	CAT 235 Excavator DC6c CAT Bulldozer Dump Truck
	Dick James Trucking	Rock trucks
Reach 4	Neko Bulldozing	Hitachi EX 220 Excavator
Reaches 5&6	Durieu Forest Products	Construction Foreman D3 CAT Bulldozer TD20 Bulldozer P-9 Heavy-Duty Dump Truck
	Brock Enterprises	D8 CAT Bulldozer Hitachi EX400 Excavator Rock Truck
	Neko Bulldozing	Hitachi EX 220 Excavator
	John Kish	Rock Truck
	C&H Forest Products	Volvo A25 6x6 Articulated Rock Truck Volvo 290b Excavator
	4N Holdings Ltd	Rock Truck

1.5 ENVIRONMENTAL ISSUES

The 2005 Recovery Works were completed without significant environmental issues, although minor issues occurred. A large rainstorm on August 29th caused a high-flow event in Pattison and Lagace Creeks that overwhelmed many of the low-flow diversion structures and forced the temporary cessation of works. However, within 24-hours flows returned to normal summer conditions and work resumed. The occurrence of minor oil spills and other minor environmental issues is detailed in the SRS report attached as Appendix B.

2 LOWER REACH 1 – DOWNSTREAM OF LOWER FARMS ROAD BRIDGE

2.1 BACKGROUND

The low-gradient downstream portion of Reach 1 flows through the Hatzic Prairie and is commonly bordered by farm fields or residential housing, with a narrow fringe of riparian vegetation. This portion of the reach is backwatered at higher stages of Hatzic Lake during the spring and early summer. A series of bank-attached sand bars have formed immediately downstream of the lower Farms Road bridge crossing.

Water levels were quite high in Lagace Creek during the planning phase of the recovery works, particularly in the lower reaches that are influenced by high water levels in Hatzic Lake. As a result, the opportunity to remove the large sand bars in lower Reach was not recognized until the water level had dropped significantly in late August. Permission was granted by DFO to remove sediment following the work plan outlined in a memo prepared by **nhc** dated August 25th, 2005. Excavation began on September 7th and was completed on September 13th.

2.2 DESCRIPTION OF THE WORKS

There were a total of four bank-attached sand bars immediately downstream of the lower Farms Road bridge (Figure 1). Three of these bars were excavated during the 2005 recovery works, one on the right bank and two on the left bank. The purpose of the excavation was to increase the sediment-trapping capability of the reach so that accumulated sediments further upstream would not be carried into the most downstream portions of Lagace Creek. Approximately 6,700 m³ of material was removed from a total bar area of approximately 8,600 m². The average depth of excavation was 0.8 m and the maximum depth was up to 2.5 m.

The works consisted of excavating sandy material from the dry bars using an excavator and removing the material by dump truck. The excavation was completed in isolation of the main flow by leaving a berm at the edge of the bar near the waterline and extending the excavation to near the edge of the vegetated portion of the bank. A low berm of local sandy material was placed along the edge of the bar to help prevent water from the channel flowing into the excavation area in the event of a small rise in the creek level.

Water infiltrated the porous sandy substrate to fill the excavation with water but the edge of the bar acted as a berm to prevent the escape of this sediment-laden water into the flowing portion of the channel. In the event of a berm failure and a second berm was created by leaving a setback from the existing edge of bar and continuing the excavation on the inside of the bar edge.

2.3 ACCESS

Access to the sand bars was from the bank via a short ramp. Ramps existed at two locations on the left bank and were reactivated and surfaced with gravel to provide traction for the trucks. The left bank is much lower and a ramp was created by simply piling sand against the bank and adding a surface layer of gravel.

2.4 SPOIL SITES

Sediment was loaded onto trucks and removed from the channel. Approximately 75% of the material was trucked offsite while the remaining material was piled on the adjacent farm fields for use by the landowner. The spoil piles are located a minimum of 30 m from the top of bank.

2.5 DEMOBILIZATION

The surfaces of the access ramps were de-compacted to promote vegetation growth and all disturbed sites were seeded with a mix of grass seeds. No other demobilization measures were required at this site.

2.6 MODIFICATION TO THE PLAN

There were no significant modifications to the work plan.

3 REACH 1 – DOWNSTREAM OF DALE ROAD BRIDGE

3.1 BACKGROUND

Reach 1 downstream of Dale Road Bridge is a low-gradient sand bed channel with a narrow fringe of riparian vegetation. Accumulated sandy sediments have raised the elevation of the bed and reduced the channel drainage capacity. The purpose of the works, which began on September 6th and were completed on September 13th, was to remove sediment to improve drainage and lower the flood profile.

3.2 DESCRIPTION OF THE WORKS

The Reach 1 work site extends for approximately 750 m downstream of the Dale Road bridge (Figure 2). Sediment was removed from the channel using two excavators working in tandem. Two different techniques were used to manage water and sediment during the excavation works: 1) flow diversion from the channel around the work site, and 2) flow diversion within the channel.

The upper 300 m of channel was excavated in isolation of the flow by constructing a temporary dam immediately downstream of the bridge. The dam was constructed using heavy-duty plastic sheeting and bulk bags filled with onsite material. A temporary channel was created to divert flow around the work site and back into the main channel via a marsh area on the west side of the channel. The 300 m length of isolated channel was then excavated to an average depth of 1.5 m and maximum depth of over 2 m below pre-excavation grade.

Downstream of the diversion, extensive sand bars had developed on the inside of the channel bend. The area of isolated sand bar was extended using “Watergate”, a product developed by MegaSecur, which is a lightweight, portable, temporary water diversion structure. The product was installed in the channel at the upstream end of the bar to divert flow to the right side of the channel and create a work area that was isolated from the flow. The total area of excavation from Reach 1 was approximately 5,100 m² with a total excavation volume of approximately 9,600 m³.

3.3 ACCESS

Initial access to the site was via a short farm track on the west side of the channel immediately beside the Dale Road bridge. Excavation of the bypass channel and installation of the temporary dams was completed from this location. Once the diversion structure was in place, and fish salvage was complete, the excavators were able to work directly from the channel. Further access to the channel downstream was via a farm track running along the east bank at the edge of the blueberry fields. Material was removed from the channel at various access points along both banks.

3.4 SPOIL SITES

Excavated sediment was temporarily stored at various locations. Within the diversion section, much of the sediment was placed in piles on the right bank in a low area on the inside of the bend, however there was some sediment that was piled on a low bench below the top of bank. Sediment was also placed on the left bank on top of the existing farm track. At the downstream excavation site, sediment was piled on the left bank on or beside the farm track. It is our understanding that the property owners have agreed to remove the sediment within 3 months of excavation.

3.5 DEMOBILIZATION

At the upper end of the site, demobilization of the diversion channel and structure was required. The lower diversion was removed first followed by a partial removal of the upper diversion structure. With a partial removal of the temporary dam, down cutting around the remaining portion of the dam occurred and the dam was decommissioned completely. Flow into the diversion channel decreased gradually because of upstream storage that was backwatering into the upstream sloughs. The mouth of the diversion channel was blocked off and left over night. Following an inspection by the fish salvage crew, the diversion channel was filled back in from the upstream to downstream direction.

All disturbed areas, including access points and the channel-facing portions of spoil piles were seeded with a mix of grass seeds. Straw or hay was placed in a thin layer over the seeded areas to prevent surface erosion and aid seed germination. Refuse such as plastic sheeting and used bulk bags were removed from the site for disposal.

3.6 MODIFICATION TO THE PLAN

The location of the diversion channel was changed somewhat at the insistence of the property owner. Rather than running parallel to the main channel, the diversion followed the edge of the adjacent hay field, draining into a marsh area and then back to the main channel.

Due to lower than anticipated water levels, the original plan for isolation cells at the downstream end of the site was modified. Rather than creating multiple, small isolation cells using only the Watergate product, the Watergate product was instead used to extend the area of dry sand bar by placing it along the upstream edge of the bar. The remaining edge of bar was used to extend the isolation berm. This method permitted a greater amount of sediment to be removed with less fish salvage effort.

4 REACH 2 – UPSTREAM OF DALE ROAD BRIDGE TO SCHROOTS' CORNER

4.1 BACKGROUND

Reach 2 extends downstream from upper Farms Road Bridge to Dale Road Bridge. From Farms Road Bridge the channel flows almost due west for approximately 300 m and then makes a 90° bend at the Schroots property (Schroots' corner) to flow due south across the Hatzic Prairie for approximately 1800 m to the Dale Road Bridge. The chainage reported in this report refers to distance downstream of Schroots' Corner. The 2005 work sites included almost the entire channel from Schroots' Corner to Dale Road. Several sections of the reach were identified as having high habitat values and were not excavated.

Reach 2 is a generally low-gradient channel with a bed material of medium gravel at the upstream end, grading to fine sand at the downstream end. There is generally a moderately wide fringe of riparian vegetation (5 to 10 m) that extends to more than 50 m in places. Material that was excavated in the past was used to create a pair of levees running parallel to the channel for most of its length. Accumulated sediments have raised the elevation of the bed and reduced the channel drainage capacity. In many places the bed elevation is higher than the surrounding farm fields. In two locations the levees were breached during the 2003 high-flow event. The purpose of the works, which began on August 22nd and were completed on September 13th, was to remove sediment from the channel to improve drainage and lower the flood profile.

4.2 DESCRIPTION OF THE WORKS

Figure 3 summarises the layout of the 2005 works. The upper 300 m of the work site were excavated by diverting the flow within the stream channel to isolate the work area. This was accomplished by taking advantage of existing high bar areas and using the Watergate product to extend the isolated area where possible. A large bar, which formed on the inside of the bend at Schroot's Corner was excavated simply by leaving a berm of material at the bar edge in order to isolate the work site.

A temporary culvert and diversion structure were installed in the channel at approximately 300 m downstream of Schroot's Corner. Flow was diverted into a ditch flowing west across the

adjacent field and into Bouchier Creek, eventually returning to Lagace Creek immediately upstream of the Dale Road bridge. A second temporary dam and pump were installed in the channel at the downstream end of the worksite to prevent sediment-laden water flowing downstream. In addition to the diversion structure in Lagace Creek, some additional works were required to maintain flow through Bouchier Creek. These works included:

- Removal and daily cleaning of several beaver dams
- Excavation of sediment blocking Bouchier Creek as a result of a logging-related landslide in November 2004

The beaver dams were removed by hand while the magnitude of the blockage caused by the landslide required the use of a backhoe. The landslide in question has been documented by the FVRD, which commissioned BGC Engineering Inc. (BGC) to investigate the cause of the slide and document the effects. Bouchier Creek has been blocked to fish passage as a result of the slide. The works completed to restore flow also restored fish access to the upper portions of Bouchier Creek.

Once isolated from the flow, Reach 2 of Lagace Creek was excavated from 300 m downstream of Schroots' Corner to the Dale Road bridge. Excavation extended across the channel from the bottom of banks to an average depth of 0.75 m. Several sections of the channel were left undisturbed to preserve high-value habitat. These sections include:

1. The section from 300 m to 485 m that was identified as good spawning gravel. Rather than full excavation, the bar tops were removed.
2. The island section from 650 m to 760 m. Results of a simple hydraulic model showed that flood profiles were not significantly impacted by the presence of the island because of a slightly steeper channel profile. The island represents valuable habitat and was left undisturbed.
3. The logjam at 1450 m represents the only significant accumulation of woody debris in the reach and was therefore left undisturbed.

The total area of excavation is approximately 12,200 m² over a channel length of approximately 1500 m. The volume of material removed is approximately 13,200 m³ with an average depth of approximately 0.75 m and a maximum depth of 1.5 m.

4.3 ACCESS

Numerous access points were created along the stream channel. The gravel berm at the Schroots property was used as an access corridor along the first 300 m of the channel. Once isolated from the flow and fish salvage was complete, the excavators entered the channel to complete the excavation. Access points to the channel for machine fuelling and maintenance, as well as for the fish salvage crews, were identified at previously established farm roads.

4.4 SPOIL SITES

Excavated sediment has been temporarily stored at various locations along the channel, generally on the outside of the levees. Within the upper 300 m of the reach, material was spoiled on the gravel berm and in the fields alongside the channel. Downstream of the diversion point, the excavated material was placed in piles adjacent to the stream channel. In general the piles were placed on the outside of the berms and spoil sites were chosen to minimise damage to trees. In several cases, material was left directly adjacent to the channel. Our understanding is that the property owners have agreed to remove the sediment within 3 months of excavation, however not all spoil sites are easily accessible to the property owners.

4.5 DEMOBILIZATION

At the upper end of the site, demobilization of the diversion structure was required. The lower diversion was removed first followed by a partial removal of the upper diversion structure. With a partial removal of the temporary dam, down cutting around the remaining portion of the dam occurred and the dam was decommissioned completely. The culvert was removed and the bank rebuilt using material that was stockpiled on site.

All disturbed areas, including access points and the channel-facing portions of spoil piles were seeded with a mix of grass seeds. Straw or hay was placed in a thin layer over the seeded areas to prevent surface erosion and aid seed germination. Refuse such as plastic sheeting and used bulk bags were removed from the site for disposal.

4.6 MODIFICATION TO THE PLAN

There were no significant modifications to the plan. The main exception is that the number of spoil piles was greater than anticipated and some of the spoil piles were left closer to the channel than was anticipated.

5 REACH 3 – UPSTREAM OF FARMS ROAD BRIDGE TO SEUX ROAD BRIDGE

5.1 BACKGROUND

Reach 3 extends downstream from Seux Road bridge to lower Farms Road Bridge, passing through the Anderson property. The lower portion of the reach has traditionally been a site of gravel extraction for flood-control purposes. The total length of reach is approximately 850 m. The 2005 works are divided between the upper portion of the reach, which was primarily re-contoured, and the lower portion of the reach, which was primarily excavated as a sediment trap.

The gradient in Reach 3 is much higher than in downstream reaches and as a result the sediment sizes that are deposited here are much coarser, being composed of medium to coarse gravels. There is also a significant portion of the material composed of sand. Accumulated sediments in the upper portion of the reach had formed into mid-channel bars, creating a convex-up cross section that was causing ongoing bank erosion. The problem was also evident in the lower portion of the reach but the greater channel width reduces the stream power and bank erosion is less evident. The works, which began on August 16th, with creation of access and removal of woody debris on the bar tops, were designed to re-contour the channel and provide increased storage capacity in the channel to minimise impacts to lower reaches. Works were completed on September 13th.

5.2 DESCRIPTION OF THE WORKS

Figure 4 summarises the 2005 recovery works. Water and sediment were managed in this reach using temporary in-channel diversions. In the lower portion of the reach a low-flow channel was excavated along the edge of the right (north) bank. Upstream of the main trap site, flow was diverted to the north side of the channel with minimal excavation using the existing gravel bars. Following flow diversion, the channel was excavated and re-contoured in isolation of the main flow.

Accumulated sediment was excavated from the downstream portion of the reach by digging to the maximum depth allowed by the presence of a peat layer. Typical excavation depth

exceeded 2 m. A low gravel berm was left around the outside of the excavation area to isolate sediment-laden seepage flow from the main channel. A trash pump was initially used to pump water from the channel and into a nearby ditch. As the excavation face proceeded upstream away from the isolation berm the trash pump was no longer required.

In the upstream portion of the reach the balance of excavation required much less sediment removal as excess material was placed against the eroding right bank. At the upstream end of the reach, there was insufficient sediment in the adjacent bar to fill the eroding bank and material was trucked to the site from Reach 5. A low bench was left along the bank and material was placed against the bank to protect the existing mature trees.

Approximately 16,300 m³ of material was removed from the channel, while the net amount of material moved within the channel is approximately 28,300 m³. The total area of excavation and channel contouring is approximately 16,600 m², with an average depth of excavation of 1.7 m and a maximum depth of 2 m.

5.3 ACCESS

Access to the site was from the Anderson works yard via a temporary bridge into the channel. A previously existing access point on the right side of the channel at the Seux Road bridge was used to deliver gravel and coarse boulders to the left bank fill site.

5.4 SPOIL SITES

Excess material was loaded on to dump trucks and removed from the channel and stored in a stockpile in the Anderson works yard on the right bank of the channel. Where required, material from the channel was used to repair eroding banks.

5.5 DEMOBILIZATION

The requirements for demobilisation were minor. Upon completion of the works, the temporary bridge was removed and the material supporting the bridge was removed.

5.6 MODIFICATION TO THE PLAN

Over the course of the past several years a vegetated gravel bar had formed on the left side of the channel immediately upstream of the Farms Road bridge. The bar was causing high flows

to be diverted to the right bank, resulting in bank erosion and a potential threat the bridge. A memo was prepared on behalf of the FVRD and permission was granted by DFO to remove the bar. The area of the bar and vegetation type was recorded and summarised in the SRS Post Construction report included in Appendix B.

The fill added to the left bank at the upper end of the site was not included in the original plan as preliminary estimates were that sufficient material existed within the channel. The material that was brought in was excavated from Reach 5 and so was coarser than existed in the adjacent bar and will be more resistant to erosion.

6 REACH 4 – UPSTREAM OF SEUX ROAD TO PATTISON CREEK CONFLUENCE

6.1 BACKGROUND

Reach 4 extends downstream from the Pattison/Lagace confluence to Seux Road bridge. Significant accumulations of sediment and organic debris are causing bank erosion and channel instability along the majority of the reach. Due to high fish usage of the reach, the proposed works were not included in the 2005 Fisheries Authorisation. The proposed works included removal of the gravel accumulation on the raised bars and protection of eroding banks using material sorted from the bar.

Works in Reach 5, including temporary diversion of the low-flow channel, created a situation where access to the upper portion of Reach 4 could be gained by along dry bars, and works would require only minor fish salvage requirements. Permission was granted by DFO to complete works in the upper 200 m of the reach, corresponding to property owned by the Huxley property. Works were completed in conjunction with those in Reach 5 and took place between late August and early September.

6.2 DESCRIPTION OF THE WORKS

Figure 5 summarises the 2005 works. The left bank in upper Reach 4 has eroded significantly over the last several years. Channel width is up to 50 m at this site compared to 25 to 30 m elsewhere in the reach. The works consisted of scalping the mid-channel bar and pushing the excess material into the left bank, re-creating a 170 m long curving bank. There was an insufficient volume of material in the adjacent bar to adequately fill the bank so extra material was brought in by truck from Reach 5. The banks were extended laterally by up to 17 m, which includes a 10 m bench and a 7 m slope. The toe of the slope was armoured using large boulders from Reach 6. The net volume of material removed was zero, however a total of 9,000 m³ of material was moved within the reach to reform the eroded bank. The maximum depth of excavation on the mid-channel bar was approximately 1 m.

6.3 ACCESS

Access to the site was from the downstream end of Reach 5. No additional stream crossings were necessary.

7 REACH 5 – PATTISON CREEK CONFLUENCE UPSTREAM TO SYLVESTER ROAD BRIDGE

7.1 BACKGROUND

Reach 5 (Pattison Creek) extends upstream from the Pattison/Lagace confluence to the Sylvester Road bridge. Significant accumulations of sediment and organic debris are causing bank erosion and channel instability along the majority of the reach. Most of the damage occurred during the 2003 and 2004 high flow events but ongoing channel processes are exacerbating the problem.

The purpose of the works were threefold:

1. Remove excess sediment deposited during recent high-flow events and re-contour the channel
2. Repair damage to banks
3. Protect banks in key locations against future erosion

Works commenced on August 17th and were completed on September 13th.

7.2 DESCRIPTION OF THE WORKS

The bed material in Reach 5 is of a much larger calibre than in downstream reaches, and the stream gradient is higher. As a result the construction methods and machinery used to complete the works were different than for downstream reaches. In general the machinery used, including excavators and bulldozers was much larger and the trucks used to haul the excavated material had reinforced boxes.

Figure 6 shows the extent of the completed works, including a comparison of pre- and post-construction surveyed cross sections. A total of 380 m length of the channel was excavated and re-contoured in addition to approximately 350 m of bank that was contoured and armoured. The net volume of material removed from the reach was 13,000 m³ with a total of 28,000 m³ removed from active transport. The area of excavation is 12,000 m² with an average excavation of approximately 2 m and maximum depth of cut of 2.4 m.

The construction method consisted of preparing the site using a large bulldozer. The bulldozer was used for general channel contouring, including pushing sediment from the bar tops into the banks and preparing the exposed bed surface to allow access for the rock trucks. Preparing the bed surface also improved the working conditions for the excavators. Excavators were used for sediment removal, general bed lowering, and placement of rock protection.

Once the site was prepared, excavators worked upstream from the bottom of the site to remove sediment to the required grade. An access road along the left bank was used by the trucks to remove the sediment and to deliver coarse rock from Reach 6. Following excavation, coarse rock was placed in the toe of the banks along selected sections of the reach.

7.3 ACCESS

Access to the site was via an existing access road off of Sylvester Road at the left bank (south) corner of the channel. A temporary ramp was created using onsite material to allow access for wheeled vehicles.

7.4 SPOIL SITES

Excess material excavated from the channel that was not used to fill adjacent banks was loaded onto trucks and removed from the site. Some of the material was trucked downstream to fill the eroded banks in the upper portion of Reach 3 and the upper portion of Reach 4 (discussed above). The remainder of the material was stockpiled offsite.

7.5 DEMOBILIZATION

The requirements for demobilisation were minor. Upon completion of the works, the temporary ramp was removed and the bank contoured. A log and large boulders were placed across the access road to prevent unauthorised access to the channel and the surface of the access road was seeded.

7.6 MODIFICATION TO THE PLAN

There were no significant modifications to the plan.

8 REACH 6 – PATTISON CREEK UPSTREAM OF SYLVESTER ROAD BRIDGE

8.1 BACKGROUND

Reach 6 (Pattison Creek) extends upstream from the Sylvester Road bridge. Works commenced on August 17th and were completed on September 13th. Riprap was applied to the banks for approximately 150 m as part of a previous project to replace the Sylvester Road bridge. Works in 2005 were completed in approximately 500 m of channel extending upstream from the end of the riprap section. There was a significant accumulation of sediment and organic debris in this reach as a result of the 2003 and 2004 high-flow events. The height of bars and sediment wedges in places approached the tops of banks and represented a significant avulsion hazard as well as having the potential for downstream transport.

As in Reach 5, the purpose of the works were threefold:

1. Remove excess sediment deposited during recent high-flow events and re-contour the channel
2. Repair damage to banks
3. Protect banks in key locations against future erosion

8.2 DESCRIPTION OF THE WORKS

Figure 7 shows the extent of the completed works, including a comparison of pre- and post-construction surveyed cross sections. A total channel length of 500 m was excavated and re-contoured in addition to approximately 350 m of bank that was contoured and armoured.

The types of machinery and methods of construction were very similar to those used in Reach 5. A large bulldozer was used for general contouring and site preparation. Material was removed using an excavator and loaded onto heavy-duty trucks for offsite disposal. A small bulldozer was used on the stockpile to push material over the edge of the pile and maintain an access road. Large boulders that were sorted from the bed material were used as armour. The completed works consisted of re-contoured banks, excavation of sediment, and armouring of the banks in key locations.

Water and sediment were managed by diverting the low-flows within the channel. A series of check dams were used to slow water flow and allow sediment to settle. Surface-water seeping

into the excavation area was collected in a series of small ditches and diverted to a sump and pumped onto the adjacent fan.

A total of 15,200 m³ of material was removed from active transport with a net volume of 8,300 m³ of material removed from the reach. The area of excavation is 12,900 m² with an average depth of excavation of approximately 1.1 m and a maximum cut of up to 2.7 m.

8.3 ACCESS

A pre-existing access right-of-way runs parallel to the channel on the left (south) bank behind the riprap berm, from Sylvester Road to the upstream end of the riprap. Access to the site was created by clearing immature alder from the right-of-way and building a tote road. A temporary ramp, constructed at the upstream end of the tote road and composed of local bed material, was constructed to allow machine access into the channel. A culvert was installed under the ramp to allow passage of the low-flow channel. Machinery moved up and down the channel on top of the existing bed material. A second access point was created by re-activating an old logging road leading from a borrow pit and running parallel to the right (north) bank. The sole purpose of the second access point was to deposit excavated sediment in the borrow pit.

8.4 SPOIL SITES

A significant amount of large boulder material was sorted from the bars in Reach 6 and used to armour the adjacent and downstream banks. The excess material was trucked off-site to one of two stockpiles. The first stockpile is located in a flat area to the south of the channel on private land, accessed via the tote road. Care was taken to ensure that the stockpile did not infringe into the 30 m riparian zone. The second stockpile is located in a borrow pit to the north of the channel, accessed via a re-activated logging road.

8.5 DEMOBILIZATION

Tote roads and bank access points were de-compacted and seeded. The bank opposite the upstream access ramp was re-contoured and the downstream access ramp and culvert were removed and the bank armoured with angular riprap.

8.6 MODIFICATION TO THE PLAN

There were no significant modifications to the plan.

9 POST-CONSTRUCTION FOLLOW-UP

A post-construction visit of Lagace Creek was conducted on October 11th, 2005 for the purposes of inspecting the work sites and evaluating the initial response of the channel to the two fall rainstorms that occurred since mid-September. The channel works were in general stable and functioning as expected. The following observations were made:

- Lower Reach 1 – transport of bed material is filling the depressions caused by the bar excavation
- Reach 1 and 2 – the bed immediately upstream of Dale Road bridge has downcut significantly since September 13th. Prior to the 2005 works, the bed elevation was approximately 0.4 m higher directly adjacent to Bouchier Slough. This resulted in poor drainage from the slough. Excavation of sediment downstream of the bridge is causing downcutting.
- Upper Reach 2 – chum salmon were observed to be spawning in large numbers in the excavated portions of the channel downstream of Schroots' Corner.
- Reach 4 – a significant amount of sand appears to have been transported into Reach 4. This is likely a short-term response to the relatively large area of de-armoured channel resulting from works upstream.
- Reaches 5 and 6 – the channel is slightly incised into the graded surface of the bed. This incision is a short-term response to the temporary imbalance in sediment supply caused by the recovery works and is not expected to continue.

10 CONCLUSIONS AND RECOMMENDATIONS

The 2005 Lagace Creek Channel Recovery works were successfully completed within the approved fisheries window. There were no significant adverse environmental impacts resulting from the project. Minor environmental impacts include small oil spills, riparian impacts and temporal disturbance in the channel associated with the construction. These environmental impacts are detailed in the accompanying SRS Post-Construction Report.

Approximately 100,000 m³ of material was moved during the course of this project, corresponding roughly to the volume of material that was introduced to the channel during the October 2003 and November 2004 debris flood events. This material was either removed completely from the channel or used to re-construct eroded banks, effectively removing it from active portion of the channel. Although this number represents a volume that is two orders of magnitude higher than the estimated annual sediment transport of Lagace Creek, the channel has in effect been returned to the condition that it would have been in prior to the high-flow events of 2003 and 2004. Table 10-1 summarises the excavation depth and volume removed by reach.

Table 10-1. Summary of excavation by reach.

Reach	Area of Excavation (m ²)	Depth of Excavation (m)		Estimate of Sediment Removed (m ³)	
		Average	Maximum	Net	Total
Lower R 1	8,600	0.8	2.5	-	6,700
R 1	5,100	1.5	2.0	-	9,600
R 2	12,235	0.75	1.5	-	13,200
R 3	16,600	1.7	2.0	16,300	28,300
R 4	7,000	-	1.0	0	9,000
R 5	12,000	2.0	2.4	13,000	28,000
R 6	12,900	1.1	2.7	8,300	15,200

10.1 BUDGET

The following budget represents the approximate construction costs by reach. The figures do not include consulting fees or GST. The cost per cubic meter of material ranges from \$2.40 to \$9.13, with an average of \$5.22.

Table 10-2. Summary of construction costs by reach.

Lower Reach 1	\$20,800
Reach 1	\$62,300
Reach 2	\$87,600
Reach 3	\$88,300
Reach 4	\$4,500
Reach 5	\$67,400
Reach 6	\$134,400
Total	\$465,300

10.2 MITIGATION AND COMPENSATION

Riparian and instream disturbance has been quantified by SRS and included in their Post-Construction Report, which is attached as an appendix. Mitigation efforts during construction included fish salvage, onsite sediment and water management, and planting and seeding of disturbed areas. The SRS report includes a summary of additional planting that will be required to complete the recover of disturbed areas.

An agreement has been made by DFO and FVRD to complete compensation works during the 2006 instream fisheries window. The specific nature and extent of the compensation works will be determined during discussions between these agencies in the coming months. Many opportunities exist to improve the habitat values of Lagace Creek and its tributaries. In particular, large woody debris (LWD) placements would have a beneficial impact in providing instream structure, overhead cover and scoured resting pools. LWD structures could be installed within selected portions of Lagace Creek or its tributaries.

10.3 RECOMMENDATIONS

Numerous techniques were employed to manage the flow of water in order to remove sediment in isolation of flow. While the overall project was successful, several issues arose that should be noted in the event that the district proceeds with similar works in future.

The WaterGate product used to isolate the excavation areas in Reach 1 cannot maintain a stable diversion for long periods of time in soft substrate such as sand. Small leaks in the system caused slow undermining and eventual failure of the structure. The product was used at two separate sites within Reach 1 and both times the diversion failed. The timing of failure was roughly coincident with the end of excavation and eventual flooding of excavated area was part of the plan but nonetheless the product was unsuccessful at controlling the flows for any great length of time. We recommend that an alternative flow diversion method be investigated.

The flow diversion downstream of Dale Road bridge caused a temporary drop in flow downstream and a steady rise in the water level upstream. In future we recommend that a full diversion channel be installed rather than diverting flow into the wetland.

The diversion channel in Reach 2 caused temporary flooding of land along the west side of the valley adjacent to Bouchier Creek. In general this flooding was caused by active beaver dams and beaver-blocked culverts. Daily removal of the beaver dams was required, however many of the culverts that caused additional flooding were not visibly clogged as beavers had built dams within the structure. The volume of water that was diverted into Bouchier Creek did not likely exceed winter flows. Therefore there is an evident drainage problem that also results in potential fish passage issues. We recommend that landowners be encouraged to replace culverts with open bottom bridges or box culverts.

The 2005 channel recovery works have returned Lagace Creek to approximately pre-event conditions. The ongoing processes of sediment transport and periodic debris floods will continue to adversely impact the stability and flow-carrying capacity of the channel. These effects will likely culminate in increased bank erosion and deposition in Reaches 3, 4, 5 and 6, and increased overbank flooding and poor drainage in Reaches 1 and 2. Ongoing maintenance

of the channel, in the form of regularly maintained sediment traps, would have the following benefits:

- Help to maintain the channel in its present condition
- Reduce or eliminate the need for periodic large-scale excavation, reducing both costs and environmental impacts
- Simplify the administrative effort
- Permit cost-recovery measures to be implemented

Periodic large-scale events such as that which occurred in October 2003 appear to re-occur on a decade time scale. Sediment traps will not have the capacity required to adequately trap the volume of material that has historically been contributed to the channel during these events. However, the impacts to the channel will be reduced if the overall channel condition is maintained through regular sediment withdrawals. We recommend that sediment traps be investigated as a channel maintenance option.

FIGURES



Figure 1. Location of excavated bars in Lower Reach 1.



Figure 2. Summary of 2005 works completed in Reach 1.

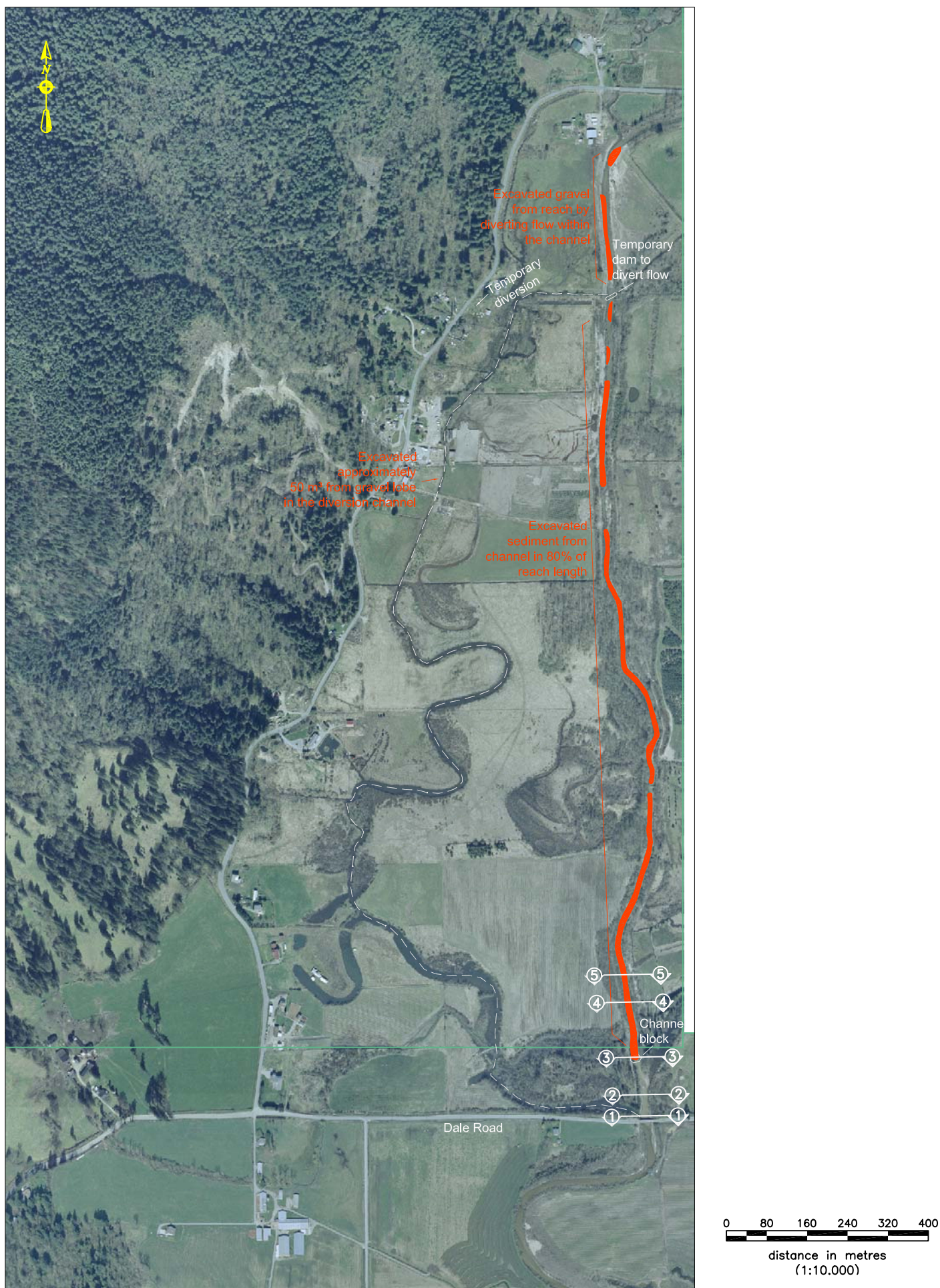


Figure 3. Summary of 2005 works completed in Reach 2.

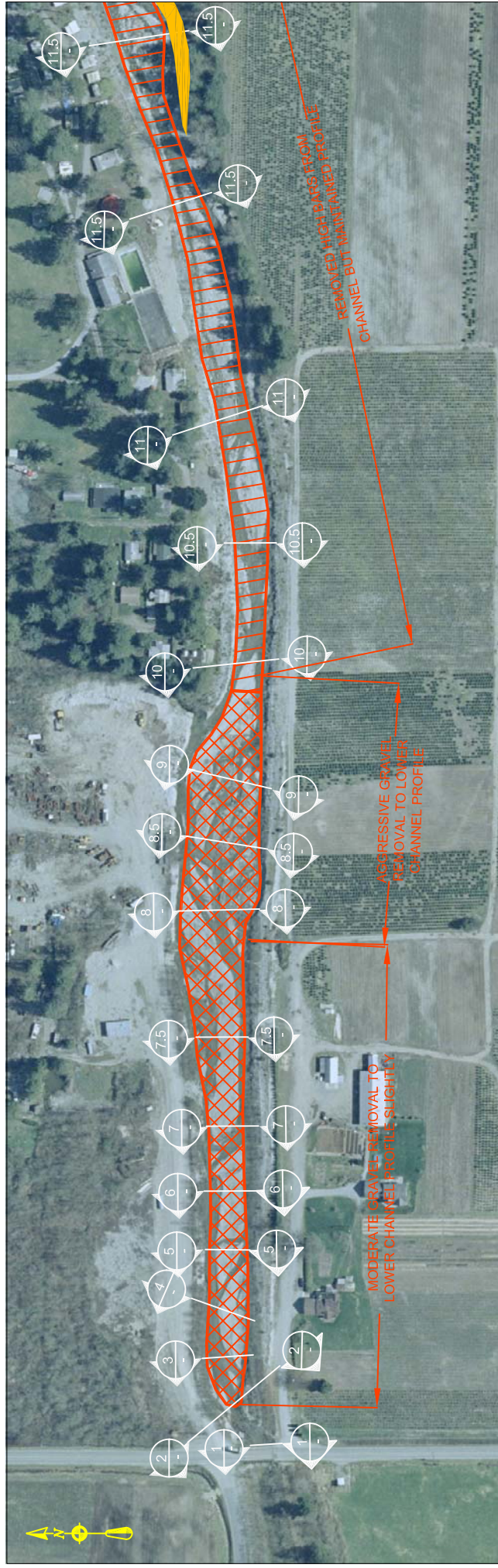
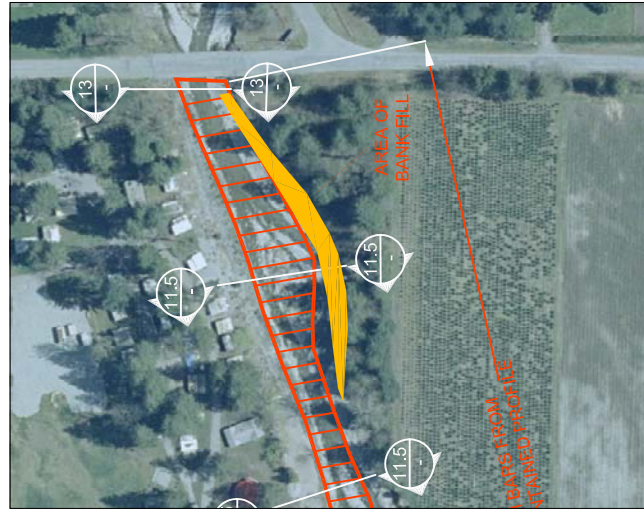
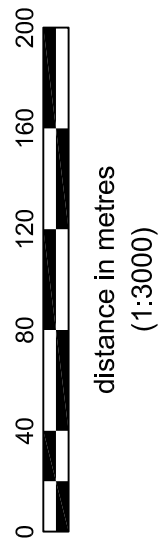
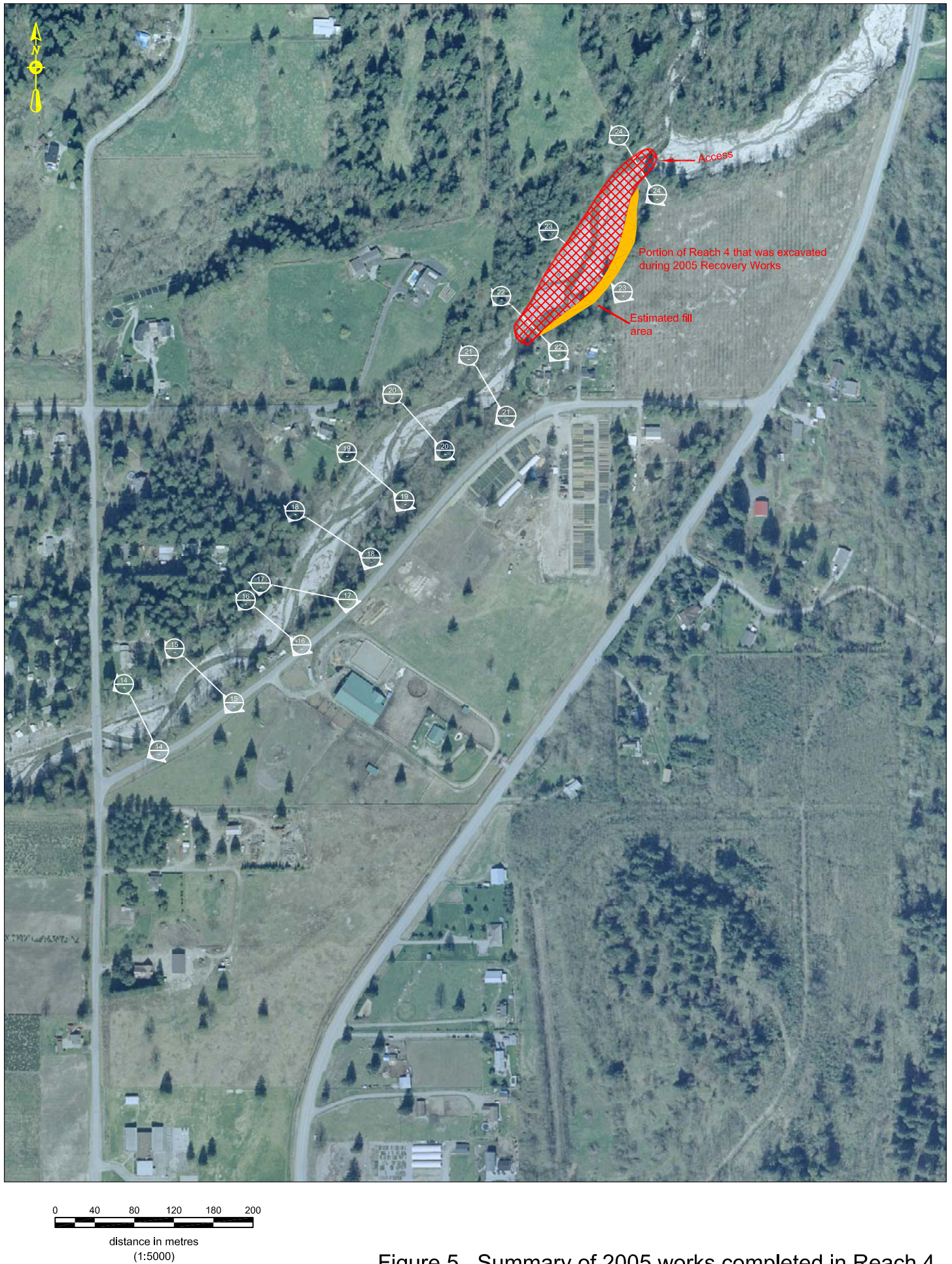


Figure 4. Summary of 2005 works completed in Reach 3.



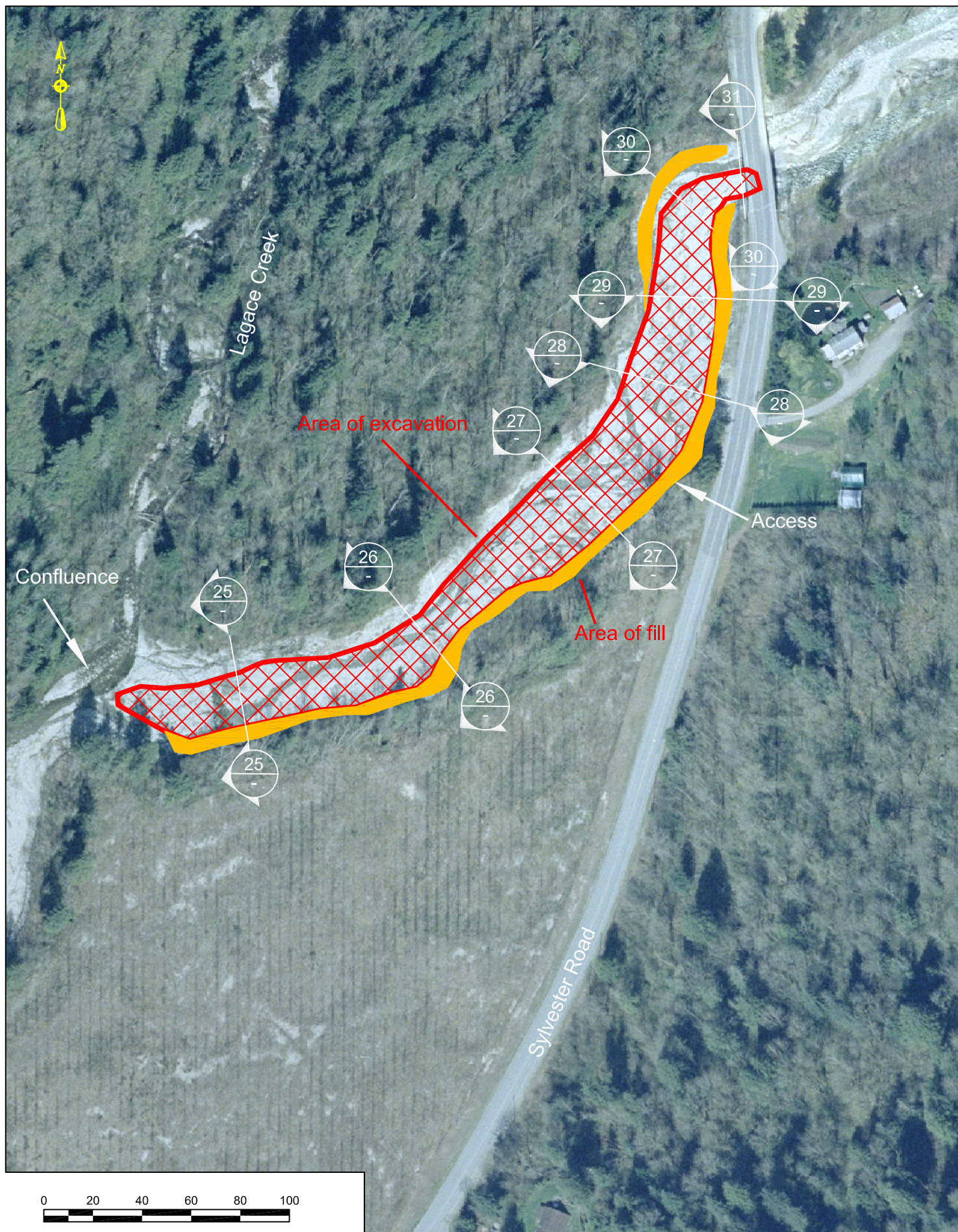


Figure 6. Summary of 2005 works completed in Reach 5.

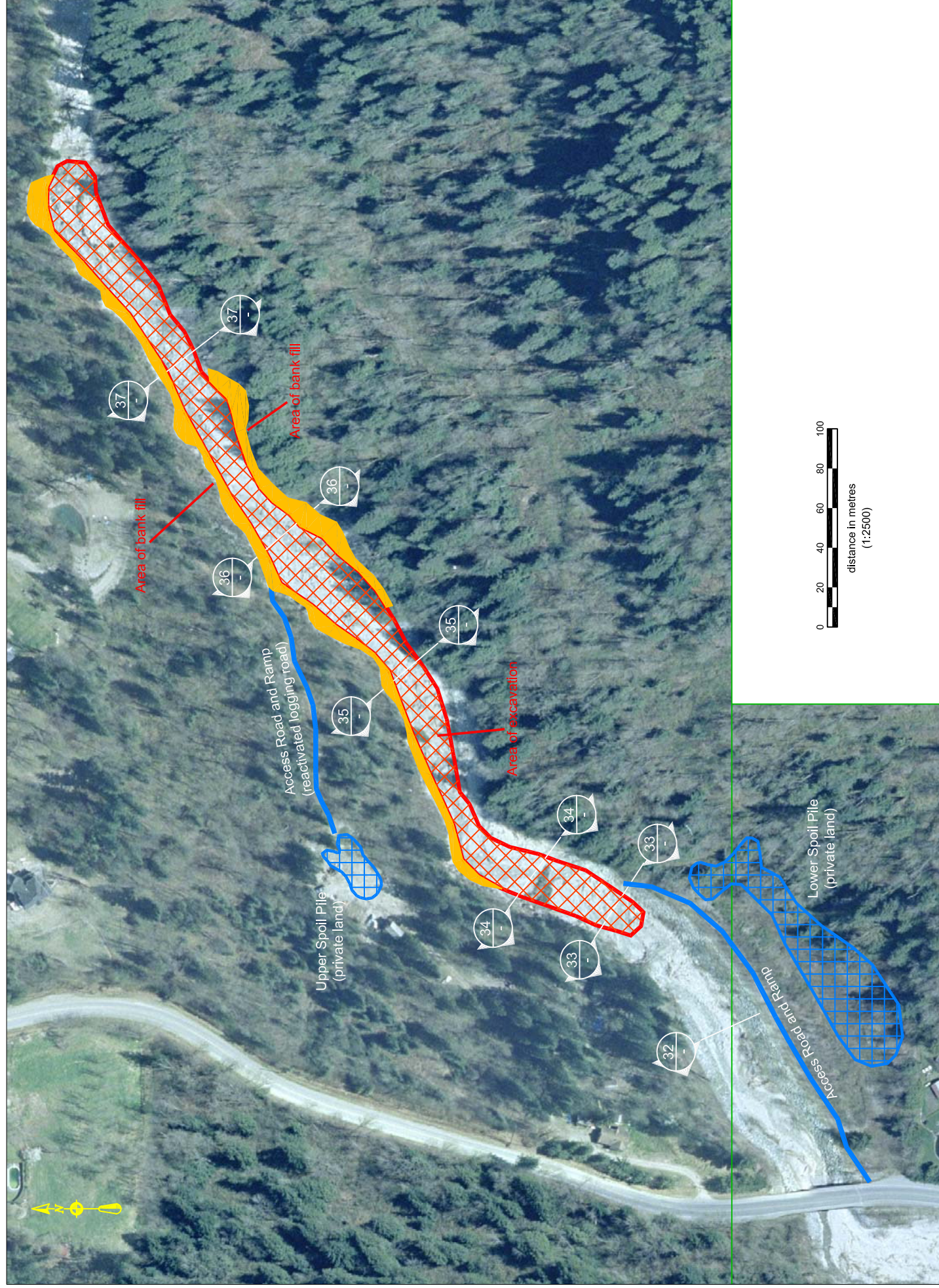
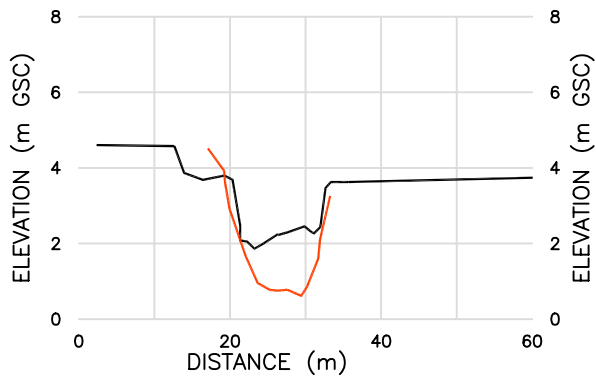
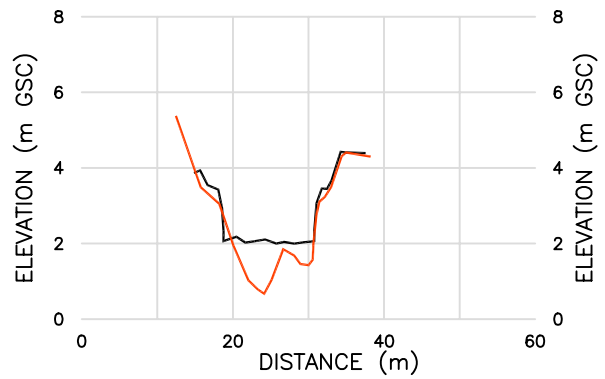


Figure 7. Summary of 2005 works completed at Reach 6.

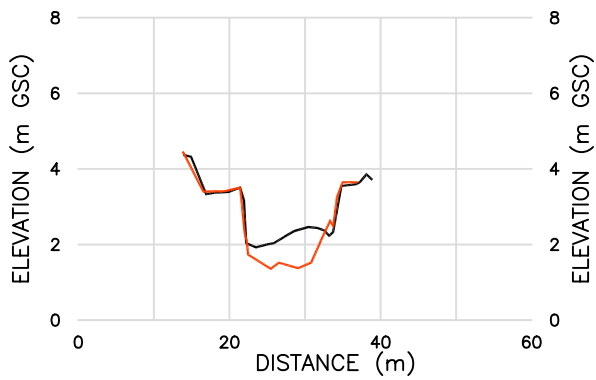
APPENDIX A
CHANNEL CROSS SECTION SURVEYS



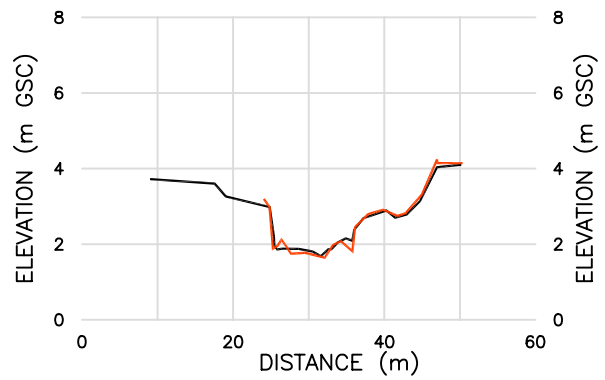
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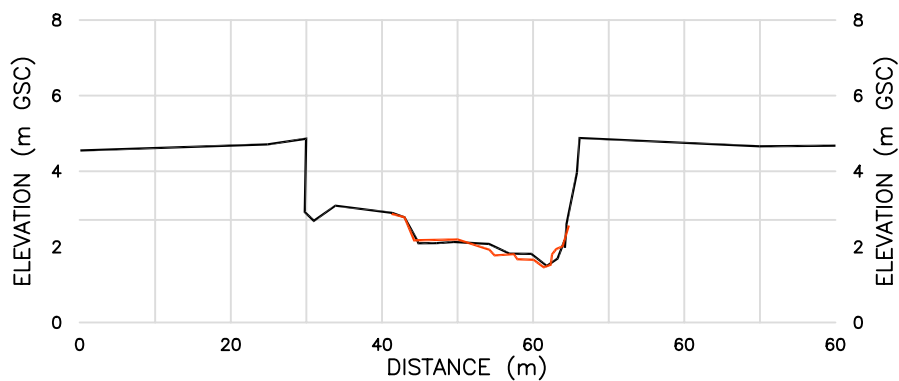
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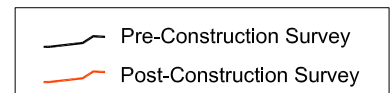
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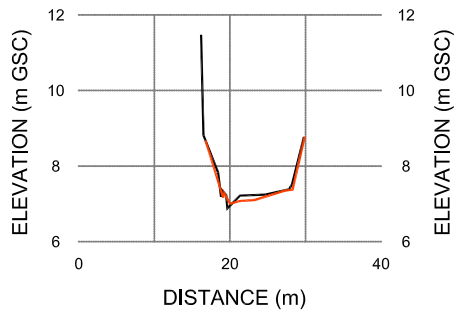


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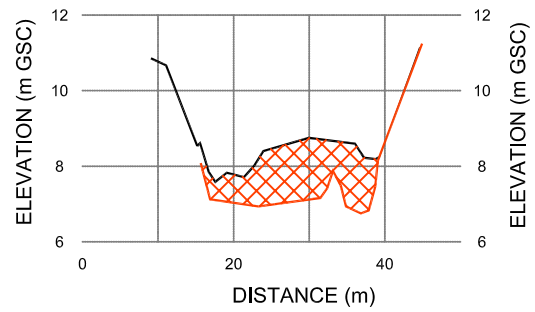


Note: Cross sections 1 and 2 are downstream of the excavation site. Lowering of the bed shown on these sections is from downcutting.

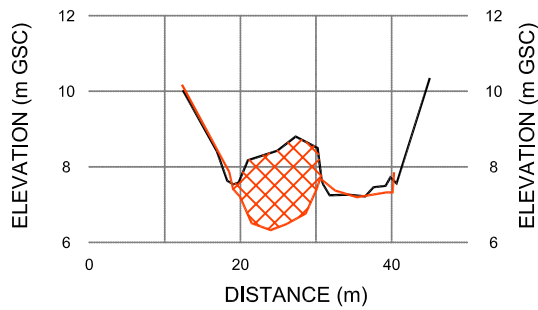
Reach 2



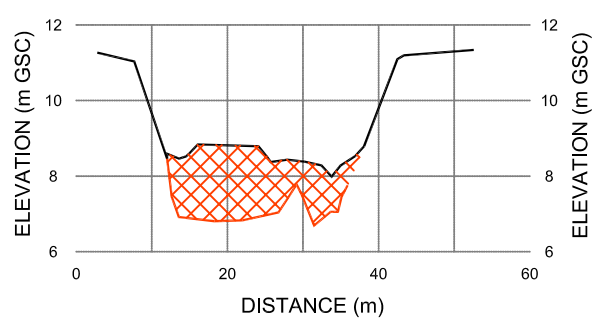
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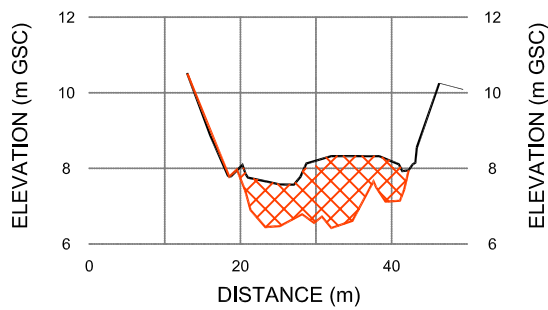
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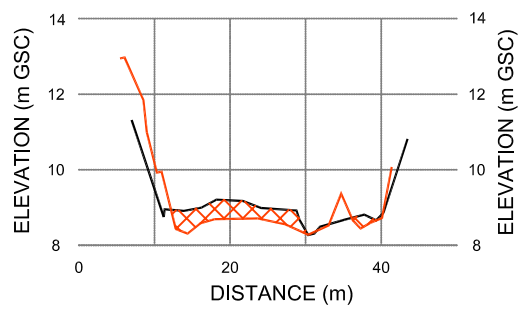
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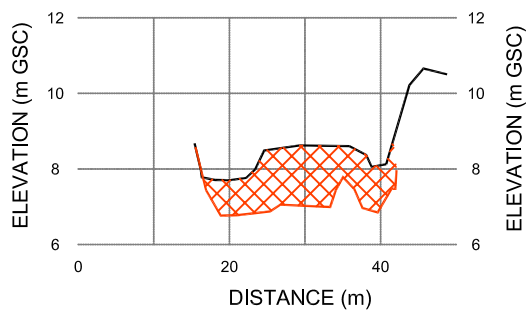
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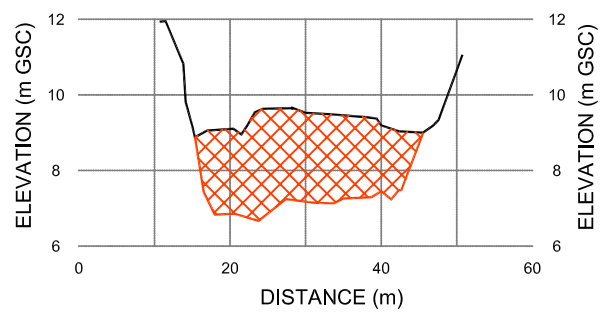
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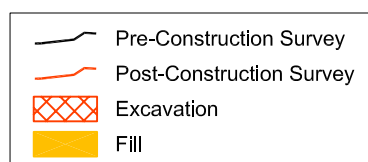
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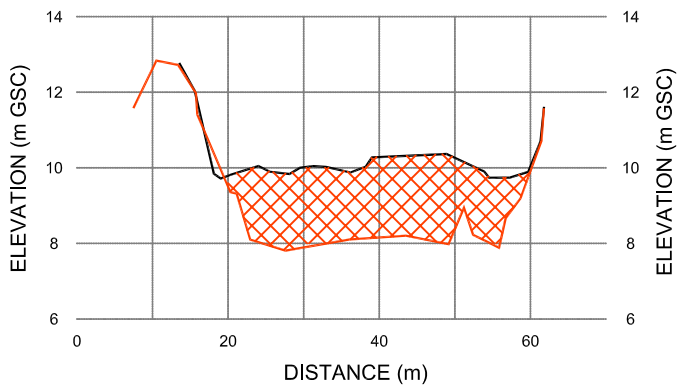
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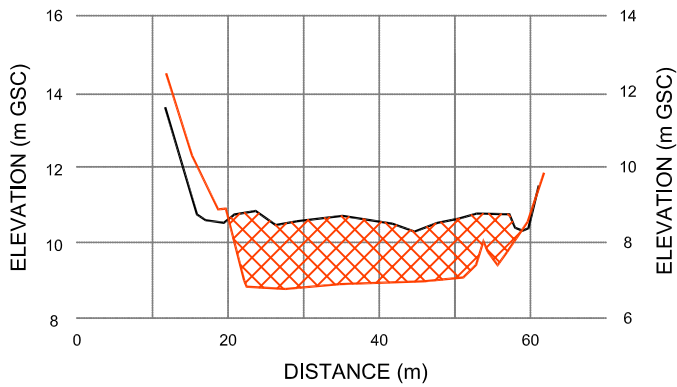
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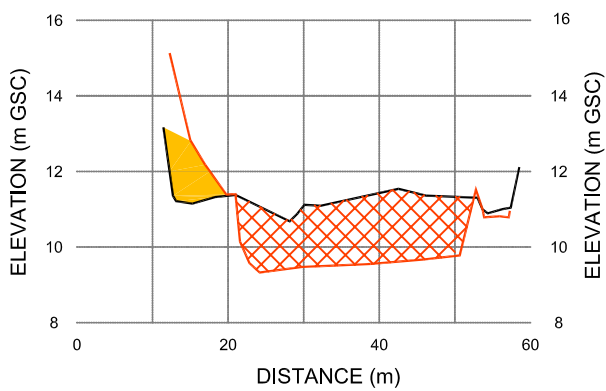
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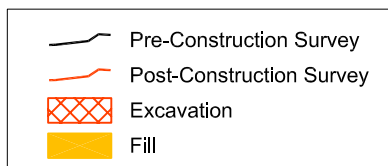
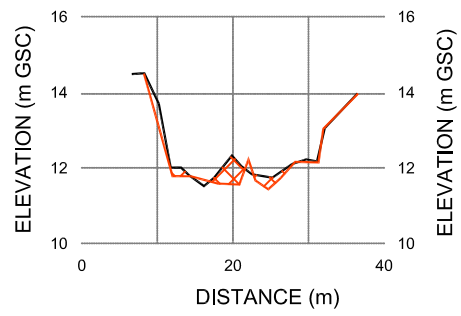


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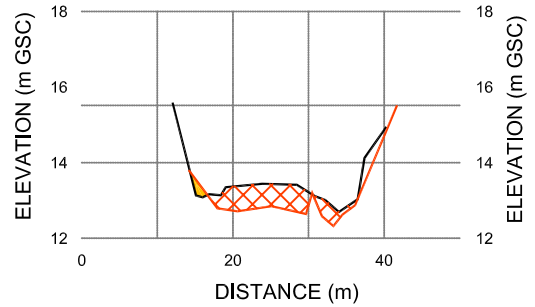


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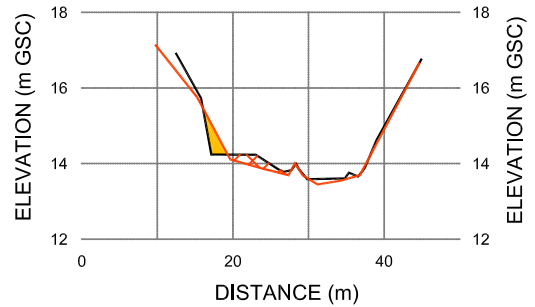
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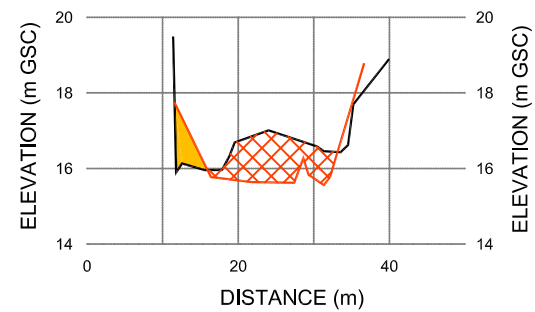
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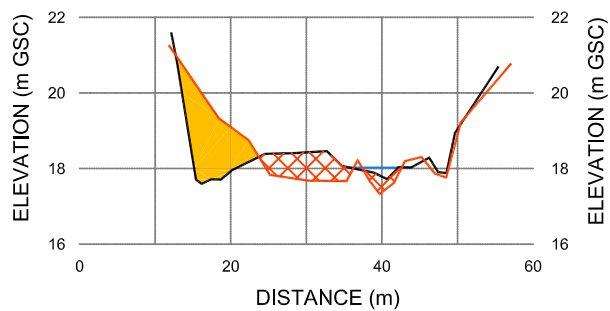
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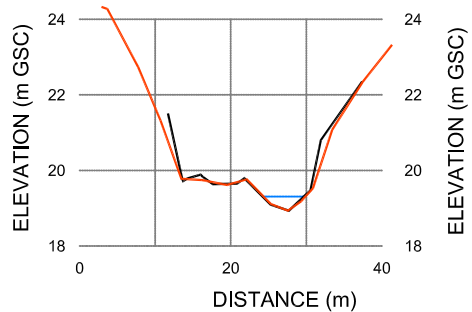
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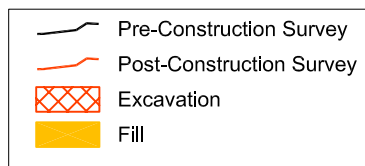


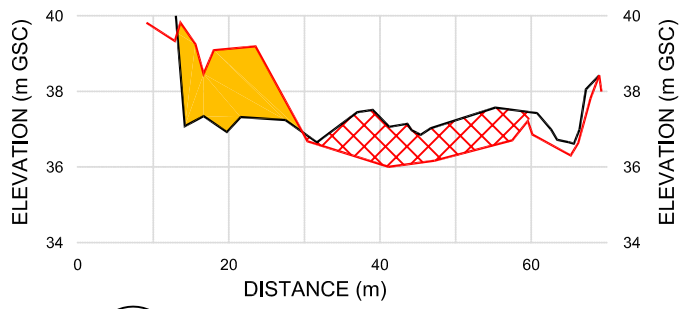
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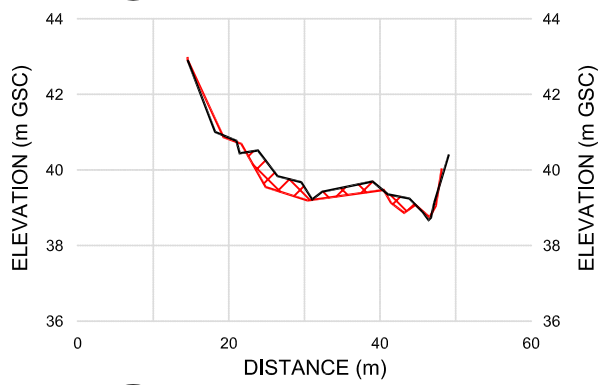
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Reach 3



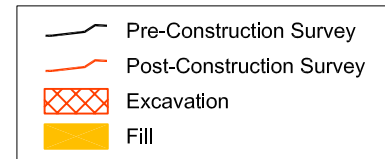


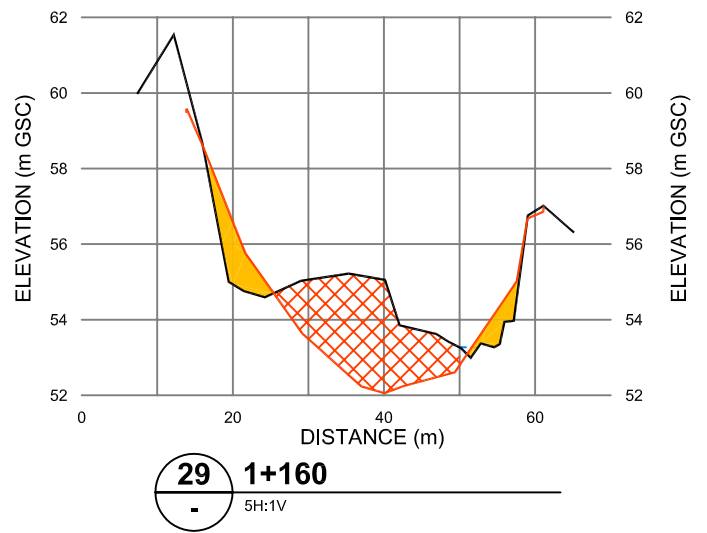
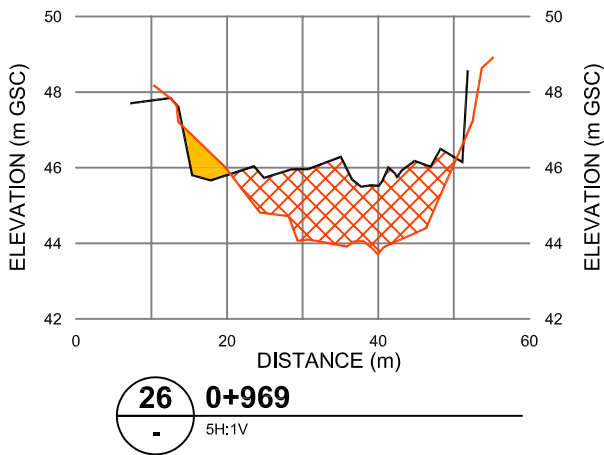
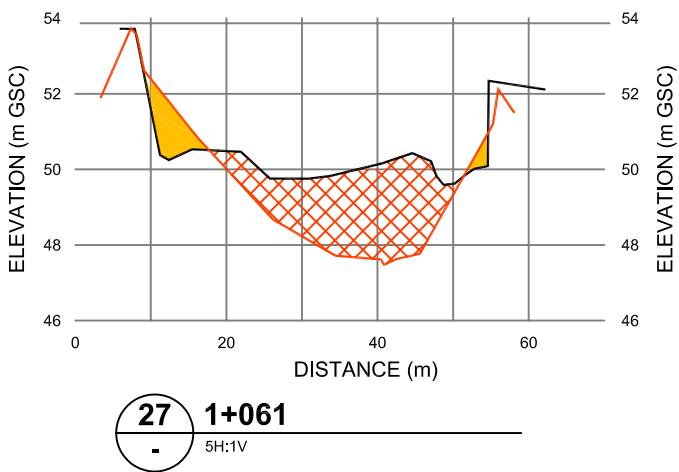
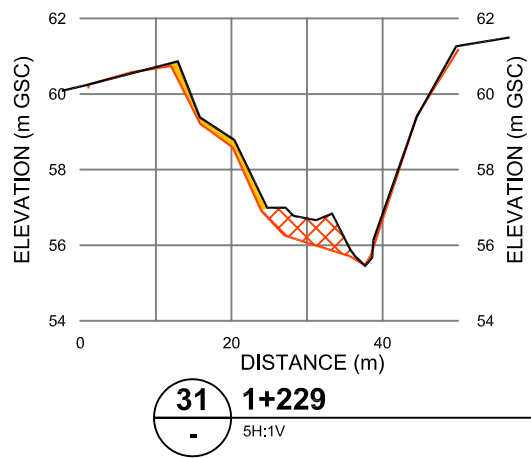
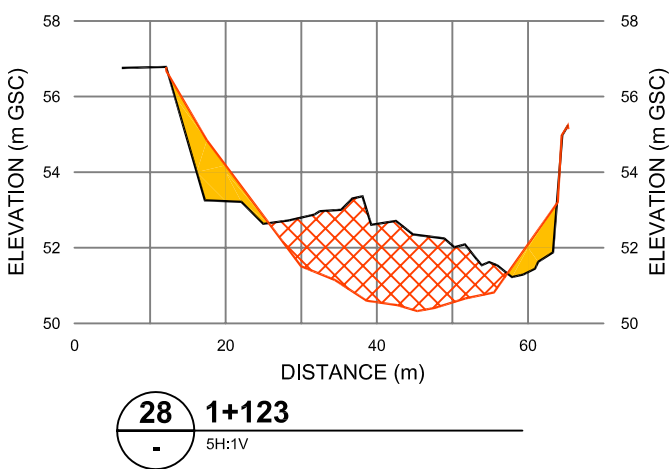
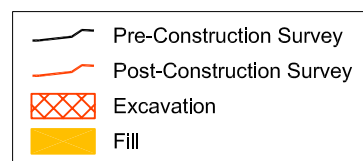
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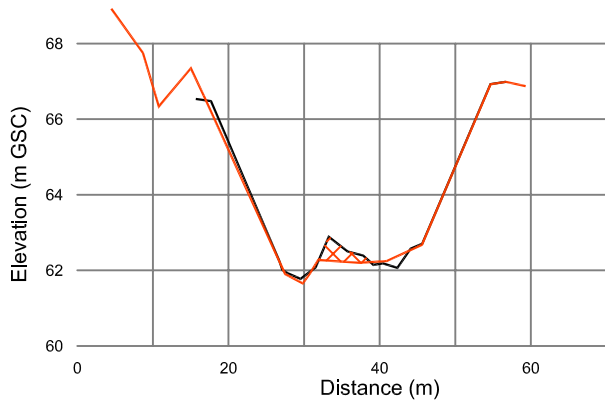
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Reach 4

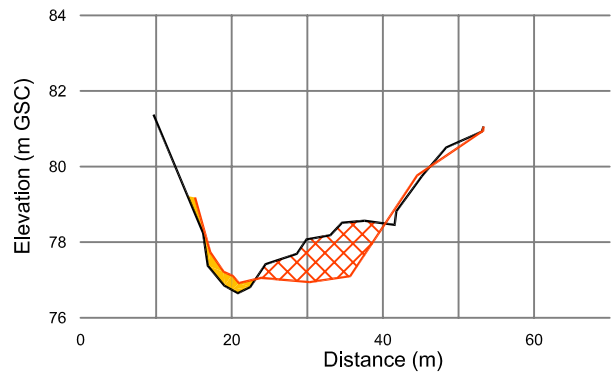




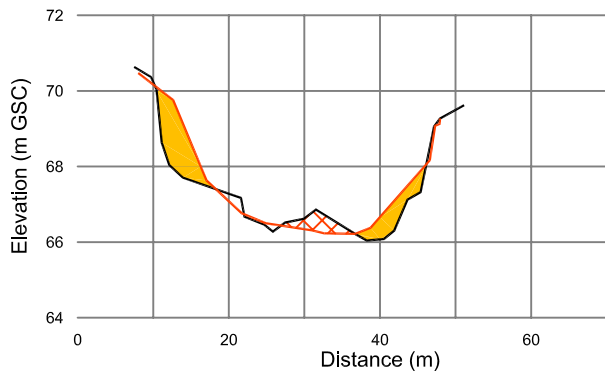
Reach 5



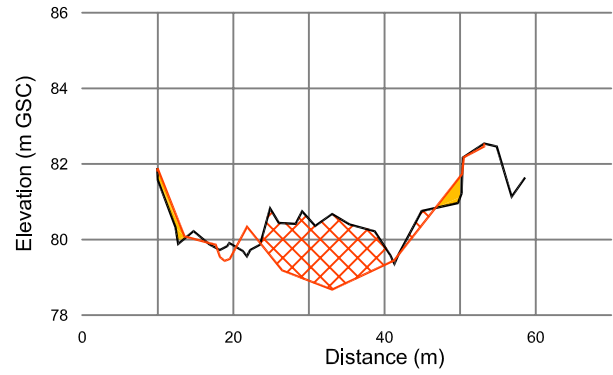
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5H:1V



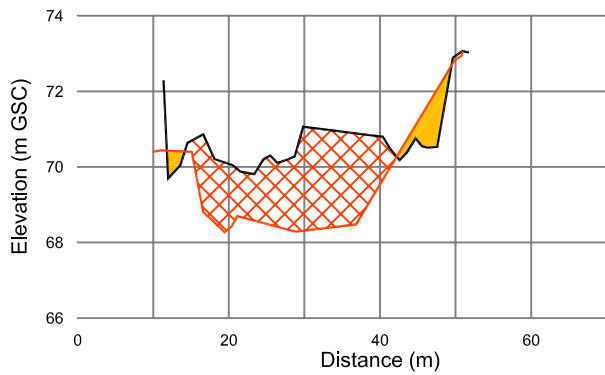
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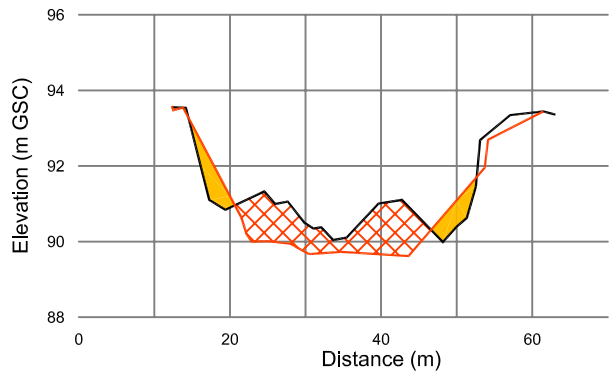
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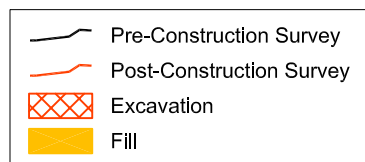
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5H:1V



34 **0+226**
5H:1V



37 **0+226**
5H:1V



Reach 6

APPENDIX B

SRS – Post Construction Report for 2005 Lagace Creek Flood Protection Works

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DFO File No.: 05-HPAC-PA2-000-000235
Our file: 508.02

Post Construction Report for 2005 Lagace Creek Flood Protection Works

1.0 Introduction

Scott Resource Services Inc. (SRS) was retained by Northwest Hydraulic Consultants (nhc) to conduct fish salvage operations and assist with the environmental monitoring of the above referenced project. Flood protection works took place on five reaches within Lagace Creek (Refer to nhc as-built drawings for locations). Fish salvage operations commenced on August 9 and were completed on September 6, 2005. Flood control works commenced on August 16 and were completed on September 13, 2005. As works occurred simultaneously over a vast stretch of Lagace Creek, several monitors were employed. The on site monitors for SRS were Andrew Walter and Jim Scott. Monitors for nhc included, Derek Ray, Bruce Hunter, Don Reid, Matt Gellis, Tasmin Lyle and Andrew Luke.

2.0 Fish and Wildlife Population and Habitat Mitigation Standards and Best Management Practices

A copy of the Authorization outlining terms and conditions of the project was delivered to all contractors. Mitigation standards as outlined in the Authorization, nhc's proposed work plan dated July 28, 2005 and SRS's impact and mitigation plan dated July 31, 2005 were generally adhered to except where noted below.

3.0 Flood Protection Activities

3.1 Lower Reach 1 (Downstream of Farms Road Bridge)

Permission was granted by DFO to conduct excavation of sand bars on Reach 1 downstream of the Farms Road bridge crossing. A total of 3 bars were excavated, (two on the left bank and one on the right bank). Works commenced the week of September 4th and were completed by September 13.

The following mitigation procedures were adhered to when conducting the works:

- Works were conducted during favourable weather conditions.

- A qualified environmental monitor was on site daily during flood protection activities.
- To minimize riparian disturbance, two existing access points were chosen on the left bank and an area with grasses and blackberry bushes chosen to access the right bank (Table 1).
- Works were conducted in isolation of flow by leaving berms around raised sand bars during extraction activities.
- Spill containment kits were stored on each excavator.
- Refueling and servicing of excavators occurred using a mobile refueling truck above the top of bank.
- All construction equipment and machinery used was inspected by the monitor and determined to be relatively clean and free of leaks.
- All material was trucked away.
- Upon completion of sand bar excavation along the left bank (two sand bars), access along the left bank was roughed up, impacted areas seeded with a rapid grow mix (Attachment 1), silage applied to speed growth and straw applied for erosion and sediment control.

3.1.1 Discussion

Excavation remained isolated from flow for the duration of the excavation with the exception of September 9. On this date, the upstream diversion berm from Reach 1 at Dale Road bridge was breached to allow flow back into this portion of the reach. Although nhc and SRS would have preferred to leave the berm in place until after excavation of Reach 1 at Farms Road was complete, nhc was receiving complaints that backed up water from the berm was causing flooding of adjacent fields. As a partial breach of the berm near the left bank resulted in active erosion along the left bank, nhc decided to breach the remainder of the berm over a relatively short time frame (approximately 1 hour). Excavators were notified in the downstream portion of Reach 1 that water levels would rise. Due to the amount of backed up water, water levels did rise and isolation berms were breached in Reach 1 at Farms Road. Excavators left the site for the day and commenced excavation on September 10, when water levels had subsided. Excavators constructed new isolation berms and continued to work in isolation of flow.

Upon completion of the works, SRS attempted to seed and straw the impacted area along the right bank access. Seeding was completed, but only half of the straw was applied as the land owner (Doug Anderson) took exception to the erosion control methods and ordered SRS off the property.

Two large cottonwood trees (estimated 8 to 10" in diameter) were pushed over when deactivating the access road and re-establishing the right bank.

It was decided by nhc to leave the berms unbreached and let water settle out in isolated excavation cells. As the substrate consisted of fine sand, it was expected that the first high water event would naturally breach and erode the isolation berms.

During an inspection on October 11, 2005, the site appeared stable apart from minor rill erosion along the right access bank of Doug Anderson's property (area where no straw was placed). Grass seed had successfully taken along access roads and berms had breached naturally.

Table 1. Details of riparian impacts, mitigation and recommended planting strategies for Lower Reach 1.

Description of Riparian Area	Temporary Riparian Impact	Mitigation	Planting Strategy
Access to river along left bank, consisting of grass	120m ²	Seed, straw and silage application	None, land owner wishes area to remain as an access point
Access to river along left bank, consisting of grass	100m ²	Seed, straw and silage application	None, land owner wishes area to remain as an access point
Sloped right bank consisting primarily of grasses and blackberry bushes	120m ²	Seed and partial straw application	None, land owner unlikely willing to plant impacted area. Natural regeneration recommended.
Total Temporary Riparian Impact	340m²		

For photographs associated with the lower Reach 1 flood protection works see Attachment 2.0; (Photographs 1 to 8).

3.2 Reach 1 Downstream of Dale Road Bridge

Excavation for Reach 1 downstream of Dale Road bridge began on September 6 (placement of diversion berm) and was finished on September 10, (deactivation of the diversion). A connecting channel (approximately 50m in length) to the wetland to the west of Lagace Creek was excavated in isolation of flow on August 24, 2005.

Approximately 300m of Lagace Creek was excavated in isolation of flow associated with the diversion channel. As well, approximately 100m of sandbar was excavated along the left bank using MegaSecur and berming on raised sand bars to isolate flow.

The following mitigation procedures were adhered to when conducting the works:

- Works were conducted during favourable weather conditions.
- A qualified environmental monitor was on site daily during flood protection activities.
- Fish salvages were conducted prior to flow isolation and excavation.
- Isolation of the upstream 300m was conducted by berming the main channel using polyethylene lined bulk bags as well as placing material on the upstream side of the bags to prevent undermining. Flow was directed to an excavated diversion channel connected to a wetland with a small excavated outlet approximately 300m downstream. A berm was also placed on the downstream side directly upstream of the diversion channel outlet completing the isolation of the site.
- Two exposed sand bars along the left bank were also excavated in isolation of flow by constructing isolation berms in combination with the MegaSecur diversion dams.
- Spoil was placed in piles along existing access roads over the left and right banks of Lagace Creek. In most cases, one excavator “hoe chucked” the spoil on the bank, while a second excavator placed the spoil in piles on the access roads.

- Material was stored above the banks. Natural openings, and areas where minimal vegetation was present were chosen for access locations to store spoil (Table 2).
- Vegetation was salvaged (shrubs or sapling trees) within spoil placement openings and later replaced.
- Benches separating large spoil piles from the stream bank were made to mitigate for erosion and create plantable surfaces.
- Spill containment kits were stored on each excavator.
- All construction equipment and machinery used was inspected by the monitor and determined to be relatively clean and free of leaks.
- Upon completion of excavation, impacted slopes were seeded with a rapid grow mix (Attachment 1) and straw applied for erosion and sediment control.

3.2.1 Discussion

Due to the nature of the substrate (primarily sands), a substantial amount of material was required to prevent undermining of the diversion dam, resulting in elevated sediment plumes during construction. Upon completion of the upstream diversion, the excavator got stuck. When the excavator extricated itself, substantial disturbance to the left bank of the channel occurred. This area was later regraded and stabilized with straw, seed and plants.

The operator inadvertently placed spoil into the floodplain of Lagace creek along the left bank directly downstream of Dale Road bridge. This material was left in place as substantial riparian disturbance would have been necessary in order to remove it for land owner use.

Once flow was diverted, a lag time occurred while the wetland filled up. As well, water backed up into the two sloughs upstream of Dale Road Bridge. Although Lagace Creek never dried up downstream of the diversion outlet, flows were reduced. SRS inspected the channel for stranding, but did not observe any pools where salmonids were stranded.

The diversion channel successfully isolated the site from flow. Due to the reduced flows, sand bars downstream of the excavation were further exposed, allowing excavators to use berms to isolate works from flow. MegaSecur diversion was also employed to further divert flow, however, the dams did not function as well as originally intended. In the two instances where the MegaSecur was used, the sand substrate undermined near the end of the excavation, allowing flow prematurely back into the excavation site. This resulted in sediment plumes as water filled up and downstream berms were breached.

During an inspection on October 11, 2005, the site appeared stable. No erosion of banks or spoil piles were evident (no sloughing of sandy spoil piles). Grass seed had taken on most slopes, Grass seed on some of the steeper slopes near the high water mark did not take as well (seed and straw appeared to have sloughed).

Agreements with landowners to remove temporary spoil piles along the access roads on the east and west sides of Lagace Creek have been made with the Fraser Valley Regional District (FVRD).

As stated in the SRS impact and mitigation plan dated July 31, 2005, baseline benthic invertebrate samples were taken in 5 random locations below Dale Road bridge within the glide habitat (sand substrate), prior to excavation activities. Results are in Attachment 3.

Table 2. Details of riparian impacts, mitigation and recommended planting strategies for Reach 1 at Dale Road bridge.

Description of Riparian Area (LB=Left Bank; RB=Right Bank) All distances taken from Dale Road bridge.	Temporary Riparian Impact	Mitigation	Planting Strategy
0+016 LB grass floodplain	56m ²	Seed and straw application	None, area in active floodplain.
0+016 RB young deciduous trees and shrubs, diversion access	75m ²	Seed and straw application, 3 trees and shrubs replanted	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation.
0+057 RB young deciduous trees and shrubs, spoil access	70m ²	Seed and straw application, 9 trees and shrubs replanted	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation.
0+084 RB young deciduous trees and shrubs, spoil access	100m ²	Seed and straw application, 3 trees and shrubs replanted	As above
0+121 RB young deciduous trees and shrubs, spoil access	160m ²	Seed and straw application, 6 trees and shrubs replanted	As above
0+172 RB primarily young deciduous trees a few larger alder (aprox 6") and shrubs, spoil access	48m ²	Seed and straw application, 3 trees and shrubs replanted	As above
0+206 RB young deciduous trees and shrubs, spoil access	80m ²	Seed and straw application, no trees or shrubs replanted	Plant vegetation in open spaces at 1 plant per m ² .
0+231 RB willow and young alder, above top of bank were access road had ended, spoil access	180m ²	Seed and straw application , 6 trees and shrubs replanted	Plant vegetation in open spaces at 1 plant per m ² . Spoil was placed in an undisturbed riparian zone (access road had ended). Recommend replanting once spoil pile has been removed.
0+030 LB floodplain, deciduous trees, shrubs and grasses, spoil access	100m ²	Seed and straw application, grass plugs replaced	Plant vegetation in open spaces at 1 plant per m ² .
0+056 LB willows, shrubs and grasses, spoil access	260m ²	Seed and straw application, 4 trees and shrubs replanted near the top of bank	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation.
0+111 LB grass bank with low shrubs, spoil access	160m ²	Seed and straw application	Plant vegetation in open spaces at 1 plant per m ² .

Description of Riparian Area (LB=Left Bank; RB=Right Bank) All distances taken from Dale Road bridge.	Temporary Riparian Impact	Mitigation	Planting Strategy
0+233 LB young deciduous trees, willows, shrubs, spoil access	60m ²	Seed and straw application, 4 trees and shrubs replanted.	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation.
0+290 LB young deciduous trees, willows, shrubs, spoil access	55m ²	Seed and straw application, 2 trees and shrubs replanted.	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation.
0+365 LB shrubs	30m ²	Seed and straw application, 3 trees and shrubs replanted.	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation.
0+390 LB young deciduous trees and shrubs, spoil access	24m ²	Seed and straw application, worked around existing tree plus 1 replanted vegetation.	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation.
0+420 LB willow, spoil access	36m ²	Seed and straw application, no planting.	Plant vegetation in open spaces at 1 plant per m ² .
0+544 LB willow grass, spoil access	32m ²	Seed and straw application, 3 trees and shrubs replanted.	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
0+586 LB willow grass, spoil access	27m ²	Seed and straw application	Plant vegetation in open spaces at 1 plant per m ² .
Total Temporary Riparian Impact	1,553m²		

For photographs associated with Reach 1 flood protection works downstream of Dale Road bridge see Attachment 2.1 (Photographs 1 to 16).

3.3 Reach 2 Dale Road Bridge to Schroots Corner.

Reach 2 flood protection works commenced on August 23, 2005, and were completed on September 3, 2005. Approximately 1,500m of channel was excavated in isolation of flow by diverting water through a diversion channel and into Bouchier Creek. From the diversion upstream to Schroots corner (300m), high bars were scalped in isolation of flow by berming and using the MegaSecur diversion.

The following mitigation procedures were adhered to when conducting the works:

- Works were conducted during favourable weather conditions and halted when conditions were not favourable.
- A qualified environmental monitor was on site daily during extraction activities.
- Fish salvages were conducted prior to isolation and excavation. Stop fencing was used in conjunction with salvages and to isolate fish from work areas.

- Diversion of the 1,500m of channel was conducted by berming the main channel using polyethylene lined bulk bags as well as placing material on the upstream side of the bags to prevent undermining. Flow was directed through a culvert into a ditch system leading to Bouchier Creek (outlet at Dale Road bridge). Reduced flow was maintained throughout the excavation as salvage operations were occurring concurrently directly upstream of the excavation operations.
- Daily removal of beaver dams was conducted by hand with potato rakes to ensure unobstructed flow in Bouchier Creek.
- As stated in the nhc 2005 work plan, a portion of Bouchier Creek was cleaned out and a culvert cleared that was completely obstructing flow to the downstream section of the channel.
- A downstream block was constructed from substrate lined with polyethylene approximately 300m upstream from the confluence of Bouchier and Lagace Creeks and a pump periodically used to pump out silt laden water.
- As stated, berming and MegaSecur diversion were used on exposed bars to isolate flow from the diversion intake, upstream to Schroots corner (300m).
- Once diversion was complete, excavation between 302 and 460m from Schroots Corner took place by scalping isolated bars. Bars were only scalped to approximately 0.45m to encourage fall spawning.
- Isolation berms were breached to prevent stranding in all scalped bars.
- Material was stored above the banks. Natural openings, and areas where smaller vegetation (e.g. shrubs and grasses) were present were chosen for access locations to store spoil (Table 3). In most cases, areas were flagged by the on site monitor prior to placement of spoil.
- A log jam at 1500m from Schroots corner was flagged and left in place (excavators walked around it on an existing path located on the left bank) as it provided substantial cover habitat.
- The centre channel gravel bar between 688 and 770m as identified in the habitat mitigation plan was flagged and left undisturbed.
- In most cases, one excavator “hoe chucked” the spoil on the banks while a second excavator moved the spoil away from the banks of the creek.
- Some vegetation (shrubs or sapling trees) within spoil placement openings was salvaged and later replaced. Selective plugs, were also placed from adjacent vegetation to fill in open spaces.
- Benches separating large spoil piles from the stream bank were made to mitigate for erosion and create plantable surfaces.
- Decommissioning of the diversion berm took place in stages over the course of a day. Salvage crews did not observe any stranding in the diversion channel or Bouchier Creek.
- Spill containment kits were stored on each excavator.
- All construction equipment and machinery used was inspected by the monitor and determined to be relatively clean and free of leaks.
- Upon completion of excavation, impacted slopes were seeded with a rapid grow mix (Attachment 1) and straw applied for erosion and sediment control.

3.3.1 Discussion

The flood protection works in Reach 2 resulted in the following benefits to aquatic habitat as observed by SRS and nhc.

- Scalping of surface gravel on exposed bars from Schroots Corner to a point approximately 460m downstream increased available spawning habitat. On October 11, 2005, chum salmon were observed paired up and actively spawning in scalped bars and fresh redds were observed.
- The blockage due to the debris flow on Bouchier Creek was a clear migration barrier. Clearing the blockage resulted in opening approximately 700m of channel to adult coho migration for fall of 2005.

Following are comments regarding environmental issues that arose during flood protection works on Reach 2.

It became clear when nhc and the contractor viewed the site that not enough natural access points were available to hoe chuck material to. As well, the creek had to remain wetted as salvage operations were too extensive to completely drain the whole diversion channel resulting in substantial flows within the channel itself. As a result, temporary riparian disturbance was greater than expected to complete the flood protection works along this reach (see Table 3). The original intent was to temporarily stockpile material for later removal by land owners, however, spoil locations included areas where land owner access was unavailable. Of the 3,070m of linear cover along the left and right banks of Reach 2 of Lagace Creek associated with the diversion channel, approximately 538 linear metres (or 17.5%) was temporarily disturbed as a result of the works. Total temporary riparian disturbance was estimated at 3,932m². Mitigation through replanting of vegetation clusters and avoiding vegetation where possible will reduce the actual amount of planting required in the disturbed areas.

Results of the spoil placement were mixed. Where natural openings occurred, little impact was noted and the operator was able to hoe chuck material along the current dyke and place plugs along constructed benches, resulting in a stable site.

Where openings were limited, girdling and scarring of alder trees occurred. Long term stability of spoil was questionable along steep slopes where a veneer of sand was left along the banks due to the hoe chucking.

Due to the expansiveness of the Lagace Creek flood protection works, the operator was not monitored continuously, resulting in a few questionable judgment calls by the excavator operator.

In a few places, excavator operators placed spoil against newly excavated over steepened banks as they thought it would reduce the grade. During high flow events, this spoil will likely erode.

Miscommunication between a landowner and the operator resulted in spoil being placed in an inaccessible location instead of at an obvious access point where the landowner was going to remove the spoil to be used for a tree farm (the operator did not want to disturb a drainage ditch).

A summer rain event on August 29, breached the diversion berm and blew out all of the fish fences placed by SRS. The berm was engineered to breach during high flows to prevent flooding within Bouchier Creek. On August 30, the diversion was re-established, isolation fences were again erected and salvages resumed. Salvaged areas upstream of the excavation required resalvaging as the fences had been compromised.

Although seed and straw were applied, straw did not hold on the steeper slopes toward the watercourse. Straw was not placed on temporary spoil piles to be removed by land owners and above constructed benches.

Table 3. Details of riparian impacts, mitigation and recommended planting strategies for Reach 2.

Description of Riparian Area (LB=Left Bank; RB=Right Bank) All distances taken from diversion channel (0+000).	Temporary Riparian Impact	Mitigation	Planting Strategy
0+000 RB (diversion channel) young alder and shrubs	200m ²	Seed and straw application	Plant vegetation in open spaces at 1 plant per m ²
0+015 LB young alder and shrubs	75m ²	Seed and straw application Replanted 1 willow	Plant vegetation in open spaces at 1 plant per m ²
0+102 RB young alder and shrubs	30m ²	Seed and straw application	Plant vegetation in open spaces at 1 plant per m ²
0+117 (bank not recorded) salmonberry and shrubs	4m ²	Seed and straw application	Plant vegetation in open spaces at 1 plant per m ²
0+129 LB blackberry	4m ²	Seed and straw application	Plant vegetation in open spaces at 1 plant per m ²
0+138 LB young alder and shrubs	100m ²	Seed and straw application Salmonberry alder and willow clusters planted	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
0+163 LB young alder and shrubs	9m ²	Seed and straw application	Plant vegetation in open spaces at 1 plant per m ²
0+185 LB (repair of avulsion through berm) willow and shrubs along bank slopes, grasses with approximately 1.5 m strip of young alder shrubs and willow along berm	190m ²	Seed and straw application along slope willow clusters planted along slope	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
0+240 RB (location of previous dyke failure) grasses and low shrubs	90m ²	Seed and straw application	Plant vegetation in open spaces at 1 plant per m ²
0+325 RB young alder and willow	40m ²	Seed and straw application 2 alder clusters planted	Plant vegetation in open spaces at 1 plant per m ² .

Description of Riparian Area (LB=Left Bank; RB=Right Bank) All distances taken from diversion channel (0+000).	Temporary Riparian Impact	Mitigation	Planting Strategy
			Replace dead replanted vegetation
0+483 LB alder and cottonwood (3 or more up to 5 diameter)	200m ² Substantial temporary disturbance	Seed and straw application 3 willow clusters planted	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
0+325 LB young alder and salmonberry	180m ²	Seed and straw application Alder and salmonberry clusters planted	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
0+525 RB grasses and gravel bar	26m ²	Seed and straw application	Plant vegetation in open spaces at 1 plant per m ² above the high water mark
0+560 LB open canopy of alder and cottonwood	225m ² (includes 100 m ² spoil pile to be removed by landowner)	Seed and straw application Both alder and salmonberry clusters planted	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
0+602 RB open canopy of cottonwood	222m ² (includes 50 m ² spoil pile to be removed by landowner)	Seed and straw application Riparian vegetation clumps planted near banks	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
0+658 LB young alder	102m ² (includes 50 m ² spoil pile to be removed by landowner)	Seed and straw application 1 alder and 1 willow clump planted	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
0+698 LB young alder	89m ² (includes 45 m ² spoil pile to be removed by landowner)	Seed and straw application 3 alder and salmonberry clumps planted	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
0+756 LB willow and young alder, grasses road on dyke and 2m fringe of alder and scotch broom east of dyke	423m ² (includes 282 m ² spoil pile to be removed by landowner) Along slopes approximately 50% of the riparian has been removed	Seed and straw application approximately 50% of the riparian remains intact downslope of the dyke	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
0+850 RB salmonberry and open canopy alder up to 6" diameter	190m ² (includes 114 m ² spoil pile accessible to landowner) Trees have been girdled in this location	Seed and straw application (no planting)	Plant vegetation in open spaces at 1 plant per m ² .

Description of Riparian Area (LB=Left Bank; RB=Right Bank) All distances taken from diversion channel (0+000).	Temporary Riparian Impact	Mitigation	Planting Strategy
0+912 RB open canopy alder, cottonwood and blackberry	81m ²	Seed and straw application Riparian vegetation clumps planted	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
0+930 RB open canopy shrubs and willows	180m ² Spoil pile infilled edge of wetted area on the bank of the dyke	Seed and straw application Riparian vegetation clumps planted along banks	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
0+985 RB willow and salmonberry	100m ² Broken tree tops noted	Seed and straw application 3 alder and willow clusters planted along banks	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
1+027 RB open canopy with blackberry and salmonberry	161m ² Girdling of trees noted on backside of spoil piles	Seed and straw application 1 willow cluster planted 2 willow clumps left in place	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
1+080 LB low willow fringe with blackberry back from banks	50m ² Spoil pile to be removed	Seed and straw application	Plant vegetation in open spaces at 1 plant per m ² .
1+125 RB shrubs and young alder	272m ²	Seed and straw application 3 riparian vegetation clumps planted as well as 5m linear section of undisturbed alder	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
1+203 LB open canopy alder, dense blackberry understory along banks, dirt road behind where spoil was piled	68m ²	Seed and straw application 3 willow clusters planted	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
1+305 LB open canopy young alder, dense blackberry dirt road behind where spoil was stored	75m ² Spoil placed on dyke road to be removed	Seed and straw application 3 willow clusters planted	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
1+370 LB sparse willow and young alder	125m ² Broken alder tops Spoil placed on dyke road to be removed	Seed and straw application Riparian clusters along bank relatively have been replaced and or left undisturbed	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation
1+452 RB dense shrub for 4m along banks, then open berm of immature alder and grasses	121m ² Broken alder tops	Seed and straw application	Plant vegetation in open spaces at 1 plant per m ² .
1+486 RB dense shrub for 4m along banks, then open berm of immature alder and grasses	130m ² Broken alder tops	Seed and straw application One replanted willow/alder cluster	Plant vegetation in open spaces at 1 plant per m ² . Replace dead replanted vegetation

Description of Riparian Area (LB=Left Bank; RB=Right Bank) All distances taken from diversion channel (0+000).	Temporary Riparian Impact	Mitigation	Planting Strategy
1+535 RB open canopy conifers (downstream diversion block and pump location)	20m ² Natural opening in between conifers – non tree damage	Seed and straw application	Plant vegetation in open spaces at 1 plant per m ² .
1+535 LB shrub cover, private residence road access and garbage pile	150m ²	Seed and straw application	Plant vegetation in open spaces at 1 plant per m ² .
Total Temporary Riparian Impact	3,932 m²		

As well, gravel material was placed along the right bank of Schroots Corner in open spaces for approximately 250m. No erosion control was necessary in this location, due to the stable nature of the gravel substrate. Supplementary planting in open spaces along the 3m slope below the dyke is recommended.

For photographs associated with Reach 2 flood protection works see Attachment 2.2 (Photographs 1 to 22).

3.4 Reach 3 Farms Road Bridge to Seux Road Bridge

Reach 3 flood protection works commenced on August 16, 2005 and were completed by the first week of September, 2005.

The following mitigation procedures were adhered to when conducting the works:

- Works were conducted during favourable weather conditions except where noted.
- A qualified environmental monitor was on site daily during extraction activities.
- Fish salvages were conducted prior to isolation and excavation. Stop fencing was used in conjunction with salvages and to isolate fish from work areas.
- Refueling and servicing of excavators occurred using a mobile refueling truck above the top of bank.
- Isolation was maintained by berming and constructing diversion channels to redirect flow.
- Check dams were placed while excavating the right bank diversion channel to settle out sediment laden water. Banks of the diversion channel were sloped to prevent bank sloughing.
- A 3" pump was used at the downstream end of Reach 2 to direct sediment laden water into an adjacent field at the beginning of the excavation (water settled out as the excavated area neared the half way point and the pump was no longer used).
- Material was either hauled onto the Anderson property approximately 10m from the top of bank or recontoured along eroded banks (e.g. upstream of the Anderson site).
- Access was established using a temporary bridge on the Anderson site and an overgrown access road along the left bank of Seux Road.
- Access at Seux Road bridge was seeded with an alder seed mix (Attachment 1).

- All construction equipment and machinery used was inspected by the monitor and determined to be relatively clean and free of leaks.

3.4.1 Discussion

Rob Anderson removed all the woody debris on the reach prior to excavation. As he was not specifically told to leave the cabled in large woody debris (LWD), he removed all but one piece. This was done prior to monitors showing up at the site. Woody debris is currently being stored on the Anderson property as a source of future woody debris placement.

Reach 2 was, for the most part, successfully excavated and recontoured in isolation of flow by berming and redirecting flow into natural or excavated channels on either the right or left bank. Sediment plumes did occur when redirecting flow or when berming braided channels to maintain flow on one side of the bank. Sustained sediment plumes were recorded when the left bank channel was deepened in spots to direct water away from the right bank. This caused sediment plumes for up to 45 minutes in duration.

In order to slow down erosion and bank failure along the right bank near Farms Road bridge, a 38 by 5m vegetated bar was removed and converted to instream habitat. Graham Daneluz informed DFO prior to removal of the bar. Removal of the bar was accomplished in isolation of flow.

On August 19, 2005, monitors observed an operator excavating out the left bank of the diversion channel causing a sediment plume. He was informed that excavation must be in isolation of flow behind a berm. Doug Anderson voluntarily shut down the work for the day. Excavation continued behind an isolation berm for the remainder of the works.

Hydraulic lines blew on two separate occasions. Approximately 10 to 20 litres of hydraulic fluid leaked onto the gravel bar. Contaminated gravel was removed and stored on the Anderson property on the opposite side of the access road. The Andersons assured SRS and nhc that spill kits were on all the pieces of machinery, but when the first leak occurred, Doug Anderson claimed his spill kit had been stolen. Rob Anderson retrieved a spill kit from his house to clean the excavator and mop up. Spill kits were then placed on excavators.

The rain event that occurred on August 29, caused the diversion berm to breach downstream of the excavation and blew out isolation fencing. Works continued per the e-mail to DFO from Derek Ray on August 29th. No further isolation fencing or resalvaging was conducted as excavation was essentially in the dry.

A total of 210m² of riparian habitat was temporarily disturbed when removing shrubs and pole sapling deciduous trees along the overgrown access road at Seux Bridge.

For photographs associated with Reach 3 flood protection works see Attachment 2.3 (Photographs 1 to 20).

3.5 Reaches 5 and 6 Confluence with Lagace Creek to 600m Upstream of Sylvester Road

Flood protection works on Reaches 5 and 6 commenced on August 16, 2005 and were completed by the first week of September, 2005.

The following mitigation procedures were adhered to when conducting the works:

- Works were conducted during favourable weather conditions and halted when conditions were not favourable.
- A qualified environmental monitor was on site daily during extraction activities.
- Fish salvages were conducted prior to isolation and excavation. Stop fencing was used in conjunction with salvages and to isolate fish from work areas.
- All construction equipment and machinery used was inspected by the monitor and determined to be relatively clean and free of leaks.
- Spill containment kits were stored on each piece of heavy equipment.
- Refueling and servicing of excavators occurred using a mobile refueling truck above the top of bank.
- Isolation was maintained, by berming and constructing diversion channels to redirect flow.
- A temporary culvert was installed to cross the left bank diversion channel in Reach 6.
- A series of sediment traps were excavated to settle out sediment laden water in the Reach 5 excavation prior to entry into the mainstem channel (at the Lagace/Pattison confluence). Hay bales were also placed (with limited effect).
- A series of sediment traps were also excavated to settle out sediment laden seepage water while excavating the Reach 6 left bank diversion in isolation of flow.
- A trench, sediment trap and 3" pump were effectively used to capture and pump out sediment laden water within the Reach 6 excavation.
- Most material was hauled off site or used to recontour eroded banks. Some gravel was stored in a location 30m away from the top of the left bank of Reach 6. As well, some material was stored in an old dump site that was cleared of refuse well over 30m away from the right bank of Reach 6.
- Access for Reach 5 was from Sylvester Road using an old unvegetated access road (Table 4).
- Two access roads were established for Reach 6 using old overgrown access roads along the left and right banks (Table 4). Riparian buffers were left along the banks (5 to 10m on the right bank and greater on the left bank).
- Clearing boundaries were flagged by nhc and SRS.
- Upon completion of works, the left bank access road was decompacted and seeded with an alder seed mix (Attachment 1). Due to a dispute with the land owner, the right bank access road was not fully decompacted, however, the alder seed mix was placed here as well. Grass seed was applied to the access for Reach 5.

3.5.1 Discussion

Reaches 5 and 6 were completed with little difficulty and few environmental issues.

With the approval of DFO, limited recontouring of the left bank within Reach 4 was completed directly downstream of the Lagace/Pattison confluence. This work was done on an elevated gravel bar in complete isolation of flow and did not impact the water course.

During the summer rain event on August 29th works were halted. Substantial amounts of sediment laden water came from upstream of the works as well as from within the works themselves. Works commenced on August 30th.

Although sediment traps did partially settle out seepage water within the Reach 5 and 6 excavations, sediment laden water (above 25NTU) was still entering the main channel at the Lagace/Pattison confluence. Discharge was minimal, however, and was mitigated when mixed with clear water from the diversion channel and the mainstem of Lagace Creek.

A small hydraulic leak occurred when preparing the left bank haul road. Spill kits were immediately deployed and all oil was contained.

Although decompaction (e.g. ripping up the access road using an excavator bucket with teeth to a depth of 0.3m) was recommended by nhc and SRS, for both the left and right haul roads, the land owner argued that the overgrown road along the right bank was not decompacted prior to the works and refused to have it decompacted at the completion of works. As a result the road was slightly roughened up and seeded as stated above.

Several fords of Reach 6 were necessary to prepare the upper portion of Reach 6. The D8 that forded the channel was clean and free of leaks, did not turn its tracks while fording and only forded over large substrate, therefore there was minimal sediment disturbance.

Table 4. Details of riparian impacts, mitigation and recommended planting strategies for Reach 5/6.

Description of Riparian Area (LB=Left Bank; RB=Right Bank)	Temporary Riparian Impact	Mitigation	Planting Strategy
Reach 6 left bank access road, young alder	1,260m ²	Decompacted and application of an alder seed mix	none
Reach 6 right bank access road, young alder, sparse shrubs and grasses	525m ²	roughened and application of an alder seed mix	none
Reach 5	100m ²	Roughened and seed mix applied	none
Total Temporary Riparian Impact	1,885 m²		

For photographs associated with Reach 5/6 flood protection works see Attachment 2.4 (Photographs 1 to 18).

4.0 Conclusions and Recommendations

4.1 Fish Salvages

Isolation fences were difficult to maintain during rain events. Fences were completely blown out during the late August rain event. Use of stop fences is a common BMP for fish salvages, however their permanency to completion of works cannot be guaranteed on this system.

Use of seine nets in combination with electroshockers was found to be the most effective salvage technique within Reaches 1 and 2 (shallow glides and sand substrate). A combination of minnow trapping, seining and electroshocking should be used in Reach 3. The only effective salvage method for Reaches 5 and 6 was electroshocking (large angular substrate and lack of deep pools).

To minimize impact to fish during salvage operations in Reach 2, frequent transport of small numbers of fish is required. Difficulty accessing portions of the channel made transport of salvaged fish an often lengthy and arduous process.

For further discussion in regards to the fish salvage, refer to the fish salvage report.

4.2 Flow Isolation Techniques

The use of the MegaSecur to divert flow on Lagace Creek met with mixed results. In association with the larger gravel substrate of Reach 2 near Schroots corner, the MegaSecur effectively isolated areas when used in combination with berming of elevated bars. Within Reach 1, the sand substrate undermined the MegaSecur, which made isolation difficult. SRS does not recommend future use of the MegaSecur within Reach 1.

The flow diversion within Reach 1 resulted in a substantial back up of water into Reach 2 of Lagace Creek as well as Bouchier Creek. The diversion channel took time to fill up, prior to out letting into Lagace Creek. This resulted in potential fish stranding issues and upstream flooding concerns. If Reach 1 below Dale Road bridge is to be maintained as a sediment trap, SRS recommends that the diversion channel be surveyed and excavated to ensure unimpeded flow.

The flow diversion into Bouchier creek associated with Reach 2 worked well and is recommended if future excavation is required on this Reach.

Berming and in channel flow diversions within Reaches 3, 5 and 6 were effective. Pumps were effectively employed to capture sediment laden water. It is recommended that pumps be always available to capture sediment laden water during excavation activities.

4.3 Riparian Disturbance

Areas recommended for replanting have been described within Tables 1 to 4. Total temporary riparian disturbance due to this project was approximately 8,110m² (including 190m² of habitat conversion upstream of Farms Road bridge in Reach 3).

It is acknowledged that all temporarily disturbed areas will naturally regenerate given time, however, supplementary planting in clearly disturbed areas is recommended to mitigate for temporal riparian disturbance. As much of the vegetation that was disturbed was low growing shrubs and young deciduous trees, lag time for regeneration to pre removal conditions should be no more than 3 to 5 years in most areas. It is also acknowledged that salvaging and replanting of riparian vegetation during the excavation has mitigated for a portion of the temporal disturbance. Table 5 summarizes the maximum disturbed area in planting locations (not including natural regeneration and salvaging of riparian plants). Due to the plant salvage efforts, the actual area of mitigative planting within cleared areas will be substantially less.

Table 5. Total Area of Temporal Riparian Disturbance Recommended for Supplemental Planting.

Reach	Area (m ²)
1	1,553
2	3,932
3	210
5/6	None, alder seed applied
Total	5,695

Due to the extensive source of willows within Reaches 1 and 2, SRS recommends pruning willows and planting willow stakes within open spaces during the dormancy period (winter months). Supplementary planting of native shrubs to replace those covered during spoil placement of material could also be considered in the spring of 2006. In lieu of a formal planting plan, any plant lists considered for purchase should be reviewed by an appropriately qualified professional for site appropriateness. Any planting (e.g. by Non Governmental Organizations) should be overseen by an appropriately qualified professional.

Riparian disturbance was substantial in Reach 1 downstream of Dale Road and in Reach 2, due to placing spoil along banks. Sloughing into the channel was also a concern. If future excavation in Reach 2 are necessary, temporary in channel haul roads should be considered in order to truck material out. Peter Kokoska, who supervised the works for Reaches 5 and 6, stated that this method had previously been used for Reach 2 and was successful.

4.4 Instream Disturbance

Although difficult to quantify, temporal instream disturbance due to the flood protection works was evident. A total of approximately 5,000m by 13m or 65,000m² (Derek Ray, Pers. comm.) of stream channel was affected by the flood control works. Table 6 indicates the likely disturbance by reach.

Table 6. Lagace Flood Control Works Instream Disturbance.

Reach	Fish Salvage Impacts	Benthic Invertebrate Disturbance	Channel Complexity	Sediment Disturbance
Lower 1	No	Minimal	Minimal	Yes
1 at Dale Rd.	Minimal	Yes	Minimal	Yes
Reach 2	Yes	Yes	Yes	Yes
Reach 3	Yes	Yes	Yes	Yes
Reach 5/6	Yes	Yes	Yes [†]	Yes

[†] Boulder complexity is expected to re-establish quickly due to the bed load movement in Reaches 5 and 6

All reaches, apart from Lower Reach 1, were subject to fish salvages prior to excavation. Although a necessary Best Management Practice, fish salvaging does result in physiological impacts to fish. The overall impact to the fish population was likely minimal due to salvaging Reach 1 as fish densities were low. Overall impacts likely increased in Reach 2 due to higher fish densities and difficulty in transporting fish. Fish densities were also high in Reach 3. Impacts due to salvaging were mitigated in Reaches 2 and 3 by employing "softer" techniques (e.g. seining and minnow trapping) in association with electroshocking. Any physiological impacts in Reach 5/6 would be primarily due to the exclusive use of the electroshocker as the salvage method due to the nature of the channel (e.g. large angular substrate, lack of pools).

It is acknowledged that gravel removal caused a temporal disturbance to benthic invertebrates in Lagace Creek however the amount of disturbance is difficult to determine given the unstable nature of this system. Extreme bed load movement within the channel occurs frequently, which will in turn impact benthic invertebrates within the channel substrate.

Nevertheless, baseline benthic invertebrate analysis was conducted for Reach 1. As recommended in the SRS impact and mitigation plan dated July 31, 2005, the sites should be resampled during the fall of 2005 and again in the summer of 2006 to roughly compare pre and post excavation benthic production.

Benthic invertebrate disturbance within Lower Reach 1 should be minimal (and may have increased production) as high bars were scalped, increasing the wetted surface area.

Minimal disturbance to channel complexity was observed in Lower Reach 1 as only elevated sand bars were removed. Minimal disturbance was noted in Reach 1 at Dale Road. One woody debris cluster was removed (small jam that looked man made and was used to cross the creek) as well as the infilling of flood plain habitat near Dale Road bridge and disturbance of undercut banks along the left bank.

Substantially more disturbance to in stream complexity was noted in Reaches 2 and 3 with the removal of relatively stable small and large woody debris (LWD) clusters, undercut bank disturbance, possible bank sloughing (in Reach 2), and disturbance to braided channels. Cover and scour pools provided by large angular boulders were impacted when Reaches 5 and 6 were recontoured. By October 2005, braids had reformed in Reach 6 and bed load movement will ensure that large boulders will be re-established in Reaches 5 and 6 by this winter.

Although mitigation techniques were utilized to minimize sediment disturbance, releases above 25NTU were unavoidable and occurred in all reaches as described in Sections 3.1 to 3.5.1. Although instream salvages took place prior to flood protection works, releases of sediment may have negatively impacted fish downstream of any given reach (e.g. unsalvaged section between Schroots Corner and Farms Road bridge).

4.4.1 Instream Benefits

As described in Section 3.3.1, scalping of high bars in the vicinity of Schroots corner increased spawning habitat and is a recommended excavation technique in sensitive portions of Lagace Creek.

As well, by clearing the blockage in Bouchier Creek, approximately 700m of channel was made available for adult migration of salmonids this fall. This should be taken into account when considering compensation for the flood control works.

4.5 Wildlife

No significant wildlife observations were made during the flood control works that could impact SARA listed species.

4.6 Compensation

It is the opinion of SRS that a limiting factor to rearing habitat in Lagace creek is functional LWD (to provide cover and scour pools). It is recommended that as partial compensation for the impacts to the watercourse, as outlined in Sections 4.3 and 4.4, opportunities for LWD placement should be explored taking into account property owner issues and channel stability. Although, during the salvage effort, it was evident that stable LWD was found to provide substantial rearing habitat in Reach 3 (Anderson's property), the property owner is extremely averse to any complexing in this sediment trap. LWD placement could be considered between Schroots Corner and Farms Road. This section of creek is essentially one long riffle/glide sequence with a lack of instream features (e.g. LWD, deep pools or cutbanks). Stable areas with access within Reach 2 downstream of Schroots Corner, the mainstem of Lagace Creek upstream of the confluence with Pattison Creek and tributaries to Lagace Creek outside of the active floodplain should also be considered.

All compensation options will be developed by the FVRD or designated individuals per Section 25 of the Authorization to be approved by DFO and constructed no later than the 2006 instream window.

4.7 Monitoring Program

A monitoring program must be implemented by the FVRD or designated individuals consistent with terms outlined in Sections 26 to 29 of the DFO Authorization.

I trust this is the information you require at this time. If you have any questions or require further information, please call the undersigned at (604) 820-1415.

Sincerely,

SCOTT RESOURCE SERVICES INC.

A handwritten signature in cursive script that reads "Andrew Walter".

Andrew Walter R.P Bio., A.Sc.T
Project Manager

Attachments:

1. Seed Mixtures Used for Lagace Creek Flood Protection Works
- 2.0 to 2.4 Selected Photographs of Lagace Creek Flood Protection Work
3. Benthic Invertebrate Results Taken Within Reach 1 at Dale Road Bridge

Attachment 1. Seed Mixtures Used for Lagace Creek Flood Protection Works

1. Richardsons Rapid Grow Revegetation Mixture

50% Fall rye
5% Perennial rye grass
7% Creeping red fescue
5% Orchard grass
24% Annual rye grass
4% Single cut red clover
5% Timothy

2. Richardsons Ground Cover Mix

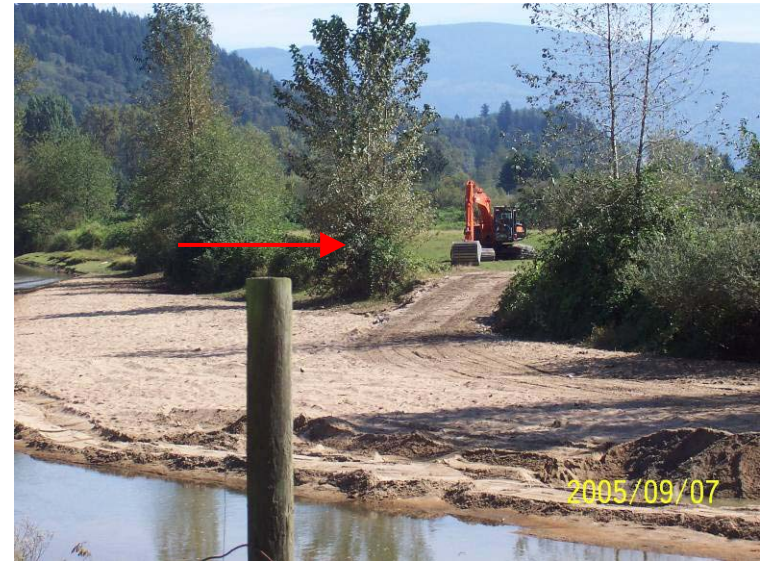
15% Kentucky blue grass
15% Single cut red clover
40% Creeping red fescue
30% Perennial rye grass
Plus 25gm red alder seed added to the mix



Photograph 1. Looking at the upstream sandbar and access along the left bank at commencement of work. In the background, the right bank sand bar can also be seen.



Photograph 2. Looking at second access road along the left bank prior to commencement of work. Access consisted of blackberries and detritus.



Photograph 3. Looking at sandbar along the right bank. A natural opening was used to access the channel. Red arrow indicates cottonwoods that were removed during the excavation.



Photograph 4. Excavating the sandbar along the right bank in isolation of flow.



Photograph 5. Water level when the diversion berm in Reach 1 at Dale Road was pulled. Raised water inundated the isolation berms (red arrow). Excavators halted work until levels dropped.



Photograph 6. Looking upstream at the excavated sandbar and access along the left bank (see Photograph 1). Grass is growing, berms are breached and the site is stable.



Photograph 7. Looking up at the second access road along the left bank of Lower Reach 1 upon completion of work. The access has been seeded and both straw and silage applied. September 13, 2005.



Photograph 8. Looking downstream from Farms Road Bridge. At the right bank excavation (Photographs 3 and 4). Berms are breached and grass is growing on the banks.



Photograph 1. Looking downstream at Reach 1 from Dale Road bridge prior to works.



Photograph 2. Looking downstream at the opening along the left bank at 60m downstream of Dale Road bridge prior to spoil placement.



Photograph 3. Sandbags wrapped in a poly liner as well as substrate were used to divert water to the excavated right bank diversion channel. September 6, 2005.



Photograph 4. A substrate berm was placed directly upstream of the diversion outlet effectively isolating the 300m excavation area. Pumps were not needed in the isolated excavation area.



Photograph 5. Excavators worked in tandem in isolation of flow to hoe chuck material to openings in the riparian zone (material placed in the foreground is located at the opening in Photograph 2).



Photograph 6. Megasecure was used in two locations in Reach 1 to enable extraction of sandbars on the left bank in isolation of flow.



Photograph 7. The Megasecure failed to isolate flow at the first location (water undermined substrate under the Megasecure). Excavation was almost complete when the failure occurred.



Photograph 8. The Megasecure also failed to isolate flow at the second location. Again, the excavation was almost complete when the failure occurred.



Photograph 9. Once excavation works were completed, the dam was breached and the diversion channel filled in. The dam breach caused isolation areas in Reach 1 at Farms Road to fail.



Photograph 10. View of temporary spoil pile placed on the access road on the west side of Lagace Creek.



Photograph 11. Looking west at the diversion dam location after the site has been seeded, covered with straw and vegetation replaced at the top of the bank.



Photograph 12. View upstream at Reach 1 at the completion of work. The opening in the background has been seeded and covered with straw. It is the same opening as in Photographs 2 and 5.



Photograph 13. Looking at the right bank at an opening used to spoil material onto the eastern access road. Riparian vegetation was salvaged and replaced.



Photograph 14. View of temporary spoil piles on the east side of Lagace Creek. The piles are located behind a small riparian buffer (3 to 5m). Spoil should be removed as soon as possible.



Photograph 15. Looking at the diversion location. Grass seed has taken and no erosion was evident. Beavers had cut some of the planted vegetation and one tree did not survive



Photograph 16. View downstream of Dale Road bridge. An elevated mid channel bar is forming.



Photograph 1. Looking downstream at the elevated left bank sandbar at Schroots corner prior to excavation. July, 2005.



Photograph 3. Excavating a right bank sandbar between Schroots corner and the diversion using the Megasecure and berms to divert flow.



Photograph 2. The left bank sandbar at Schroots corner being excavated in isolation of flow.



Photograph 4. The Bouchier Creek channel required excavating prior to flow diversion from Lagace Creek. The channel had filled in and blocked a culvert due to a debris torrent.



Photograph 5. Sandbags wrapped in a poly liner were used to divert water to the excavated right bank diversion channel. Some substrate was also used on the upstream side to ensure a proper seal.



Photograph 6. Reduced flow was maintained throughout the excavation, as salvage operations were occurring concurrently directly upstream of the excavation operations.



Photograph 7. Once isolated, excavation between 302 and 460m from Schroots Corner took place by scalping isolated bars. Bars were only scalped to approximately 0.45m to encourage fall spawning.



Photograph 8. As few open spaces were evident between 302 and 460m, open areas were well marked for spoil placement.



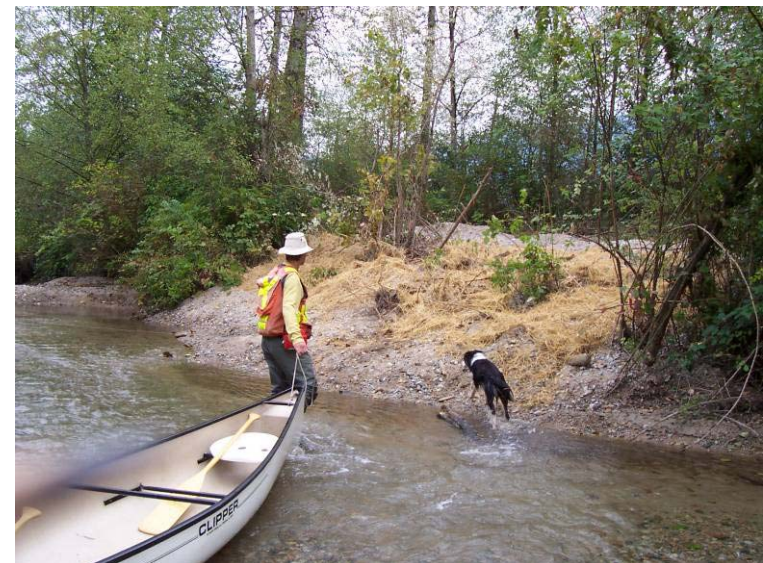
Photograph 9. A substrate berm was constructed approximately 300m upstream from the outlet of the diversion. Silt laden water was periodically pumped into the adjacent forest (red arrow).



Photograph 10. On August 29, a summer rain event overtopped the berm (as was planned to prevent flooding in the diversion channel) and blew out fish fences.



Photograph 11. Looking upstream at the diversion area after the berm and culvert have been removed. The site is stable, seeded and covered with straw.



Photograph 12. Looking at a properly mitigated spoil site. Banks are shallow, vegetation has been replaced and banks seeded and covered with straw.



Photograph 13. In a few places, excavator operators placed spoil against newly excavated over steepened banks as they thought it would reduce the grade. During high flow events, this spoil will likely erode.



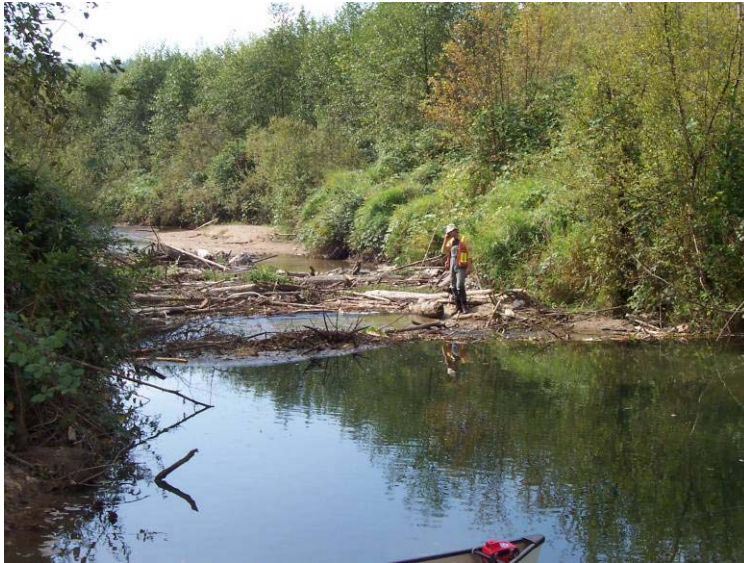
Photograph 14. View of temporary spoil piles along the left bank. A bench was created to separate the spoil from the sloped river bank (straw covered area).



Photograph 15. Looking at spoil piles along the right bank that are inaccessible. Spoil was placed in open spaces, but girdled alder trees. The trees should survive as they will grow advantageous roots.



Photograph 16. Temporary spoil piles have been placed above the top of bank (red arrow) and some vegetation replaced, however, sloughing may occur on this site due to exposed steep banks.



Photograph 17. A log jam at 1,500m from Schroots Corner was left in place, as it provided good cover habitat.



Photograph 18. The centre channel gravel bar between 688 and 770m as identified in the habitat mitigation plan was flagged and left undisturbed.



Photograph 19. The left bank sandbar at Schroots corner with berms breached at completion of works. Temporary spoil piles have been removed.



Photograph 20. Looking at riffle habitat after excavation (Photograph 7). Chum were observed spawning in scalped bars.



Photograph 21. Looking downstream at the diversion area after the berm and culvert have been removed. Grass seed has taken and the banks are stable.



Photograph 22. The Bouchier Creek channel after removal of material from the debris torrent.



Photograph 1. Looking downstream at the Anderson site prior to work. July 2005.



Photograph 3. Placement of the bridge at Andersons site to access the bar.



Photograph 2. Looking downstream from Seux Road Bridge prior to work. July 2005.



Photograph 4. Woody debris was removed from the bar prior to excavation. Unbeknownst to the on site monitors, anchored in large woody debris was also removed.



Photograph 5. All flow was directed at to the left bank by berming the intake of small seepage channels to the right bank



Photograph 7. Looking downstream at the Anderson site after all flow has been diverted to the left bank. The braided channels are dry.



Photograph 6. The left bank channel was deepened in spots to direct water away from the right bank. This caused sediment plumes for up to 45 minutes in duration.



Photograph 8. Once water had been diverted to the left bank a deep channel was excavated along the right bank. Rock weirs were placed to settle out sediment laden water.



Photograph 9. Upstream of the Anderson property, channel diversions successfully isolated the work area.



Photograph 11. Removal of the vegetated bar in isolation of flow.



Photograph 10. View of 38 by 5m vegetated bar that was removed in order to direct flows away from the eroding right bank near Farms Road bridge



Photograph 12. Excavation in isolation of flow.



Photograph 13. Rain event on August 29.



Photograph 15. At approximately 2/3 of the way upstream to the temporary bridge crossing, excavation was almost in the “dry” (little flow seeping into the excavation site).



Photograph 14. Hydraulic leak on gravel bar at the Anderson site on August 25, 2005.



Photograph 16. Looking downstream from Seux Road Bridge at completion of the work. September 14, 2005



Photograph 17. Access road from Seux Road along the left bank. September 14, 2005



Photograph 19. Looking upstream from Farms Road bridge after excavation was complete. September 14, 2005



Photograph 18. Looking downstream towards Farms Road Bridge from the Anderson site after excavation was complete.



Photograph 20. View of excavation spoil pile on Anderson's property.



Photograph 1. Looking downstream at Reach 5 from Sylvester Road bridge prior to flood protection works.



Photograph 3. Looking at riparian habitat of the overgrown access road along the right bank used for hauling gravel.



Photograph 2. Looking west at young alders prior to removal along the dyke which was used to access to the upper portion of Reach 6 along the left bank.



Photograph 4. Looking downstream at Reach 5 from Sylvester Road bridge at the inception of recontouring and bank stabilization in isolation of flow.



Photograph 5. A small bulldozer was used to grade the gravel bar to allow access for a D8. The D8 forded the channel several times to access and prep the upper portion of Reach 6.



Photograph 7. In order to work in the dry, all flow in Reach 5 was diverted to an excavated channel along the right bank. Flow was diverted away from the right bank near the bridge to conduct right bank stabilization work.



Photograph 6. A small hydraulic leak occurred when preparing the left bank haul road. All oil was contained.



Photograph 8. In order to work in the dry, all flow in Reach 6 was diverted to an excavated channel along the left bank.



Photograph 9. View of the completed haul road. Cleared vegetation to the west (red arrow) was outside the 30m setback and was used to store gravel



Photograph 11. During gravel excavation and recontouring, water seeped into the isolation site. Water was directed into a shallow swale.



Photograph 10. View of completed diversion channel along the left bank of Reach 6.



Photograph 12. Water from the shallow swale entered a sediment trap and was pumped out using a 3" pump.



Photograph 13. A series of sediment traps were excavated to settle out seepage water in the excavation site within Reach 5.



Photograph 15. A berm was constructed to separate Pattison Creek from the right bank haul road on Reach 6. The road was roughened up an alder seed mix applied.



Photograph 14. The haul road along the left bank was decompacted and an alder seed mix applied. Compacted gravel to the left of the photograph will be removed by the landowner. September 14, 2005.



Photograph 16. View of Reach 5 access at completion of work. The access has been seeded.



Photograph 17. View of Reach 5 from Sylvester Road bridge in October, 2005.



Photograph 18. View of Reach 6 in October from the upstream end of the flood protection works.

Attachment 3. Benthic Invertebrate Results Taken Within Reach 1 at Dale Road Bridge

Treatment	Date	Site	Sample #	O. Plecoptera (ny)	F. Chloroperlidae (ny)	O. Trichoptera (L)	O. Diptera (I)	F. Chironomidae (L)	F. Dixidae (L)	F. Empididae (L)	F. Tipulidae (L)	O. Acarina	Bivalvia	S-C. Oligochaeta	Zooplankton	Hirudinea
Reach 1	3-Sep-05	Lagace	1			1		4			39		3	2	1	
Reach 1	3-Sep-05	Lagace	2								20	3	4			
Reach 1	3-Sep-05	Lagace	3					15			39		2	4	1	1
Reach 1	3-Sep-05	Lagace	4		1			4	1		69	1		2		
Reach 1	3-Sep-05	Lagace	5					8		1	16					

APPENDIX C

**SRS – Fish Salvage Report for Lagace/Pattison Creek for
Flood Protection Work Fraser Valley Regional District, B.C.**

SCOTT RESOURCE SERVICES INC.
Environmental Consultants
31856 Silverdale Avenue, Mission, BC V2V 2K9
Tel: (604) 820-1415 Fax: (604) 820-1621
Email: scottres@telus.net



FAX COVER SHEET

Date: October 6, 2005

DFO File: 05.143
MWLAP File: SU0512076
Our File: 508.02

Please deliver the following message:

TO: Yvonne Shiratti Fisheries and Oceans Canada Iain Lunn Ministry of Water, Land, and Air Protection

FAX NO: (604) 666-7112 (604) 930-7119

SUBJECT: Fish Salvage Report for Lagace/Pattison Creek for Flood Protection Work
Fraser Valley Regional District, B.C.

COMMENTS:

Project Location: Lagace/Pattison Creek Fraser Valley Regional District, B.C.
(Figure 1)

Permit: **DFO: 05.143**
MWLAP: SU0512076 (Report number – 050714-508.02)

Project Description: Exclusion fencing was utilized where necessary. Fish Salvages were conducted using a combination of minnow traps, seine nets and electroshocking.

Collection Team Supervisors: Andrew Walter, Walter Silver, Mike Umbrite

Salvage Information

Reach 1

Dates: September 6 and 8, 2005

Location: Lagace Creek directly downstream of Dale Road Bridge

Method: Seine Nets/Electroshocking

Approximate Length (m): 400m

Electroshocker Settings: I-5 300V

Electroshocker Seconds: 8,627

Minnow Trap Effort: N/A

Fish Totals: CO 300; RB 13; CT 26; SC 14

Comments: Habitat was limited in this reach (primarily glides with sand substrate, little cover or complexity). Large cutthroat trout were salvaged (up to 40cm). It is suspected that at least a portion of the fish salvaged (e.g. the large cutthroat) were likely migrating to the upper reaches after being salvaged and placed downstream of the Reach 1 salvage location. Seine nets were used in conjunction with electroshocking to encourage fish out of the work area.

Reach 2

Dates: August 23, 25, 26, 29, 30, 31/2005, September 1, 2/2005

Location: Dale Road upstream to Schroots Property

Method: Minnow Traps/Seine Nets/Electroshocking

Approximate Length (m): 1,200

Electroshocker Settings: I-5 300V, I-5 400V

Electroshocker Seconds: 57,234

Minnow Trap Effort: 48 Trapping Days

Fish Totals: CO 4,734; RB 90; CT 36; SC 405; STB 5; LAMP 4

Comments: Reach 2 was more complex than Reach 1 (primarily riffle/glide with a substrate predominately gravel with good riparian cover). Large cutthroat and rainbow trout were salvaged (up to 40cm) out of undercut banks and small woody debris jams that were found throughout the reach. To reduce the impact on all fish we strategically placed seine nets in areas where we could effectively beach seine. We then coaxed fish out of areas that were difficult to salvage using electroshockers into our seine nets. In an effort to further reduce stress on captured fish due to the distance between the reach being salvaged and our release location, we made regular trips throughout each day to release captured fish.

Reach 3

Dates: August 9, 10-13, 15-20, 23, 24 / 2005

Location: Farms Road Bridge upstream to Suex Road Bridge

Method: Traps/Seine Nets/Electroshocking

Approximate Length (m): 700m

Electroshocker Settings: I-5 300V, I-5 400V, J-5 300V

Electroshocker Seconds: 65,773

Minnow Trap Effort: 150 Trapping Days

Fish Totals: CO 4,272; RB 338; CT 13; SC 1,857; STB 2; LAMP 10

Comments: Reach 3 contained a large amount of fluvial deposition (primarily gravel/cobble substrate with fast flowing runs and riffles) causing Lagace Creek to braid into multiple channels throughout. A large number of Coho were caught in well covered deep pools found along the edge of banks (associated with both Large and Small Woody Debris). Minnow trapping and the use of seine nets (as we did in Reach 2) were effective salvage techniques. A large amount of detritus was consistently moving downstream which in turn clogged up our fish fencing. We had to constantly clean and maintain these fences to keep the area isolated.

Reach 5/6

Dates: August 17-20, 22, 24/ 2005, September 1, 6/ 2005

Location: Pattison Creek Confluence to above Sylvester Rd Bridge

Method: Electroshocking

Approximate Length (m): 720m

Electroshocker Settings: I-5 300V, I-5 400V

Electroshocker Seconds: 42,181

Minnow Trap Effort: N/A

Fish Totals: CO 37; RB 570; CT 0; SC 417; STB 0; LAMP 0

Comments: Reach 5/6 on average had a much steeper gradient (substrate consisting primarily of cobble and boulders) than any of the previous reaches. Many shallow step pools were found throughout the reach. Large numbers of rainbow trout and very few coho were captured and removed from the work area. Electroshocking was the only effective technique to use due to the cobble substrate and lack of deep pool habitat to place minnow traps.

Effort Calculations:

Electroshocker Seconds: 173,815

Minnow Trap Effort: 198 trapping days

Total Fish Salvaged:

Coho	CT	RB	STB	SC	LAMP
9,343	62	1,011	7	2,693	14

Note: CT=Cutthroat trout (*Onhcorhynchus clarki*); CO=coho salmon (*O. kisutch*); PNK=Pink Salmon (*O. gorbuscha*); CHM=Chum (*O. keta*); SKY=Sockeye (*O. nerka*); RB=Rainbow Trout (*Onhcorhynchus mykiss*); SM=Dolly Varden/bull trout (*Salvelinus* spp.); AMPH= amphibian spp.; UIM=Ciprinidae spp.; CRAY=crayfish spp.; CHB=Peamouth Chub (*Mylocheilus caurinus*); STB=stickleback (*Gasterosteus* spp.); LAMP=River Lamprey (*Lampetra ayresi*); SC=Cottus spp.; SQW=Squawfish (*Ptchocheilus oregonensis*); CRPY=Black Crappie (*Pomoxis* spp.); PMK SEED=Pumpkin Seed (*Lepomis gibbosus*); OTHER=Unidentified spp.

To limit the amount of handling, all species were counted rapidly and identification to species level should not be considered 100% accurate. All fish were released safely either downstream or upstream of work areas. Please call me at 604-820-1415 if you have any further questions or comments.

Sincerely,

SCOTT RESOURCE SERVICES INC.

Mike Umbrite, *Dip. Tech.*
Project Supervisor

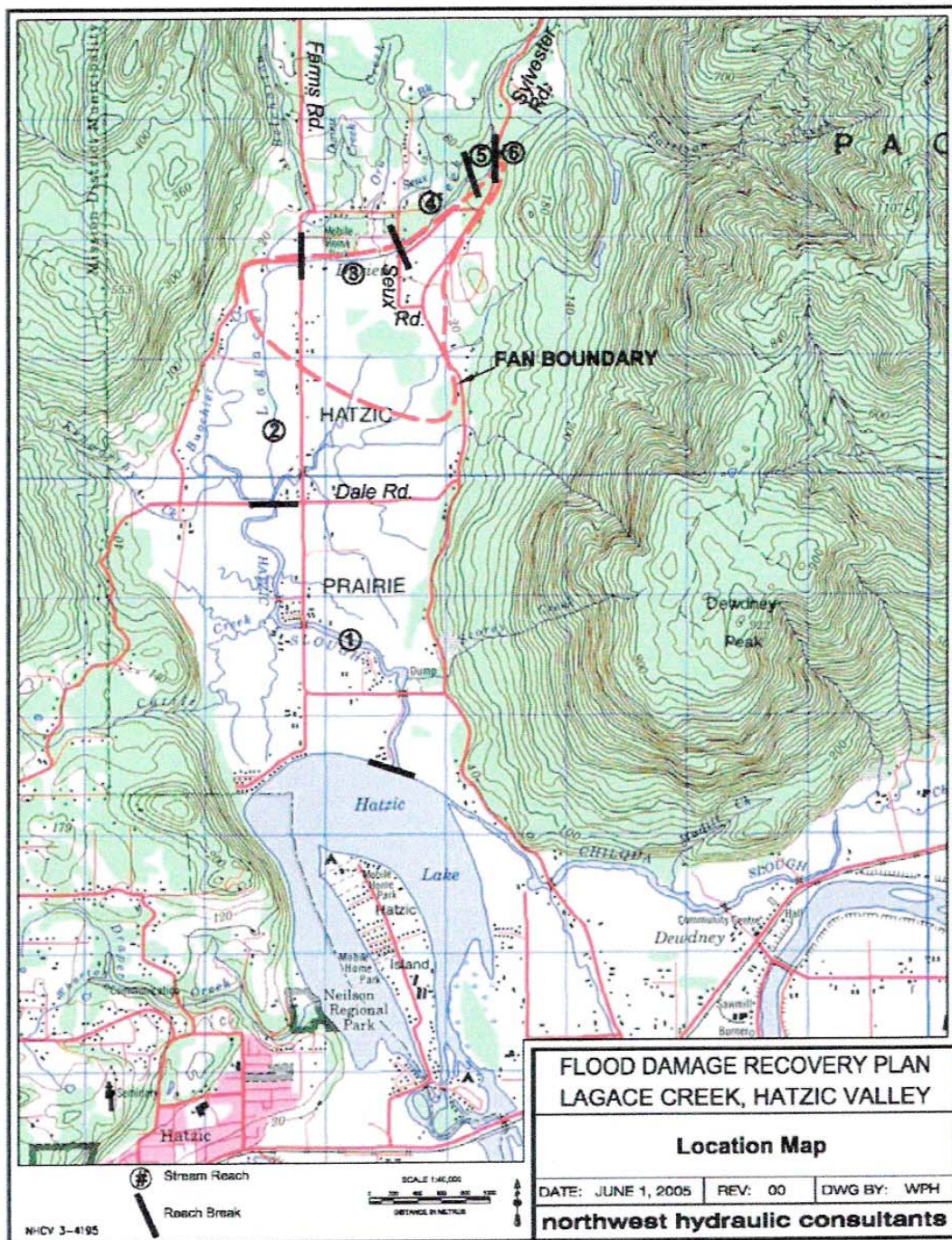


Figure 1. Study area location map of Hatzic Valley.

FIGURE 1