

## **PROPONENT ACTION PLAN FOR SHELLEY TOWNSITE BANK STABILIZATION**

### **Need for the Project:**

In late 2006 an ice jam formed in the Fraser River near the community of Shelley, which is located on river left approximately 22 kilometres upstream from the Nechako River confluence. The ice jam formed between the right bank and a mid-channel sand bar, which translated into extensive scour on the left bank affecting at least seven properties (Figure 1). Over a matter of days the estimated bank loss was 5 m deep x 30 m long x 8 m high. In 2007 the Province responded to the situation by contributing funds from the Urgent Flood Mitigation Fund to riprap armour 80 m of the most impacted bank section.

Since the 2007 works only treated the most highly affected riverbank section, further effort is still needed to protect the remaining properties downstream over a linear distance of 298 m (Figure 1). In some cases, outbuildings within metres of the current slope edge are at risk. On behalf of the community of Shelley, the Regional District of Fraser-Fort George was successful in receiving funding from the Provincial Flood Protection Program to fund 90% of the estimated project cost. The remaining 10% will be funded locally by the residents.

### **Work Plan Objective Statement:**

The primary objective is to stabilize 298 m of eroding bank adjacent to residential property by placing approximately 9,300 m<sup>3</sup> of riprap materials along the affected left banks section of the Fraser River. This will prevent further unravelling of the bank, and abate the continued loss of residential property and risk to infrastructure.

Secondary objectives of the project include:

- Minimizing the footprint of disturbance at the site;
- Preventing the introduction or mobilization of sediment to downstream habitats;
- Enhancing fish habitats; and
- Restoring and enhancing riparian vegetation along the channel margin.

### **Alternatives to the Project:**

It is anticipated the “do nothing” alternative would result in continued loss of residential property and risk to infrastructure which is not acceptable to the residents.

Another alternative would be creating a retaining wall near the toe of the slope beyond the high water mark using materials such as sheet piling, lock blocks or timber cribbing. This process may be susceptible to future undercutting and erosion by the Fraser River.

Also, a retaining wall would result in a smooth, relatively featureless channel margin that provides no habitat potential, as opposed to interstitial space habitat offered by riprap. Overall, riprap was considered the most efficient method to minimize the risk of continued bank failure in this section, with the highest potential for positive environmental impacts.



**Figure 1.** Overview map of project area (1:50,000 scale).

## Watershed Information:

<b>Site UTM:</b>	10U 524243E 5983659N
<b>Lat./Long.</b>	54° 00' 02" N 122° 37' 48" W
<b>Watershed:</b>	Fraser River
<b>Stream Name/Watershed Code:</b>	Fraser River / 100
<b>Stream Order/Tributary Status:</b>	9th order tributary to Pacific Ocean
<b>Average Channel Width:</b>	249 m at the project location
<b>Stream Class:</b>	S1
<b>Stream Gradient:</b>	approximately 0.5 %
<b>Streambed Substrates:</b>	20% sand/silt, 50% gravels, 30% cobbles
<b>Streambank Substrates:</b>	sand silt with a trace of gravel
<b>Riparian Vegetation:</b>	grasses/herbs (10%), shrubs (30%), and trees (60%)
<b>Fish Sampling Summary:</b>	Not sampled for this assessment.
<b>Fish Habitat Values:</b>	<b>Rearing:</b> low value for juvenile salmonids, moderate value adult rearing habitat <b>Spawning:</b> poor to low value for spring spawners; none to poor value for fall spawners <b>Overwintering:</b> none to poor value for juvenile or adult salmonids

## Existing Fisheries Information

Existing fisheries information is available for the Fraser River in the provincial on-line database. Upper Fraser River species include: bull trout (*Salvelinus confluentus*), burbot (*Lota lota*), chinook salmon (*Oncorhynchus tshawytscha*), lake chub (*Couesius plumbeus*), largescale sucker (*Catostomus macrocheilus*), longnose dace (*Rhinichthys cataractae*), longnose sucker (*Catostomus catostomus*), mountain whitefish (*Prosopium williamsoni*), northern pikeminnow (*Ptychocheilus oregonensis*), peamouth chub (*Mylocheilus caurinus*), pygmy whitefish (*Prosopium coulterii*), rainbow trout (*O. mykiss*), redbreast shiner (*Richardsonius balteatus*), slimy sculpin (*Cottus cognatus*), sockeye salmon (*O. nerka*), and white sturgeon (*Acipenser transmontanus*) (DFO 2009).

The channel margin at this site contains sand, gravels, and cobbles (Plates 1 to 4). At low winter flows the footprint area of the revetment is expected to be dry or, if wetted, the water would be so shallow it would typically freeze to the bottom. At higher water levels, this area provides minimal cover due to the lack of boulders, large woody debris or undercut banks. The channel margin habitat may be utilized by sculpins and juvenile salmonid species but this type of habitat is not limiting along this section of river.

Although woody riparian vegetation does exist along the majority of the project area, it is generally limited to a single band of trees and/or shrubs at the edge of the residential properties. A thicker band existed historically, but it has been significantly reduced as property loss has progressed, including the loss of some mature trees. In general, the existing riparian vegetation provides low potential for large woody debris (LWD) contribution, moderate amounts of small organic debris (SOD; e.g. leaf litter, twigs,

falling insects), low to moderate shading value, moderate to high surface sediment filtering, and low bank and channel stability.

### **Major Construction Activities:**

The primary elements of construction would include:

- Mobilizing equipment and materials to the site;
- Placing riprap on the channel bank; and
- Remediating the site to ensure it is appropriately revegetated and left in a stable and non-erosive condition.

### **Environmentally Sensitive Features:**

No rare, unique or particularly sensitive ecosystems, plant species, wildlife habitats or habitat features have been observed within or immediately adjacent to the construction area. Environmentally sensitive features at the site include:

- The eroding bank is over-steepened and contains a significant proportion of fine sediment;
- Fish habitat is present within the Fraser River adjacent to the site;
- Depending on water levels, fish may be along the channel margin within the work area at the time of construction (not expected);
- Some riparian vegetation may be disturbed at access points adjacent to the work site. Wherever possible, unvegetated access points will be utilized and winter construction will minimize damage to root structures.

### **Construction Techniques and Methods:**

#### *Site Access and Staging*

At low flow, a dry gravel bar exists at the toe-of-slope throughout the project area that is sufficiently wide to allow an excavator to walk along the channel margin. These conditions will exist when the project is scheduled for completion in early 2010 (January/February). Since a minor amount of bank slope recontouring may be required to facilitate excavator access to this dry gravel bar, it is anticipated that only one access point will be utilized (likely at the downstream end of the project area).

Since the project area is several hundred metres long, it will be important to stage rock as close to the excavator as possible to maximize efficiency. Rock truck access to the slope bottom is not feasible since extensive bank disturbance and construction effort would be required. As such, each property owner was asked to identify one access point on their property that a rock truck could use to stage material. Access points should have minimal existing riparian vegetation, and the winter construction timing minimize or avoid disturbance to property soils and vegetation root structures.

### *Revetment Construction*

As detailed in the engineered drawings (Appendix B), the grade stabilization works will involve placement of approximately 9,300 m<sup>3</sup> of riprap materials along a 298 m long section of the left bank of the Fraser River in order to establish a 2.0 m thick blanket of protective rock armour at the base, tapering to 1.2 m at the upper slope.

Construction is expected to progress from upstream to downstream. At the upstream end, it will be important to tie in to the existing revetment that was placed in 2007 (Plate 5). This will include filter cloth overlay, and may require some redistribution of the existing material. Prior to placing the rock, existing materials such as snow, ice, fallen trees, loose stumps and roots will be removed to minimize the risk the revetment could unravel when these features melt or decay. A layer of geotextile will underlie the riprap. The engineer-specified rock mixture will include a significant proportion of large material with 50% over 800 mm and 15% over 1100 mm.

At the downstream end, the revetment will be keyed into the bank at the edge of Spectra's right-of-way (ROW), approximately 25 m upstream of where some previous armouring had been done (Plate 6). Since this previous rock work is now unravelling and offers minimal protection to the bank, the design objective for the downstream end of the new revetment is to blend into the bank to minimize downstream effects to Spectra's ROW.

### *Site Remediation*

Following construction, topsoil will be placed overtop of the riprap above the high water line. Topsoil may be taken from wasted excavation material taken from the upper slope, with local seed banks intact. Disturbed soil will be seeded with an erosion control seed mixture, and covered with straw mulch. Planting of shrubs and/or trees will occur to mitigate for any woody vegetation that is lost, and additional planting opportunities may also be undertaken to further improve the status of the riparian zone in this area. The riparian zone in the work area is currently underdeveloped, and any supplemental planting may be considered to be a net habitat improvement.

### **Potential Fish and Fish Habitat Impacts:**

The potential effects of the proposed works on fish and fish habitat include:

- Introduction or mobilization of sediment, fuel or hydraulic fluids into the watercourse during construction;
- The alteration of 298 m of channel margin habitat;
- Physical injury to fish; and
- The enhancement of fish habitats through the conversion of low value habitats (*i.e.* outside bank lacking cover) to high value eddy habitats with cover in the form of interstitial spaces between boulders (see Mitigation Techniques section below for discussion).

In summarizing the overall effects of riprap projects on fish and fish habitat, Quigley and Harper (2004<sup>1</sup>) indicate that some projects are perceived to have localized negative effects while others can have positive effects (Table 1). Negative effects were typically associated with locations where riprap had replaced natural, vegetated banks, since studies have shown that these conditions are more heavily utilized by fish than riprap structures. Positive effects were associated with previously disturbed locations with limited existing cover, since the riprap material provided an increase to habitat complexity.

**Table 1.** Project associated relevance of the positive and negative riprap effects listed by Quigley and Harper (2004).

Positive Effects	Relevance to this project	Negative Effects	Relevance to this project
reduce sediment inputs	high	reduced allochthonous input due to riparian loss	low
increased cover from interstitial spaces	high	reduced LWD recruitment	low
deep pool creation due to scour along the armoured bank	moderate	reduced shade	low
improved fish passage along armoured bank	low	decreased habitat diversity	none
		loss of inchannel habitat	low
		loss of gravel recruitment	low
		channelization transferring hydrologic impacts downstream	low
		scouring spawning substrate	low
		loss of pool/riffle sequences	low
		attenuating natural meanders	high
		loss of high-water floodplain refuge	low
lost access to off-channel rearing habitat	low		

Given the adjacent landuse to the project area is residential property, it is inherent that some level of vegetation clearing would occur up to a designated riparian buffer. As such, a finite amount of channel migration could progress before the natural riparian buffer would eventually be lost unless mitigative actions are taken. By overlaying the lot boundaries identified in the digital cadastral layer onto a recent orthophoto, it appears that up to 37 m of property has been lost due to channel migration (Figure 2).

Due to the steep, unstable nature of the river bank slope within the project location, trees and tall shrubby vegetation are not present, and they are progressively being depleted from the slope crest as erosion progresses, to the point where only a single band of trees now exists (if any). When present, vegetation on the bank slope is limited to the upper 3 m, and consists of low level shrubs and herbaceous species that provide limited or no direct fish habitat benefits (*i.e.* in the form of overhanging cover). As such, conditions at the project location would most accurately represent the ‘disturbed’ condition, and

<sup>1</sup> Quigley, J.T. and D.J. Harper. 2004. Streambank protection with rip-rap: an evaluation of the effects on fish and fish habitat. Can. Manuscr. Rep. Fish. Aquat. Sci. 2701: xiv + 76 p.

revetment construction should be viewed as predominately positive from a fish and fish habitat perspective.



**Figure 2.** Sketch plan of the proposed project area (1:2,300 scale).

During construction, disturbance to riparian vegetation will be limited to the low value vegetation on the upper slope, and it is anticipated the cumulative impact will be equivalent to approximately 447 m<sup>2</sup> of a fully stocked shrub community. No trees are

expected to be removed from the slope crest unless they are deemed to be a safety hazard during construction.

Attenuating the natural meandering process of the river at the project location was the only negative consideration identified as highly relevant to the proposed works. However, as previously described, it was inherent that a finite amount of channel migration could ever occur at this location once residential landuse was allowed to proceed by the various levels of government who would have contributed to that decision (*i.e.* federal, provincial, and local).

With respect to potential downstream effects, this section of channel margin is located mid-way along a gentle outside bend of the river. The armouring of the bend will halt the migration of the river in a southeast direction, and will possibly anchor the position of the river at this location. The engineer designed the downstream end of the revetment to blend into an unarmoured bank section to minimize the backeddy effect that could otherwise accentuate the risk to Spectra's ROW immediately downstream.

### **Mitigation Techniques:**

In general, the design of the works, construction approach, and disturbance footprint have all been considered in the context of mitigating potential environmental impacts. In particular, the overall objectives in designing and planning the proposed works is to minimize environmental effects to the greatest extent possible while addressing an immediate problem associated with residential property and infrastructure loss.

The excavator to be used should be in good working order and a thorough inspection should be conducted to ensure there are no fluid leaks or excess grease prior to delivery to the site. The environmental monitor will inspect the machine on site to ensure it is clean and free of excess grease or leaks. The excavator operator would be requested to inspect the condition of hydraulic lines and comment on the condition of the machine. A spill kit should be on site prior to the start of works.

To mitigate the potential for sediment introduction into the river, clean rock materials should be used and individually placed with an excavator. Construction timing during the winter months should minimize or avoid disturbance to the surface soils and protect the root structure of riparian vegetation. Access points should occur where little or no vegetation currently exists along the slope crest, and if disturbance to vegetation is unavoidable, stems should be brushed with a saw close to the ground to minimize the risk of desiccation and protect the root structure. It is not anticipated that any mature trees would be disturbed unless they are deemed to pose a safety risk to the construction crew. This determination should be made by an individual certified as a Wildlife/Danger Tree Assessor.

To mitigate for the estimated 447 m<sup>2</sup> of low level shrub loss along the unstable upper slope, an equivalent amount or greater will be planted along the riprap bench at the slope

crest, which will be covered with topsoil. Since positive responses have been received by the landowners with regard to revegetation, additional planting opportunities may exist that could result in a net gain of riparian vegetation at the site.

The winter construction timing will also coincide with low flows, which should allow the entire revetment to be constructed in the dry, thus avoiding the small risk that physical injury to fish could occur.

In order to avoid the perception of a harmful alteration, disruption or destruction of fish habitat (HADD), mitigation measures were incorporated into the engineered plans for the revetment. These considerations were in line with recommendations outlined by Kochlie and Neville (2004<sup>2</sup>) including:

- Size of riprap
  - Evidence suggests that larger riprap is generally more beneficial to rearing juvenile salmonids because interstitial spaces are maximized. Specifically, material with a mean diameter over 300 mm is recommended. Rock gradations specified in the engineered plans for this project call for 85% of the material to be greater than 350 mm, 50% to be >800 mm, and 15% to be >1100 mm. The very large boulders (>1 m diameter) will be embedded into the revetment such that they protrude by up to 40%. These boulders will be placed throughout all elevations of the revetment, will have a maximum spacing of 4 m, and will provide extra surface roughness that will provide eddy habitat to fish at various flow levels.
- Angularity of riprap
  - Angular rocks have been shown to maximize revetment stability and provide crevice habitat for rearing fish. Angular rocks will be used to construct the revetment for this project.
- Scalloping of riprap
  - By implementing a scallop design to the revetment, a series of small embayments will be created that will provide low velocity eddies and shear zones that will be particularly valuable at moderate to high flows. Over the length of the revetment there are 10 main scallops, with an average embayment width of 12 m and depth of 2 m. This would result in approximately 240 m<sup>2</sup> of eddy habitat being created where previously there was none.
- Slope of riprap
  - Although the influence of revetment slope angle has not been directly related to effects on fish, a maximum angle of 3:1 is current best management practice. The maximum slope angle for this project will be less than 1.5:1.

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<sup>2</sup> Kochlie, D.A. and J.I. Neville. 2004. Literature review on the effects of rip-rap on fish and fish habitat with habitat management implications. *In* Streambank protection with rip-rap: an evaluation of the effects on fish and fish habitat. Edited by J.T. Quigley and D.J. Harper. Can. Manuscr. Rep. Fish. Aquat. Sci. 2701: xiv + 76 p.

By incorporating the mitigation recommendations suggested by Kochlie and Neville (2004), the project site should provide a suitable amount of habitat improvement to avoid the perception of a HADD.

### **Contingency Plans:**

As the proposed activities involve works along a stream bank, it is suggested that a suitably qualified and experienced environmental monitor be onsite for a tailgate meeting with the contractor prior to construction start-up, and that daily visits occur throughout the duration of the project. The EM should be prepared to implement erosion and sediment control measures as necessary, however this would require having appropriate materials available on-site, which should include, but not be limited to:

- 2 rolls of silt fencing;
- Hay bales (10-12);
- 1 bag erosion control seed mixture; and
- 1 roll of heavy gauge polyethylene plastic.

### **Permitting/Approvals:**

Where there is significant risk of potential impacts to fish and fish habitat, the Department of Fisheries and Oceans (DFO) usually takes the lead in the review and approval of the application. Where it is determined that there will be no harmful alteration, disruption or destruction (HADD) of fish habitat, the Ministry of Environment (MOE) has currently been providing approvals based on the notification process.

The Water Act will permit the repair of existing bank protection works to be completed under the notification process but since this section of bank has not previously been armoured, a Section 9 approval for new bank protection works would be required from the Water Stewardship division of the MOE. As such an Approval request will be submitted to Front Counter BC in Prince George.

Since the completion of the proposed works is scheduled to occur during the winter of 2010 (January/February), a variance to operate outside the instream work window (July 15 to August 15 for spring and fall spawners) will be required from MOE. To issue a variance, the MOE require:

1. Justification for why the works could not be completed within the window;
2. Demonstration that there is sufficient means to fully mitigate the potential for the releases of sediment into fish habitats; and
3. Demonstration that fish passage to or from spawning areas will not be interrupted.

This project should be completed during the winter months when water levels are low, so that works can be completed in-the-dry. Also, winter construction will help to minimize

the risk of sediment and erosion control issues since the ground will be frozen and rainfall is not expected. Since the works will be conducted on a dry gravel bar along the channel margin (outside of the spawning window), spawning related fish movements will not be interrupted.

As described in the 'Potential Fish and Fish Habitat Impacts' section, this project should be viewed as having an overall positive effect on fish habitat when the existing site conditions are considered with respect to the criteria outlined by Quigley and Harper (2004). To ensure that no net loss to fish habitat results, the DFO typically requires revetment projects to incorporate some level of mitigation. One strategy that is suggested by Quigley and Harper (2004), and has been commonly accepted by the DFO as adequate for mitigation, is incorporating LWD into the revetment to provide overhead and scour pool cover. However, it must be recognized that no mitigative prescription can or should be universally applied to every project. With that in mind, the engineer for this project was not comfortable incorporating LWD into the revetment due to the potential effects of shore ice within the Fraser River that could compromise the revetment's structural integrity. The relatively short lifespan of wood, which is typically less than 10 years, is another downside to its application.

Since LWD was not a preferred solution for this particular project, the full range of alternatives suggested by Quigley and Harper (2004) were reviewed. Along with standard mitigation measures that are typically associated with any revetment concept (*i.e.* size and angularity of the riprap material and slope of the revetment), the scalloping concept was also adopted as a substitute for using LWD (see Mitigation section). In general, the project has been designed to mitigate harmful effects to fish and fish habitat and will likely result in net gains<sup>3</sup>. The habitat balance demonstrates that the footprint effects of a well designed revetment are self compensating, although it is possible the DFO may still wish to formally authorize the project under the Federal Fisheries Act due to the length of the proposed structure.

### **Environmental Monitoring Responsibilities:**

Proposed activities with associated environmental monitoring responsibilities include:

- Holding a tailgate meeting with the construction contractor prior to initiating any works;
- Delineating the limits of disturbance at the site;
- Inspecting the excavator to ensure it is clean and free of excess grease and fluid leaks;
- Recommending sediment and erosion control measures;

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<sup>3</sup> Approximately 298 m of low value, seasonally wetted channel margin habitat will be converted into ~315 m of moderate to high value channel margin habitat by incorporating the scalloped design. Also, the scalloped design pattern may create up to 240 m<sup>2</sup> of new eddy habitat and approximately 670 m<sup>2</sup> of boulder cover will be provided by large (>1 m) protruding rocks (*i.e.* 1 m<sup>2</sup> of eddy effect per rock x ~670 rocks) where no cover previously existed.

- Assisting with the construction and placement of compensation features (if necessary); and
- Seeding, mulching and directing revegetation (*i.e.* tree and shrub planting).

**Recommendations:**

Due to the sensitive nature of the works, it is recommended that a qualified environmental monitor is present on site for the duration of the works.

A brief post-construction report should be completed to provide as built specifications and photo-documentation, which can be used to monitor changes.

## **APPENDIX A.**

### **Photo Plates**



**Plate 1.** Upstream view from mid-project location showing the habitat conditions on August 31, 2009.



**Plate 2.** Downstream view from mid-project location showing the habitat conditions on August 31, 2009.



**Plate 3.** Upstream overview of the project area from the downstream end on August 31, 2009.



**Plate 4.** Downstream overview of the project area from the upstream end on August 31, 2009.



**Plate 5.** Upstream view showing the tie in point with the 2007 revetment project.



**Plate 6.** Downstream view showing remnants of previous riprap work within Spectra's ROW.

**APPENDIX B.**

**Engineered Drawings  
(located within the tender document)**



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## MEMORANDUM

**To:** Mr. Terry McEachen

**From:** Mark LeRuez – Triton Environmental Consultants Ltd.

**Date:** November 27, 2009

**File name:** WP#:P-2146

**Re:** Compensation/Monitoring Plan for Works along Shelley Townsite Riverbank

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Dear Mr. McEachen;

This memo is provided as a fish habitat compensation/monitoring plan for bank stabilization works to be conducted by the Regional District of Fraser-Fort George at the following location: between Lots 21 to 26, DL 810, PL 2231, Cariboo District.

As the Department of Fisheries and Oceans will be authorizing this project, they will require a fish habitat compensation and monitoring plans to address any fish habitat loss resulting from the project. This compensation plan will be submitted to the DFO for their review and they will decide if the compensation activities are adequate.

The goal of a compensation plan is to ensure your project does not result in a net loss of fish habitat. The total disturbance footprint of the riprap bank revetment below the high water mark is going to be approximately 2980 m<sup>2</sup> (10 m total average width by 298 m length). The habitat within the footprint of the revetment is only seasonally available since the entire area is in-the-dry during part of the year and provides no direct or indirect habitat value. Therefore, it is suggested the lower bench portion of the revetment design be used to calculate the instream habitat amount subject to compensation. This footprint area would be 1490 m<sup>2</sup> (5 m average lower bench width by 298 m length). In addition, disturbance to riparian vegetation will be limited to low value vegetation on the upper slope, and it is anticipated the cumulative impact will be equivalent to approximately 447 m<sup>2</sup> of a fully stocked shrub community. This would bring the total footprint amount to 1937 m<sup>2</sup>.

The Authorization will require habitat compensation to be provided at a ratio greater than the equivalent amount of habitat to be impacted. Depending on the relative value of the impacted habitat and the location of the proposed compensation (*i.e.* on-site versus off-site), compensation ratios typically range between 1.5:1 to 3:1. As outlined in the 'Potential Fish and Fish Habitat

Impacts' section of the Proponent Action Plan (PAP) dated November 5, 2009, habitat value at the project site is inherently low. Rationale presented in the PAP also demonstrates the project location would most accurately represent the 'disturbed' condition, and revetment construction should be viewed as predominately positive from a fish and fish habitat perspective, based on criteria presented in Quigley and Harper (2004<sup>1</sup>). Therefore, compensation should be accepted at the lower end of the compensation scale.

As per my discussions with Shane Smith at DFO on November 26, 2009, the revetment design considerations outlined in the PAP will offset its footprint area. Since positive responses have been received by the landowners with regard to some level of revegetation initiative adjacent to the revetment, we recommend the 'premium' component of the compensation requirement be provided through riparian planting. We propose a planting objective of 1490 m<sup>2</sup>, which would be equivalent to a 5 m vegetation strip along the project length and an overall compensation ratio of 1.5:1.

It is envisioned that a portion of the planting will be achieved along the riprap bench at the slope crest, which will be covered with topsoil. Pending discussion with the individual landowners, planting may extend further onto their properties beyond the revetment bench, although it is unlikely the entire 1490 m<sup>2</sup> can be achieved in this way. Any shortfall in the planting objective will be fulfilled through planting at another location(s) where a riparian deficit(s) exist.

Following discussion with Doug Dewar (Spectra Energy Transmission) on November 26, 2009, Spectra would be receptive to planting on a portion of their right-of-way (ROW) adjacent to the project. Since Spectra's ROW at this location has only a single strip of trees and shrubs adjacent to the river along a 300 m length, a plantable riparian strip that is at least 10 m wide exists within 15 m of the slope crest. That area would be sufficient to accommodate 100% of the planting objective for this project, while leaving sufficient area to be used for compensation by Spectra once they proceed with their bank armoring initiative (likely in 2012). The caveat would be that planting within the ROW in association with the Shelley Townsite project would not occur until after Spectra completes their bank stabilization works, since plants could be damaged by vehicle/equipment traffic during construction. Although a portion of the compensation requirement may be delayed until ~2012, the benefit would be that all compensation would occur very close to the Shelley Townsite project area.

All riparian planting should consist of native species planted within 15 m of the stream. If rooted stock is used, a planting density of at least one plant per square meter should be applied including trees spaced at 4 metre intervals. At least 25% of trees are to be coniferous. If soils are deemed unsuitable for vigorous plant growth, the soil will be appropriately treated prior to planting (*e.g.* scarification, fertilization, soil conditioning, or replacement, *etc.*). If you are going to plant live stakes, then 4 stems per m<sup>2</sup> is required to allow for decreased survivorship. Documenting the total stems planted is required in order to provide a means for DFO to monitor project success.

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<sup>1</sup> Quigley, J.T. and D.J. Harper. 2004. Streambank protection with rip-rap: an evaluation of the effects on fish and fish habitat. *Can. Manuscr. Rep. Fish. Aquat. Sci.* 2701: xiv + 76 p.

All disturbed soil (if any) should be hydroseeded with a mix suitable for the area. Companies in the area should recommend an appropriate mix. The hydroseed mix should include a tackifier to ensure it stays on the slope as well as fertilizer to help seeds germinate.

In addition to this compensation, a monitoring plan will be required for the Authorization. Typically this involves annual site visits over a 5 year period to document plant survivorship. Planting goals will be achieved if a density of one stem per square metre is maintained throughout the duration of the monitoring period. Based on the planting criteria previously specified, at least 1490 plants should exist within the treated area consisting of 1117 shrubs and 373 trees (at least 94 will be conifers). Starting one full growing season after planting, monitoring should occur at the end of the growing season, ideally between September 1 and October 1. Stems should be counted within at least 30% of the treated area, with proportion of species present recorded. Stems that emerge from the ground at least 2.5 cm from another plant of the same species will be considered to be a separate plant. A photo record of the treatment area should also be completed during each monitoring visit.

This memo will be forwarded to Shane Smith at DFO in Prince George for his review after you have had a chance to review it. Should you have any questions or require any additional information, please call (562-9155), fax (562-9135) or e-mail (MLeRuez@triton-env.com).

Yours truly,

**TRITON ENVIRONMENTAL CONSULTANTS LTD.**



Mark LeRuez, B.Sc.  
Biologist/Project Manager