Aquatic Impact Assessment:
Burnaby Lake Coal Derailment, Yale Subdivision
Mile 122.7

Final Work Plan

Prepared by:

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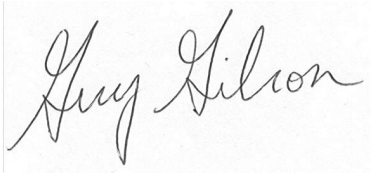

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1.0 Introduction

1.1 Background

A Canadian Pacific train derailment at Mile 122.7 on the Canadian National Railway Company ("CN") Yale Subdivision in Burnaby, British Columbia, occurred on January 11, 2014, and resulted in the partial release of metallurgical coal from three rail cars into, and adjacent to, Silver Creek. From the derailment site, Silver Creek flows approximately 350 m, before entering Burnaby Lake, 200 m upstream of Cariboo Dam and from Cariboo Dam, the Brunette River flows approximately 6 km before entering the Fraser River.

Coal Recovery. Following the derailment and subsequent spill, CN - in discussions with the regulatory agencies - opted to follow a 'precautionary principle' risk management approach, and simply remove the majority volume of the coal. This was deemed the preferred option, given the urgency expressed by the agencies and the general public, rather than the alternative – take time to assess the potential impact of the spill and weigh out whether or not a cleanup operation was necessary.

To support this coal recovery decision, CN developed a Coal Recovery Plan that was reviewed, and accepted, by the regulatory agencies. The works were also reviewed for all permitting requirements and potential impacts to the environment as a result of the clean-up activities. The permits were issued for the coal removal activities and grade stabilization works, and no additional impacts were identified. Based on these permits, CN was not required to conduct compensation or mitigation measures other than what had already been identified in the Coal Recovery Plan.

In order to implement the Coal Recovery Plan, CN retained Quantum Murray (Quantum) and Triton Environmental Consultants (Triton). Agency staff from the British Columbia Ministries of Environment (MOE), Forests, Lands and Natural Resource Operations (MFLNRO), Environment Canada, the City of Burnaby and Metro Vancouver, were - through daily work summaries - apprised of all details related to the various stages of the recovery work. The Coal Recovery program was completed on April 2, 2014, and a summary of the results of these efforts is currently being drafted. As part of the monitoring conducted during these works, CN also submitted a summary of the water quality monitoring program to Environment Canada, MFLNRO, the City of Burnaby and Metro Vancouver (CN, 2014a, b).

This Study. In order to evaluate any residual impacts from unrecoverable coal downstream of the main spill area[1], CN retained Borealis Environmental Consulting (Borealis) to develop, conduct and report on, an Aquatic Impact Assessment of receiving environments in Silver Creek and Burnaby Lake. A draft of this proposed work plan was developed and submitted for review on April 22, 2014, a meeting was held with agency staff on May 1, 2014 and a subsequent final draft was issued on May 9, 2014. Based on these drafts, the meeting, conference calls and written comments received, the work plan was refined and is presented below. This document serves as the "road map" to the assessment.

1.2 Rationale, Purpose and Objectives

Based on the characteristics of the spilled product (i.e., raw, clean, metallurgical coal), the focus of the Aquatic Impact Assessment will be on residual (i.e., post-coal recovery) impacts to sediments; a weight-of-evidence approach will be applied in order to consider any potential impacts of product components, and any potential toxicity to water- and sediment-based valued ecosystem components (e.g., fish, benthic invertebrates and aquatic plants), which themselves can also exert effects to upper trophic levels (e.g., amphibians, water birds, and fur-bearing riparian species).

As indicated above, a significant water quality monitoring effort conducted during the recovery program, has already been completed; results indicated that, overall, water quality parameters are within applicable water quality guidelines, with some minor exceptions that were not deemed to be spill-related (CN, 2014a, b). Based on these results, and the fact that any residual coal material is likely to have the greatest impact in sediments, this initial investigation and evaluation of the aquatic system – "Tier 1" – will focus on potential short- and long-term sediment impacts. Should the initial "Tier 1" investigation yield significant impacts (based on the weight-of-evidence), a subsequent "Tier 2" evaluation will be conducted, to understand the extent of indirect, higher trophic level impacts (see Section 3.0).

The purpose of this document is to outline the elements of a Work Plan to support an Aquatic Impact Assessment for the potentially-affected water bodies (i.e., Silver Creek, Burnaby Lake). The key objectives of the Work Plan will include the following tasks under a series of hypothesis-based questions:

[1] Note: physical habitat changes (if any) will be discussed in a separate report.

What are the potential agents (chemicals) of effect/impact?

- chemical characterization and environmental fate of the spilled material, including constituents of the metallurgical coal, in addition to any potential breakdown products.

Where at the site can effects/impacts occur?

- delineation of study areas of environmental concern (AECs).

Do chemicals in water and sediment occur at concentrations deemed to result in effects/ impacts?

- characterization of concentrations of chemicals of potential concern (COPC) in receiving environments; this would include background, predicted, and actual concentrations (where possible), with a comparison of parameter concentrations to applicable guidelines, objectives and standards (in this case, provincial and federal water and sediment quality guidelines).

Will chemicals in water and sediment be taken up by organisms (bioaccumulate) over time?

- description of any short- and/or long-term potential impacts to receiving environment (e.g., based on bioavailability of contaminants related to the spill, impacts and risks to receptor groups), including magnitude, extent and duration of impact (if any).

As indicated above, a weight-of-evidence approach integrating the potential impact of surface water chemistry, sediment chemistry, toxicity, and bioaccumulation will be employed to evaluate aquatic impact (see section 3.0 below).

1.3 Study Area

The study area, including proposed sampling stations, is presented in Figure 1, below.

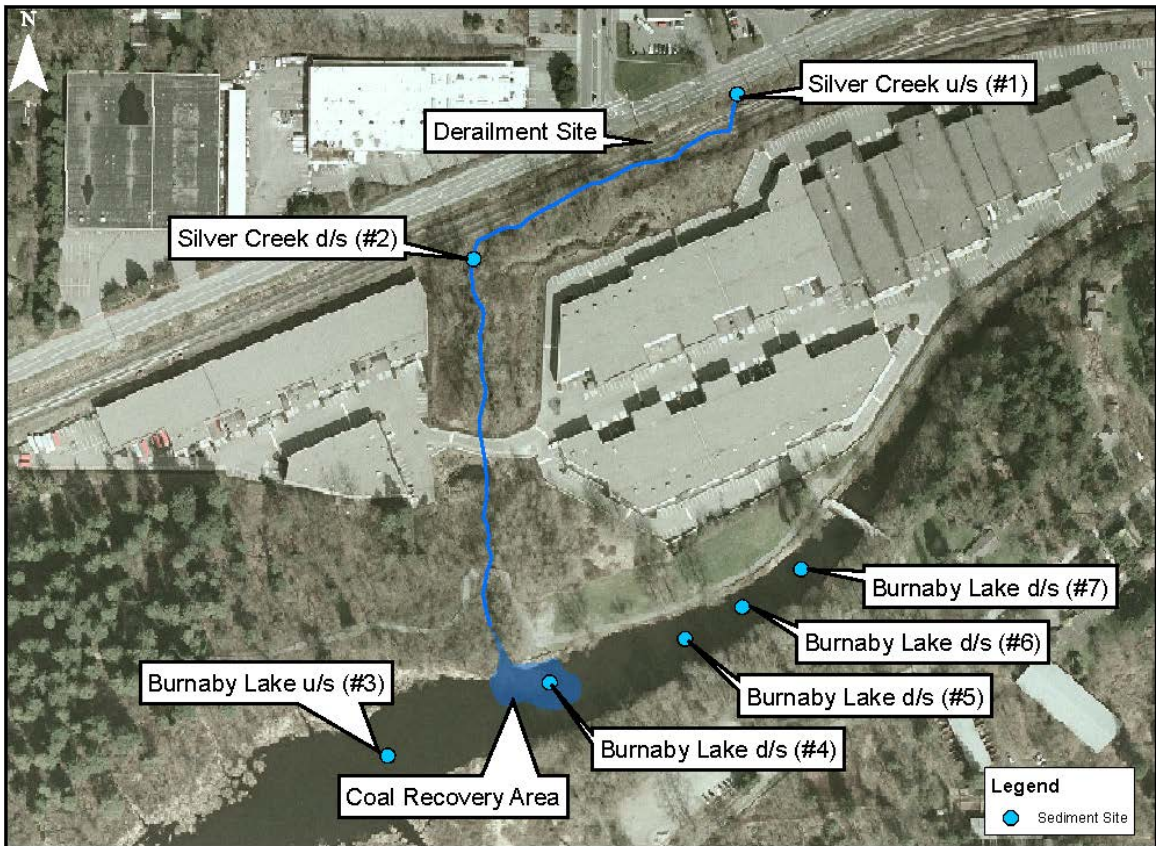

Figure 1. Environmental Setting and Sampling Stations to be used in the Aquatic Impact Assessment

2.0 Aquatic Impact Assessment: Work Plan Elements

2.1 Product Chemistry and Spill Characteristics

Based on available information, the assessment will initially detail:

- chemical and toxicological characterization of the spilled material[2], including constituents of the metallurgical coal, in addition to potential break-down products (e.g., polycyclic aromatic hydrocarbons); and,
- potentially-impacted areas, based on the results of the recovery program.

This information will be presented to provide context to the impact assessment.

2.2 Surface Water Chemistry

The objective of this component of the assessment will be to evaluate water quality conditions (e.g., concentrations of COPCs and relevant physical parameters) in both background/reference and "exposed" areas in the immediate receiving environment (i.e., Silver Creek, Burnaby Lake). Overall, an understanding of these conditions will help to identify areas of potential residual impact from the spill.

2.2.1 Assessment of Results from Water Quality Monitoring Program

Given the robustness of the data set, the recently-submitted final results from the water quality monitoring program conducted subsequent to the coal recovery program (CN, 2014a, b), additional surface water sampling and analysis is not being proposed at this time. The data compiled in CN (2014a, b) will be integrated into the aquatic impact assessment.

2.2.3 Statistical Analyses and Reporting

Analytical results will be used to calculate summary statistics using ProUCL (Version 4.1). These summary statistics will include: mean, median, interquartile range, and 95% Upper Confidence Limit (UCL95). Due the variety of potential numerical distributions (e.g., normal, log-normal, etc.), standard non-parametric statistics will be used to predict the UCL95.

[2] This may include testing of a sample of the source material (clean coal sample from Line Creek Operations).

The results from the water quality program will be compared with applicable provincial and federal guidelines. Specifically, aqueous (surface water) concentrations will be compared with provincial water quality guidelines for the protection of aquatic life (BCMOE, 2013), as well as the Canadian Council of Ministers of the Environment (CCME, 2013) guidelines for the protection of aquatic life.

2.3 Sediment Chemistry

The objective of this component of the assessment will be to evaluate sediment quality conditions (e.g., concentrations of COPCs and relevant physical parameters) in both background/reference and "exposed" areas in the immediate receiving environment (i.e., Silver Creek, Burnaby Lake). Overall, an understanding of these conditions will help to identify areas of potential residual impacts from the spill.

2.3.1 Project Planning and Desktop Assessment

A preliminary review of any historical and existing background sediment chemistry data will be conducted for the spill area. Additional historical data will be compiled from any existing baseline reports (if available), in order to understand temporal changes. Based on this information, field sampling will be conducted at selected sampling stations (Figure 1), as follows:

- background/reference Silver Creek (i.e., above the derailment point) (Silver Creek u/s #1);
- immediate downstream in Silver Creek (Silver Creek d/s #2);
- background/reference Burnaby Lake (i.e., upstream of the 'exposed' areas) (Burnaby Lake u/s #3); and,
- 'exposed' far-field (i.e., downstream of the recovery area) (Burnaby Lake d/s #4, #5, #6, #7).

This 'gradient' approach will coincide with the established extent of dispersion of the sediments into the receiving environment (from recovery plans; Triton, 2014 a, b). As indicated above, selected sampling stations will consist of a gradient of both background/reference and 'exposed' stations, to allow for spatial comparisons of pre- and post-spill conditions.

2.3.2 Field Sampling

The sampling program will tentatively be implemented during the week of May 26, 2014, with analytical work being conducted immediately thereafter. All sampling will be

conducted according to BCMOE (2003). All chemical analyses will be conducted at AGAT Laboratories (AGATC), in Burnaby, BC. AGAT is a competent environmental laboratory, accredited – according to ISO Standard 17025 - by Canada's national accreditation body, the Canadian Association for Laboratory Accreditation (CALA).

Sediment samples will be collected from a total of 7 stations (Figure 1; see list above), located at varying distances from the source of the spilled coal material. Three discrete replicates from each of the sampling stations will be collected, in order to reflect the variability of chemicals in sediments at a given station.

Field sampling will be coordinated with the sample collection for sediment toxicity testing (see below). This will help place results into the context of the larger ecological conditions. The sediment quality program will be inclusive of all of the applicable parameters and measures outlined in approved monitoring guidance (i.e., BCMOE (2012).

Samples will be fully homogenized at the laboratory, and a subsample of the homogenized sample will be analyzed for a full suite of standard parameters/variables including: grain size (i.e., particle size distribution), moisture content, common anions, nutrients, alkalinity, total dissolved and suspended solids, total organic carbon, total metals, and polycyclic aromatic hydrocarbons (PAHs). In order to address variability associated with subsampling, duplicates and blanks will also be analyzed.

2.3.3 Statistical Analyses and Reporting

Analytical results will be used to calculate summary statistics using ProUCL (Version 4.1). These summary statistics will include: mean, median, interquartile range, and 95% Upper Confidence Limit (UCL95). Due the variety of potential numerical distributions (e.g., normal, log-normal, etc.), standard non-parametric statistics will be used to predict the UCL95.

The results from the sediment quality program will be compared with applicable provincial and federal guidelines, namely: provincial sediment quality guidelines for the protection of aquatic life (BCMOE, 2013); and, federal Interim Sediment Quality Guidelines (ISQG), and Probable Effect Levels (PEL) (CCME, 2005).

2.4 Sediment Toxicity Testing

2.4.1 Project Planning and Desktop Assessment

Given that any long-term impacts are likely to be linked to potential contaminants in sediment and/or sediment porewater, most resident species are likely to be associated with sediments (i.e., benthic macroinvertebrates, periphyton). Moreover, there is an interest in protecting aquatic organisms from different taxonomic groups, and, potentially, from higher trophic levels. Therefore, an appropriate suite of sediment toxicity tests has been developed and proposed (see below).

2.4.2 Field Sampling and Laboratory Testing

For the purposes of conducting sediment toxicity testing, an additional 10 L of bulk sediment will be collected from five of the seven stations (i.e., toxicity testing will not be conducted on samples from stations #5 and #7), co-located with sediment chemistry sampling stations (as above). These samples will be collected according to BCMOE (2003) and Environment Canada (1994).

The testing suite will comprise five tests (representing the three major trophic levels in freshwater environments similar to those in Silver Creek and Burnaby Lake), as follows:

- one freshwater fish test (modified, using leached porewater from sediment);
- three benthic freshwater invertebrate toxicity tests (using sediment as test medium; one of these tests will also measure bioaccumulation); and,
- one freshwater plant (alga) test (using sediment porewater as test medium).

Table 1 below outlines relevant details related to the selected toxicity tests.

Table 1. Toxicity tests proposed for the Silver Creek/Burnaby Lake Aquatic Impact Assessment.

Representative trophic level	Test species	Biological endpoint	Duration	Method reference	Notes
Freshwater Fish	Rainbow Trout (*Oncorhynchus mykiss*)	Survival	96 hours (acute)	Environment Canada, (July 1990, 1996); 1/RM/9 Environment Canada (2000, 2007); 1/RM/13	Modified; conducted as a leachate test
Benthic Invertebrates	*Chironomus* sp.	Survival/ Growth	14 days (chronic)	Environment Canada (1997); EPS1/RM/32	Whole sediment test
	Hyalella azteca	Survival and growth	10 days (chronic)	Environment Canada (2013); EPS1/RM/33	Whole sediment test
	Tubifex tubifex or *Lumbriculus variegatus*	Survival and bioaccumulation	28 days (chronic)	ASTM International, 2014a,b; E1706-00, E-1688-10	Whole sediment test
Freshwater algae	*Pseudokirchneriella subcapitata*	Growth Inhibition	72 hours (acute)	Environment Canada, 2007; EPS1/RM/25	Sediment porewater test

Sediment toxicity testing will be conducted at Nautilus Environmental (Nautilus), in Burnaby, BC. Nautilus is a competent ecotoxicity laboratory, accredited – according to ISO Standard 17025 - by Canada's national accreditation body, CALA.

2.4.3 Analysis and Reporting

The results from the sediment toxicity testing (various toxicity endpoints: LT50s, LC50s, and IC25s, etc.) will provide an integrative, ecologically-relevant, site-specific evaluation of both short- and long-term biological effects to aquatic receptors that may be expected in the receiving environment.

3.0 Aquatic Impact Assessment – Weight-of-Evidence Approach

As indicated above, this Tier 1investigation and evaluation of the aquatic system has been designed to focus on potential short- and long-term water and sediment impacts. Should the initial investigation yield significant effects/impacts, a subsequent Tier 2 evaluation will be conducted to understand the extent of any impacts at higher trophic levels and/or greater spatial extent (i.e., Brunette River). The evaluation of these two tiers is discussed below.

3.1 Tier 1 Assessment

The proposed Aquatic Impact Assessment – focusing on risks to water and sediment in Silver Creek and Burnaby Lake - will utilize a weight-of-evidence approach to sediment quality, based on the principles of the Sediment Quality Triad (Chapman, 1990); this approach, which has been applied in both marine and freshwater environments for over two decades, integrates results from evaluations of: water and sediment chemistry; sediment toxicity and bioaccumulation; and, biological community health.

Given the success of the coal recovery program, and the results of the water quality program (CN, 2014a, b), only the first two above-mentioned lines of evidence (i.e., water/sediment chemistry, and sediment toxicity/bioaccumulation) are being proposed for implementation in this assessment. The conclusions from these lines of evidence (e.g., exceedance of water and sediment quality guidelines, potential chronic toxicity and/or demonstrated bioaccumulation) will provide a basis for whether or not a further evaluation of biological community health or other components tentatively identified in a Tier 2 assessment, may be necessary.

All information collected and analyses and evaluations conducted will culminate in the development and preparation of a comprehensive, weight-of-evidence-based Aquatic Impact Assessment report.

3.2 Tier 2 Assessment

The Tier 2 assessment - for which a detailed work plan is yet to be developed (based on the results and conclusions of the Tier 1 assessment (if necessary)) - will address whether impacts are predicted to other trophic levels. For example, this could include:

- additional sediment chemistry/toxicity studies in Burnaby Lake

- fish population impacts - fish population modeling (using toxicity endpoints from acute and chronic toxicity tests with common fish species) may be used to predict whether residual impacts of the coal spill may have the potential to impact on resident fish populations;

- potential impacts to the Brunette River downstream of Burnaby Lake; and/or,

- potential impacts to riparian amphibious and terrestrial species (e.g., Pacific water shrew, red-legged frog, Western painted turtle [3]) and benthivorous water birds.

[3] Pacific water shrew *(Sorex bendirii);* red-legged frog *(Rana aurora);* Western painted turtle *(Chrysemys picta bellii)*.

4.0 Proposed Schedule

Table 2 below outlines the details of the proposed schedule of the Aquatic Impact Assessment.

Table 2. Proposed Schedule for Aquatic Impact Assessment, Burnaby Lake

Milestone	Date	Completion	Notes
Field Sampling	Week of May 26, 2014	May 30, 2014	
Laboratory Analyses			
Chemical Analyses	Week of June 2, 2014	Week of June 9, 2014	
Toxicity Tests	Week of June 2, 2014	Week of July 7, 2014	Oligochaete bioaccumulation test is the longest test (28 days).
Statistical Analyses/Interpretation		July 22, 2014	
Draft Report		August 15, 2014	Allow for 2-week review and comment period.
Final Report		September 15, 2014	Subsequent to revisions made based on comments received on Draft Report.

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