REPORT

Evaluation of Industrial Chemicals, Spills and Unauthorized Releases

SME Report for Evaluation of Cause: Upper Fording River Westslope Cutthroat Trout Population Decline

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Executive Summary

Golder Associates Ltd. (Golder) was retained by Teck Coal Limited (Teck Coal) to provide the following evaluation of the potential contribution of industrial chemicals and spills in the upper Fording River watershed to the Westslope Cutthroat Trout (WCT; *Oncorhynchus clarkii lewisi*) population decline.

The objective of this report is to evaluate the potential role of industrial chemicals and spills in the WCT decline, considering the following:

- Chemicals stored on each mine site and the potential for those to have been released, including controlled releases for intended use and potential unintended releases that may not have been documented.
- Documented spills of mine-related substances such as industrial chemicals, process waters, tailings, or sewage that could potentially reach surface water via surface or groundwater pathways. Discharge from the Sewage Treatment Facility was evaluated by Azimuth Consulting Group Inc. (Branton and Power 2021).

The evaluation included a chemical list provided from Teck Coal's storage tank database and recorded spills in the decline window (defined herein as September 1, 2017 to September 30, 2019) provided from Teck Coal's tracking system for environmental incidents. The evaluation of industrial chemicals and spills involved an initial screening of the potential for each chemical or spill to have affected WCT, followed by a more detailed evaluation of the potential to have contributed to or caused the WCT population decline.

A screening approach was used to identify substances that warranted further investigation in the evaluation of cause. The objective of the screening was to identify substances that could potentially have been released and transported to fish accessible waters, and if so, evaluate whether that substance could potentially be toxic to fish. The screening approach was aligned with the concept that the risk of an adverse effect is a function of hazard (the inherent potential of a substance to cause harm) and probability of exposure (the likelihood that exposure conditions may have arisen under which harm could have been caused).

- Exposure potential was characterized as negligible (use and storage prevents unintended release; entire spill recovered), low to moderate (use or storage could result in unintended release; entire spill volume not recovered), or high (use or spill results in discharge). For industrial chemicals, exposure potential was rated according to available information on intended or approved use, storage, and potential release mechanisms. Intended or approved use, storage, and potential release mechanisms were evaluated from site information provided by Teck. For spills, exposure potential was rated according to available information on the properties of the spilled substance and the description of the incident, including the nature and location of the spill, the surface onto which the spill occurred, and what actions were taken to recover the spilled material. Negligible ratings were not carried forward for further assessment. For ratings of low to moderate, judgement was used to decide whether to retain for evaluation. High ratings were automatically retained for a detailed evaluation.
- Hazard was characterized using toxicity test data for rainbow trout (*Oncorhynchus mykiss*) as a surrogate for WCT. The 96-hour acute LC_{50}, which is a concentration causing 50% mortality under acute (i.e., short-term) exposure conditions, was the main hazard criterion because this is a standard effects endpoint that is usually reported on Safety Data Sheets and therefore was available for most evaluated substances.

For the substances carried forward from the risk screening step, an evaluation was then conducted of the potential for each chemical or spill to have contributed to or caused the WCT population decline. The detailed evaluation summarized available information relevant to use, monitoring, transport, fate, and the potential for acute or chronic (i.e., long-term) effects.

Detailed methods for how each chemical and spill was assessed are provided in their respective sections. The requisite condition to have contributed to the WCT decline was any substance with moderate or high potential for exposure that indicated a potential for acute or chronic effects at a time and location where fish could have been present. For short-term spill events, in accordance with the BC ENV (2019a) definition of acute effects, emphasis was placed on evaluating potential for acute effects because spills are transient events. The requisite condition to have caused the WCT decline was a substance or finding that indicated a potential for acute or chronic effects that could have affected a large fraction of the WCT population.

The following bullets summarize results for the evaluation of industrial chemicals:

- All industrial chemicals (except methyl isobutyl carbinol [MIBC], kerosene, antiscalant and flocculant, which are discussed below) were used and stored in a manner that prevented them from being released to the environment (e.g., no discharge to fish-accessible waters; secondary containment; stored far away from any watercourse), and no releases were documented. These chemicals had a negligible likelihood of reaching a watercourse where exposure of WCT could occur.
- MIBC and kerosene used in coal processing are discharged in wet tailings slurry into tailings ponds, and release from the tailings ponds to the receiving environment would only occur if there was potential infiltration to downgradient watercourses. However, available information on persistence and monitoring data indicated that these chemicals had a low likelihood of reaching a watercourse where exposure of WCT could occur.
- Antiscalants and flocculants were evaluated in detail because their intended and approved uses result in these products being directly released to creeks or settling ponds. As a result, there is a high likelihood of exposure for WCT under certain circumstances:
    - Concentrations of antiscalant were below acute and chronic toxicity values at GHO, and antiscalant was not used at FRO during the decline window. Therefore, antiscalant was not expected to have contributed to or caused the WCT population decline.
    - Maximum dosage concentrations of liquid flocculant and estimated concentrations dissolved from floc blocks used at FRO were less than acute toxicity values, except for April 30, 2018 when cationic liquid flocculant was dosed into a sedimentation pond at a concentration above the associated acute toxicity value. No acute toxicity was observed in water samples collected from the sediment pond discharge location during flocculant use, which confirmed the expectation of no acute toxicity. Therefore, flocculants were not expected to have caused acute effects to WCT.
    - It is unknown if flocculants may have contributed to chronic effects because no chronic toxicity information is available for these products. Potential exposure to residual liquid flocculant was expected to be limited to short-term durations based on use. However, concentrations of residual flocculant in the receiving environment are expected to have been low, if at all present, because of flocculant interaction with total suspended solids (TSS), settling in the ponds, and subsequent dilution downstream.

- The strength of evidence that this stressor was the sole cause of the decline was classified as weak/none. The estimated contribution to the decline was classified as negligible, with moderate confidence for flocculant, which could not be ruled out as potential contributor, and high confidence for all other chemicals, including antiscalant.

The following bullets summarize results for the evaluation of spills:

- Most spills were to ground surface, several hundred metres from the nearest watercourse, and were contained or cleaned up using sorbent pads, berms, removal of contaminated material, and/or vacuum trucks, limiting the amount of time the product had to potentially infiltrate into the ground surface. These spill details, in addition to available information on mobility and degradation of the spilled substance, indicated that these substances had a negligible or low likelihood of reaching a watercourse where exposure of WCT could occur.
- Five spills were evaluated in detail because they involved a direct release to fish-accessible waters or waters with a surface connection to fish-accessible waters, or, for the Maxam event (see Van Geest et al., 2021), because Teck Coal identified the event as an incident that merited more detailed assessment because it occurred during the decline window:
  - In three of the five spills (including the Maxam event), concentrations of relevant constituents in the spilled material at were below relevant water quality guidelines or screening values for fish. These results indicate a negligible likelihood that the constituents contributed to the decline.
  - Two of the five spills could not be ruled out as contributors because relevant water chemistry samples were not collected; however, evidence for potential contribution was interpreted as weak because the spills occurred in the lower end of the watershed at GHO and at the end of the decline window, in August 2019. The role of these spills in the decline was interpreted as negligible to minor with uncertainty dependent on the spilled material.
- The strength of evidence that this stressor was the sole cause of the decline was classified as weak/none. The estimated contribution to the decline was classified as minor to negligible, with moderate confidence for the two spills that could not be ruled out as potential contributors and high confidence for all other spills.

Study Limitations

This report was prepared for the exclusive use of Teck Coal Limited. Any use that a third party may make of this report, or any reliance on or decisions made based on it, is the responsibility of the third parties. We disclaim responsibility for consequential financial effects on transactions or property values, or requirements for follow-up actions and costs.

We have relied in good faith on information provided by others as noted. We assume that the information provided is factual and accurate. We accept no responsibility for any deficiency, misstatement or inaccuracy contained in this report as a result of omissions, misinterpretations or fraudulent acts of persons interviewed or contacted.

The services performed as described in this report were conducted in a manner consistent with the level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services. The content of this report is based on information collected during our investigation, our present understanding of site conditions, the assumptions stated in this report, and our professional judgement in light of such information at the time of this report. This report provides a professional opinion and, therefore, no warranty is expressed, implied, or made as to the conclusions, advice and recommendations offered in this report. This report does not provide a legal opinion regarding compliance with applicable laws. With respect to regulatory compliance issues, it should be noted that regulatory statutes and the interpretation of regulatory statutes are subject to change. The findings and conclusions of this report are valid only as of the date of the report. If new information is discovered in future work, or if the assumptions stated in this report are not met, Golder Associates should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of Golder's report or other work products.

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Acronyms and Abbreviations

Acronym	Definition
ATSDR	Agency for Toxic Substances and Disease Registry
BC	British Columbia
BC ENV	British Columbia Ministry of Environment and Climate Change Strategy
BCF	bioconcentration factor
CCME	Canadian Council of Ministers of the Environment
CSR	Contaminated Sites Regulation
decline window	between September 2017 and September 2019
ECCC	Environment and Climate Change Canada
ECHA	European Chemicals Agency
FRO	Fording River Operations
GHO	Greenhills Operations
Golder	Golder Associates Ltd.
K_{OC}	soil adsorption coefficient
LC_{25}	Lethal concentration determination 25%
LC_{50}	Lethal concentration determination 50%
LCO	Line Creek Operations
LGHO System	Lower Greenhills Operations Antiscalant Addition System
log K_{OW}	octanol water partition coefficient
MIBC	Methyl isobutyl carbinol
Nautilus	Nautilus Environmental Inc.
NCBI	National Center for Biotechnology Information
NIH	National Institutes of Health – National Library of Medicine
No.	number
NOEC	no observed effect concentration
PHC	petroleum hydrocarbon
SDS	Safety Data Sheet
SME	Subject Matter Expert
STP	South Tailings Pond
Teck Coal	Teck Coal Limited
TG	Technical Guidance
TSS	total suspended solids
US EPA	United States Environmental Protection Agency
WCT	Westslope Cutthroat Trout
WCT decline	Westslope Cutthroat Trout population decline
WHO	World Health Organization
WL	Water Lynx
WQG	water quality guideline

Units of Measure

Unit	Definition
%	percent
<	less than
>	more than
atm m^3/mol	atmospheres cubic metres per mole
h	hour
km	kilometre
L	litre
L/s	litres per second
LPM	litres per minute
m	metre
m^3	cubic metre
mg/L	milligrams per litre
mL	millilitre

READER'S NOTE

What is the Evaluation of Cause and What is Its Purpose?

The Evaluation of Cause is the process used to investigate, evaluate and report on the reasons the Westslope Cutthroat Trout population declined in the upper Fording River between fall 2017 and fall 2019.

Background

The Elk Valley is located in the southeast corner of British Columbia (BC), Canada. It contains the main stem of the Elk River (220 km long) and many tributaries, including the Fording River (70 km long). This report focuses on the upper Fording River, which starts 20 km upstream from its confluence with the Elk River at Josephine Falls. The Ktunaxa First Nation has occupied lands in the region for more than 10,000 years. Rivers and streams of the region provide culturally important sources of fish and plants.

The upper Fording River watershed is at a high elevation and is occupied by only one fish species, a genetically pure population of Westslope Cutthroat Trout *(Oncorhynchus clarkii lewisi)* — an iconic fish species that is highly valued in the area. This population is physically isolated because Josephine Falls is a natural barrier to fish movement. The species is protected under the federal Fisheries Act and the Species at Risk Act. In BC, the Conservation Data Center categorized Westslope Cutthroat Trout as "*imperiled or of special concern, vulnerable to extirpation or extinction."* Finally, it has been identified as a priority sport fish species by the Province of BC.

The upper Fording River watershed is influenced by various human-caused disturbances including roads, a railway, a natural gas pipeline, forest harvesting and coal mining. Teck Coal Limited (Teck Coal) operates the three surface coal mines within the upper Fording River watershed, upstream of Josephine Falls: Fording River Operations, Greenhills Operations and Line Creek Operations.

Monitoring conducted for Teck Coal in the fall of 2019 found that the abundance of Westslope Cutthroat Trout adults and sub-adults in the upper Fording River had declined significantly since previous sampling in fall 2017. In addition, there was evidence that juvenile fish density had decreased. Teck Coal initiated an *Evaluation of Cause* process. The overall results of this process are reported separately (Evaluation of Cause Team, 2021) and are supported by a series of Subject Matter Expert reports such as this one. The full list of SME reports follows at the end of this Reader's Note.

Evaluation of Cause

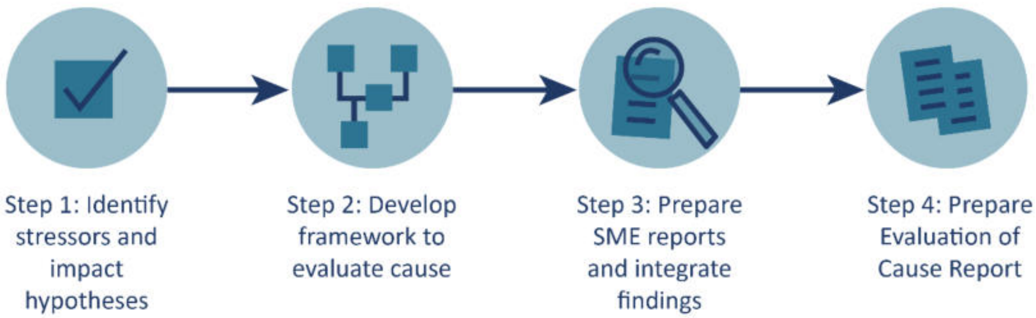
Following identification of the decline in the Westslope Cutthroat Trout population, Teck Coal initiated an Evaluation of Cause process. The overall results of this process are reported in a separate document (Evaluation of Cause Team, 2021) and are supported by a series of Subject Matter Expert reports.

The report that follows this Reader's Note is one of those Subject Matter Expert Reports.

Building on and in addition to the Evaluation of Cause, there are ongoing efforts to support fish population recovery and implement environmental improvements in the upper Fording River.

How the Evaluation of Cause was Approached

When the fish decline was identified, Teck Coal established an *Evaluation of Cause Team* (the Team), composed of *Subject Matter Experts* and coordinated by an Evaluation of Cause *Team Lead.* Further details about the Team are provided in the Evaluation of Cause report. The Team developed a systematic and objective approach (see figure below) that included developing a Framework for Subject Matter Experts to apply in their specific work. All work was subjected to rigorous peer review.



Conceptual approach to the Evaluation of Cause for the decline in the upper Fording River Westslope Cutthroat Trout population.

With input from representatives of various regulatory agencies and the Ktunaxa Nation Council, the Team initially identified potential stressors and impact hypotheses that might explain the cause(s) of the population decline. Two overarching hypotheses (essentially, questions for the Team to evaluate) were used:

- Overarching Hypothesis #1: The significant decline in the upper Fording River Westslope Cutthroat Trout population was a result of a single acute stressor[1] or a single chronic stressor[2].
- Overarching Hypothesis #2: The significant decline in the upper Fording River Westslope Cutthroat Trout population was a result of a combination of acute and/or chronic stressors, which individually may not account for reduced fish numbers, but cumulatively caused the decline.

The Evaluation of Cause examined numerous stressors in the UFR to determine if and to what extent those stressors and various conditions played a role in the Westslope Cutthroat Trout's decline. Given that the purpose was to evaluate the cause of the decline in abundance from 2017 to 2019[3], it was important to identify stressors or conditions that changed or were different during that period. It was equally important to identify the potential stressors or conditions that did not change during the decline window but may, nevertheless, have been important constraints on the population with respect to their ability to respond to or recover from the stressors. Finally, interactions between stressors and conditions had to be considered in an integrated fashion. Where an *impact hypothesis* depended on or may have been exacerbated by interactions among stressors or conditions, the interaction mechanisms were also considered.

[1] Implies September 2017 to September 2019.

[2] Implies a chronic, slow change in the stressor (using 2012–2019 timeframe, data dependent).

[3] Abundance estimates for adults/sub-adults are based on surveys in September of each year, while estimates for juveniles are based on surveys in August.

The Evaluation of Cause process produced two types of deliverables:

1) **Individual Subject Matter Expert (SME) reports** (such as the one that follows this Note): These reports mostly focus on impact hypotheses under Overarching Hypothesis #1 (see list, following). A Framework was used to align SME work for all the potential stressors, and, for consistency, most SME reports have the same overall format. The format covers: (1) rationale for impact hypotheses, (2) methods, (3) analysis and (4) findings, particularly whether the requisite conditions[4] were met for the stressor(s) to be the sole cause of the fish population decline, or a contributor to it. In addition to the report, each SME provided a summary table of findings, generated according to the Framework. These summaries were used to integrate information for the Evaluation of Cause report. Note that some SME reports did not investigate specific stressors; instead, they evaluated other information considered potentially useful for supporting SME reports and the overall Evaluation of Cause, or added context (such as in the SME report that describes climate (Wright et al., 2021).

2) **The Evaluation of Cause report** (prepared by a subset of the Team, with input from SMEs): This overall report summarizes the findings of the SME reports and further considers interactions between stressors (Overarching Hypothesis #2). It describes the reasons that most likely account for the decline in the Westslope Cutthroat Trout population in the upper Fording River.

Participation, Engagement & Transparency

To support transparency, the Team engaged frequently throughout the Evaluation of Cause process. Participants in the Evaluation of Cause process, through various committees, included:

Ktunaxa Nation Council
BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development
BC Ministry Environment & Climate Change Strategy
Ministry of Energy, Mines and Low Carbon Innovation
Environmental Assessment Office

[4] These are the conditions that would need to have occurred for the impact hypothesis to have resulted in the observed decline of Westslope Cutthroat Trout population in the upper Fording River.

Citation for the Evaluation of Cause Report

When citing the Evaluation of Cause Report use:

Evaluation of Cause Team, (2021). *Evaluation of Cause — Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited by Evaluation of Cause Team.

Citations for Subject Matter Expert Reports

Focus	Citation for Subject Matter Expert Reports
Climate, temperature, and streamflow	Wright, N., Greenacre, D., & Hatfield, T. (2021). *Subject Matter Expert Report: Climate, water temperature, streamflow and water use trends. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Ecofish Research Ltd.
Ice	Hatfield, T., & Whelan, C. (2021). *Subject Matter Expert Report: Ice. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Ltd. Report Prepared by Ecofish Research Ltd.
Habitat availability (instream flow)	Healey, K., Little, P., & Hatfield, T. (2021). *Subject Matter Expert Report: Habitat availability. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited by Ecofish Research Ltd.
Stranding – ramping	Faulkner, S., Carter, J., Sparling, M., Hatfield, T., & Nicholl, S. (2021). *Subject Matter Expert Report: Ramping and stranding. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited by Ecofish Research Ltd.
Stranding – channel dewatering	Hatfield, T., Ammerlaan, J., Regehr, H., Carter, J., & Faulkner, S. (2021). *Subject Matter Expert Report: Channel dewatering. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited by Ecofish Research Ltd.
Stranding – mainstem dewatering	Hocking M., Ammerlaan, J., Healey, K., Akaoka, K., & Hatfield T. (2021). *Subject Matter Expert Report: Mainstem dewatering. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Ltd. by Ecofish Research Ltd. and Lotic Environmental Ltd. Zathey, N., & Robinson, M.D. (2021). *Summary of ephemeral conditions in the upper Fording River Watershed. In Hocking et al. (2021). Subject Matter Expert Report: Mainstem dewatering. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Ltd. by Ecofish Research Ltd. and Lotic Environmental Ltd.

Focus	Citation for Subject Matter Expert Reports
Calcite	Hocking, M., Tamminga, A., Arnett, T., Robinson M., Larratt, H., & Hatfield, T. (2021). *Subject Matter Expert Report: Calcite. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Ltd. by Ecofish Research Ltd., Lotic Environmental Ltd., and Larratt Aquatic Consulting Ltd.
Total suspended solids	Durston, D., Greenacre, D., Ganshorn, K & Hatfield, T. (2021). *Subject Matter Expert Report: Total suspended solids. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Ecofish Research Ltd.
Fish passage (habitat connectivity)	Harwood, A., Suzanne, C., Whelan, C., & Hatfield, T. (2021). *Subject Matter Expert Report: Fish passage. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Ltd. by Ecofish Research Ltd. Akaoka, K., & Hatfield, T. (2021). Telemetry Movement Analysis. In Harwood et al. (2021). *Subject Matter Expert Report: Fish passage. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Ltd. by Ecofish Research Ltd.
Cyanobacteria	Larratt, H., & Self, J. (2021). *Subject Matter Expert Report: Cyanobacteria, periphyton and aquatic macrophytes. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Larratt Aquatic Consulting Ltd.
Algae / macrophytes	
Water quality (all parameters except water temperature and TSS [Ecofish])	Costa, EJ., & de Bruyn, A. (2021). *Subject Matter Expert Report: Water quality. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Golder Associates Ltd. Healey, K., & Hatfield, T. (2021). *Calculator to assess Potential for cryoconcentration in upper Fording River.* In Costa, EJ., & de Bruyn, A. (2021). *Subject Matter Expert Report: Water quality. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Golder Associates Ltd.
Industrial chemicals, spills and unauthorized releases	Van Geest, J., Hart, V., Costa, EJ., & de Bruyn, A. (2021). *Subject Matter Expert Report: Industrial chemicals, spills and unauthorized releases. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Golder Associates Ltd. Branton, M., & Power, B. (2021). *Stressor Evaluation – Sewage.* In Van Geest et al. (2021). *Subject Matter Expert Report: Industrial chemicals, spills and unauthorized releases. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Golder Associates Ltd.

Focus	Citation for Subject Matter Expert Reports
Wildlife predators	Dean, D. (2021). *Subject Matter Expert Report: Wildlife predation. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by VAST Resource Solutions Inc.
Poaching	Dean, D. (2021). *Subject Matter Expert Report: Poaching. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population*. Report prepared for Teck Coal Limited. Prepared by VAST Resource Solutions Inc.
Food availability	Orr, P., & Ings, J. (2021). *Subject Matter Expert Report: Food availability. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Minnow Environmental Inc.
Fish handling	Cope, S. (2020). *Subject Matter Expert Report: Fish handling. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Westslope Fisheries Ltd.
	Korman, J., & Branton, M. (2021). *Effects of capture and handling on Westslope Cutthroat Trout in the upper Fording River: A brief review of Cope (2020) and additional calculations.* Report prepared for Teck Coal Limited. Prepared by Ecometric Research and Azimuth Consulting Group.
Infectious disease	Bollinger, T. (2021). *Subject Matter Expert Report: Infectious disease. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by TKB Ecosystem Health Services Ltd.
Pathophysiology	Bollinger, T. (2021). *Subject Matter Expert Report: Pathophysiology of stressors on fish. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by TKB Ecosystem Health Services Ltd.
Coal dust and sediment quality	DiMauro, M., Branton, M., & Franz, E. (2021). *Subject Matter Expert Report: Coal dust and sediment quality. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Azimuth Consulting Group Inc.
Groundwater quality and quantity	Henry, C., & Humphries, S. (2021). *Subject Matter Expert Report: Hydrogeological stressors. Evaluation of Cause - Decline in upper Fording River Westslope Cutthroat Trout population.* Report Prepared for Teck Coal Limited. Prepared by SNC-Lavalin Inc.

1.0 INTRODUCTION

1.1 General Introduction

Golder Associated Ltd. (Golder) was retained by Teck Coal Limited (Teck Coal) to evaluate the potential for industrial chemicals or spills[5] at Fording River Operations (FRO), Greenhills Operations (GHO), and/or Line Creek Operations (LCO; Dry Creek) to have contributed to or caused the Westslope Cutthroat Trout (WCT; *Oncorhynchus clarki lewisi*) population decline in the upper Fording River watershed. For brevity, the upper Fording River WCT population decline is referred to hereafter as the "WCT decline" and the time period within which the WCT decline occurred (between September 2017 and September 2019) is referred to as the "decline window".

This document is one of a series of Subject Matter Expert (SME) reports that support the overall Evaluation of Cause into the upper Fording River WCT decline (Evaluation of Cause Team 2021). For general information, see the preceding Reader's Note.

1.2 Report-Specific Introduction

The evaluation herein focused on the following:

- Chemicals stored on each mine site and the potential for those to have been released, including controlled releases for intended use and potential unintended releases that may not have been documented. The approach is provided in Section 1.3 and the evaluation of industrial chemicals is provided in Section 3.0.
- Documented spills of mine-related substances such as industrial chemicals, process waters, or tailings that could potentially reach surface water via surface or groundwater pathways. The approach is provided in Section 1.3 and the evaluation of spills is provided in Section 4.0.
- Discharge from the Sewage Treatment Facility. The evaluation of sewage, which was prepared by Azimuth Consulting Group Inc. (Branton and Power 2021), is provided in Appendix A.

1.3 The Authors

The authors' qualifications to conduct this work are outlined below.

Jordana Van Geest, Ph.D., R.P.Bio., has over 10 years of experience in the areas of aquatic toxicology, environmental monitoring and assessment, and ecological risk assessment. She has experience leading specialized environmental toxicology projects and aquatic health assessments for Teck Coal in the Elk Valley, including projects in support of permit applications to use antiscalant for calcite management.

Victoria Hart, M.Sc., R.P.Bio, has 10 years of experience in the areas of human health risk assessment, environmental assessment, and contaminated site risk assessment. She has conducted risk assessments to support environmental assessment applications across Canada for the mining sector, including the Teck Coal Elkview Operations Baldy Ridge Extension Project. She has also conducted risk assessments for several federal and provincial contaminated sites across Canada.

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[5] The term 'spill' is used throughout this report to collectively refer to any spill, unintended release, or unauthorized discharge. A spill is any uncontrolled release of a substance to the environment (Meredith 2021). An "unauthorized discharge" is associated with regulatory permits such as exceedances of effluent limits; these exceedances are reported the same way a spill is reported as per the direction of the permit and the Ministry (Meredith 2021).

Emily-Jane Costa, M.Sc., has 8 years of experience in the areas of aquatic health risk assessment, environmental assessment, and aquatic toxicology. She has worked on numerous aquatic health assessments and water quality-related investigations for Teck Coal in the Elk Valley, including the Elk Valley Water Quality Plan, the 2019 Implementation Plan Adjustment, and chronic toxicity testing programs.

Dr. Adrian de Bruyn, Ph.D., R.P.Bio., has 17 years of experience in the areas of environmental monitoring and assessment, risk assessment, investigation of contaminant fate and effects, and the statistical analysis of environmental data. He has worked on numerous environmental assessments and investigations throughout Canada and abroad, extending from northern Canada to southern Australia. Dr. de Bruyn is one of the leading selenium scientists in Canada, and in this capacity has taken a lead technical role in the aquatic component of complex environmental assessments for Teck Coal in the Elk Valley.

2.0 APPROACH

The evaluation of industrial chemicals and spills involved an initial screening of the potential for each chemical or spill to have affected WCT, followed by a more detailed evaluation of the potential to have contributed to or caused the WCT population decline. These two components are described in more detail below. For brevity, the term ‘substances’ is used in this section to collectively refer to industrial chemicals and spills.

First, a screening approach was used to identify substances that warranted further investigation in the evaluation of cause. The objective of the screening was to identify substances that could potentially have been released and transported to fish accessible waters, and if so, evaluate whether that substance could be potentially toxic to fish. The screening approach was aligned with the concept that the risk of an adverse effect is a function of *hazard* (the inherent potential of a substance to cause harm) and *probability of exposure* (the likelihood that exposure conditions may have arisen under which harm could have been caused). This screening approach is standard practice for environment assessment and risk assessment and follows federal guidance for risk assessment (Fisheries and Oceans Canada 2011; US EPA 1992), which states that “risk does not exist unless: (1) the stressor has an inherent ability to cause adverse effects; and (2) it is coincident with or in contact with the ecological component long enough and at sufficient intensity to elicit the identified adverse effect(s)”.

Because generic water quality guidelines often do not exist for the substances assessed herein, other criteria were developed to evaluate hazard and likelihood of exposure. The hazard criteria used in this assessment were developed to be consistent with the categories for substances hazardous to the aquatic environment in the United Nations (2019) Globally Harmonized System of Classification and Labelling of Chemicals. Use of the Globally Harmonized System criteria enables rating of each chemical following a standardized and internationally accepted approach.

The following were developed as screening criteria:

- Exposure Potential: The likelihood of exposure of WCT to each substance. For industrial chemicals, exposure potential was rated according to available information on intended or approved use, storage, and potential release mechanisms. Intended or approved use, storage, and potential release mechanisms were evaluated from site information provided by Teck. For spills, exposure potential was rated according to available information on the properties of the spilled substance and the description of the incident, including the nature and location of the spill, the surface onto which the spill occurred, and what actions were taken to recover the spilled material. Exposure potential was rated as follows:
  - **Negligible Likelihood:** For industrial chemicals, this rating was assigned when the product was used and stored in a manner that ordinarily would be expected to prevent release to the environment (e.g., no discharge from plant, secondary containment, stored far away from any watercourse) and no releases were documented. For spills, this rating was assigned when all of the spill volume was reported as recovered. Substances meeting these criteria were not evaluated further.
  - **Low to Moderate Likelihood:** For industrial chemicals, this rating was assigned when the product was used and stored in a manner that could potentially result in unintended release to the environment. This would include a product used in a controlled system, such as a processing plant, that discharges to tailings ponds. For spills, this rating was assigned when some or all of the spill was not recovered and the residual material could have eventually reached a fish accessible watercourse. Environmental fate data (bioconcentration factor [BCF], octanol water partition coefficient [log K_{OW}], soil adsorption coefficient [K_{OC}], Henry's law constant, degradability) available from each substance's Safety Data Sheet (SDS) and PubChem (NIH 2019) were reviewed to rate whether the substance is reported to be persistent and/or bioaccumulative because these properties would increase the potential for transport to and persistence in a watercourse if a spill occurred. Substances with high volatility and degradability would have lower potential of reaching a downstream watercourse, whereas substances that are soluble and resistant to degradation may have a greater likelihood of reaching a downstream watercourse. For spills, additional information reviewed to inform the rating included the distance from the spill location to the nearest surface water, the volume of the spilled material, and cleanup actions that were undertaken. The lower the volume and the farther the distance to water, the less likely the spill was interpreted to reach fish accessible waters. Similarly, if cleanup actions were initiated, these were also interpreted to reduce the likelihood of the spill reaching fish accessible waters. Professional judgement was used to decide whether these substances were retained for further evaluation.
  - **High Likelihood:** For industrial chemicals, this rating was assigned when the intended or approved use of the product is expected to result in direct or residual chemical discharge to the environment (e.g., chemicals directly applied to creeks or settling ponds). For spills, this rating was assigned when the spill was reported as a direct discharge to waters with a surface water connection to fish accessible waters. Substances meeting this criterion were retained for evaluation as described below.
- Hazard: Because toxicity data can be limited for substances assessed herein, hazard was used as a second screening criterion for those substances identified as warranting further investigation based on the likelihood of exposure (i.e., low to moderate likelihood, as high likelihood substances were automatically retained for evaluation). The inherent hazard of an industrial chemical or spilled substance was characterized using toxicity test data for rainbow trout (*Oncorhynchus mykiss*) as a surrogate for WCT. The 96-hour acute LC_{50}, which is a concentration causing 50% mortality under acute (i.e., short-term) exposure conditions, was the

main hazard criterion because this is a standard effects endpoint that is usually reported on SDS and therefore was available for most evaluated substances. The acute LC_{50} would be most directly relevant to hazard under scenarios in which potential exposure of WCT would be transient and/or localized. This definition of acute toxicity is consistent with the BC Ministry of Environment and Climate Change Strategy (BC ENV) guidance for water quality guideline development for acute exposures (BC ENV 2019). LC_{50} values were presented for the spilled substances for information purposes, as data on exposure concentrations were generally not available for the spills to quantify potential risks. Other toxicity data from SDS with lower effect sizes, chronic exposure (i.e., long-term), or sublethal responses were summarized where available and considered in evaluating hazard. Where no data were reported for rainbow trout, toxicity test data reported on SDS for other fish species were considered.

For the substances carried forward from the risk screening step, an evaluation was conducted of the potential for each chemical or spill to have contributed to or caused the WCT population decline. The evaluation considered the following:

- Available information relevant to the potential for acute toxicity at the point of release and potential for chronic toxicity in fish accessible waters. Fish could potentially have experienced short-term exposure to maximum concentrations at a point of release or could potentially have experienced longer-term exposure to lower concentrations downstream of a release. For a subset of spills, water chemistry samples were collected of the released material, upstream receiving environment, and/or downstream receiving environment. Concentrations in those samples were compared to water quality guidelines and/or screening values for fish to evaluate the potential for acute effects. Rationale for the guidelines and screening values used herein is provided in the surface water quality report (Costa and de Bruyn 2021). For spill durations that were less than 96 hours, the evaluation focused on the potential for acute effects because spills are transient events; this approach aligns with BC ENV (2019), which specifies that short-term water quality guidelines (WQGs) are "intended to protect aquatic organisms against severe effects such as lethality due to short-term intermittent and/or transient exposures to contaminants (e.g., spill events; infrequent releases of short-lived/non-persistent substances)".
- Available information for each substance regarding use, monitoring, toxicity testing, transport, and fate, including:
  - Comparison of toxicity testing data to concentrations used in the decline window, where concentrations could be estimated or were measured. This evaluation considered whether concentrations exceeded acute or chronic effects concentrations for fish, the magnitude and duration of exposure, and whether site-specific toxicity testing with the chemical showed potential for effects.
  - Comparison of concentrations used or potentially released during the decline window relative to pre-September 2017. If chemical use or potential release increased after September 2017, this would support an interpretation that the chemical may have contributed to or caused the WCT population decline. Alternatively, if chemical use or potential release decreased after September 2017, this would support an interpretation that the chemical was less likely to have contributed to the population decline.
  - Summary of fate and transport work that Teck has conducted previously. This would include additional site-specific information indicating whether a substance has been or is anticipated to be transported to and/or persistent in a watercourse.

- Consideration of the spatial extent and temporal duration of potential exposure. For spills to ground, it was not possible to consider spatiotemporal fish use information because the travel pathway and timeline from the spill to surface water was not characterized.[6]

The above information was used to evaluate the possibility that one or more of the chemicals or spills may have contributed to or caused the WCT population decline.

The requisite condition to have contributed to the WCT decline was any substance with moderate or high potential for exposure that indicated a potential for acute or chronic effects at a time and location where fish could have been present. For short-term spill events, as described above, emphasis was placed on evaluating potential for acute effects because the spills are transient events. The requisite condition to have caused the WCT decline was a substance or finding that indicated a potential for acute or chronic effects that could have affected a large fraction of the WCT population.

Results are presented in Section 3.0 for industrial chemicals and Section 4.0 for spills.

3.0 EVALUATION OF POTENTIAL EFFECTS OF INDUSTRIAL CHEMICALS

3.1 Screening and Identification of Chemicals

Teck identified two chemicals with intended and approved use that involves release to the receiving environment: antiscalant used for calcite management and flocculant used for total suspended solids (TSS) management. Because antiscalant and flocculant are directly applied or released to creeks or settling ponds, they were categorized as high likelihood of exposure and retained for detailed evaluation in Section 3.2.

The list of chemicals and tanks from Teck's storage tank databases was reviewed to apply the screening outlined in Section 1.3. In the initial screening step, tank data were categorized and filtered to exclude entries that were not applicable, as follows:

- Tank status = 'disposed', 'dormant – empty', or 'not yet active'. These tanks and their associated product were not used in the decline window. These entries were categorized as 'not applicable'.
- Product type = 'water'. It was assumed that tanks storing water on site did not contain other chemicals. These entries were categorized as 'not applicable'.
- Tanks with secondary containment, defined as indoor storage, wall description = double wall, or containment description = concrete. It was considered unlikely that product from these tanks would have been released into the receiving environment because of the type of containment, in addition to there being routine inspection of tanks. These entries were categorized as 'negligible likelihood', per Section 1.3.
- Product type = 'unknown'. Golder was unable to further evaluate these tanks for hazard because the product type was not identified in the initial list provided by Teck. These entries were categorized as 'cannot assess'.

This initial filtering of tank data resulted in the following:

- Of the 125 tank entries combined for FRO and GHO (Appendix B, Table B-1), 19 were categorized as 'not applicable' based on tank status or water as the product type, 62 were categorized as 'negligible likelihood'

[6] One exception was for Incident 4383 (the Maxam event), which is discussed in Section 4.2.1.

based on secondary containment, and 7 were categorized as 'cannot assess' because of unknown product. Entries assigned to these categories were not evaluated further.

- In addition to the above screening, the following entries were also excluded from further evaluation:
  - 11 additional tank entries were considered to have negligible likelihood of exposure because the product was in a dry form and there was no reported release to a watercourse
  - 1 tank entry was considered to have negligible likelihood of exposure because the product was a refrigerated gas and would not be released to a watercourse
- The remaining 25 tank entries were for the following chemicals: antifreeze, diesel fuel, emulsion/high energy fuel, flocculant concentrate and mixed head, freeze conditioning agent, gasoline, kerosene, propane, Tire Life®, waste oil, and waste oil/diesel blend. These chemicals are not added to media with a pathway to water (with the exception of kerosene used in coal processing noted below) and there were no reported releases from the tanks. Reported spills for these and other chemicals are evaluated in Section 3.0.

Methyl isobutyl carbinol (MIBC) and kerosene are flotation reagents used to enhance separation of ultra-fine coal used in coal processing plants. MIBC is a frother (makes bubbles) and kerosene is a collector (coats the coal and helps it float) that are discharged in wet tailings slurry to a tailings facility. Release to the receiving environment would only occur if there is potential infiltration from a tailings facility to downgradient watercourses. Additional information for these chemicals was reviewed to further evaluate the potential for transport to and persistence in a watercourse:

- The SDS for MIBC indicates it is readily biodegradable (Quadra Chemicals Ltd. 2017). Previous investigations undertaken by Teck at Elkview Operations measured MIBC concentrations of up to 2.8 mg/L in static thickener (May, July, and September 2013) and 2.1 mg/L in froth test wastewater (June 2014). These MIBC concentrations are below reported acute toxicity values for rainbow trout (96-hour no-observable-effects concentration [NOEC] = 105 mg/L and LC_{50} = 359 mg/L; ECHA 2020a). Because of its high degradability and relatively low concentrations in source applications, MIBC was considered to have a low likelihood of reaching a watercourse and was not evaluated further.
- The SDS for kerosene indicates it is inherently biodegradable and its volatile components degrade rapidly in air (Imperial Oil Limited 2017). Previous investigations undertaken by Teck at Elkview Operations in 2013-2014 did not detect concentrations of kerosene downstream of the source application. Therefore, kerosene was considered to have a low likelihood of reaching a watercourse and was not evaluated further.

3.2 Evaluation of Potential Effects

Chemicals retained for detailed evaluation of potential effects were antiscalant and flocculant. Information on toxicity, fate and transport, and chemical use (as described in Section 1.3) was reviewed to evaluate the potential for each chemical to affect fish and thereby have contributed to or caused the WCT population decline. The evaluation for each chemical is provided in the following sections.

3.2.1 Antiscalant

The antiscalant Scaletrol PDC9317 (also known as Depositrol PY5206) has been authorized for use by Teck at GHO to prevent further calcite formation in lower Greenhills Creek since October 2017. Antiscalant is added via the Lower Greenhills Operations Antiscalant Addition System (LGHO System) immediately downstream of the

Greenhills Sediment Pond, prior to water being released into lower Greenhills Creek. The creek then converges with the Fording River just upstream of Josephine Falls.

The maximum effluent antiscalant concentration approved for use in the LGHO system is 150 mg/L, with a maximum in-creek concentration of 5 mg/L in lower Greenhills Creek. This system is not operated during low and high flow conditions such that no antiscalant addition occurs at flows less than 20 L/s or greater than 300 L/s. As reported in Teck's 2018 LGHO Commissioning and Operations Report and the 2019 Operations Report, the estimated in-creek target dosing has ranged from 1.0 to 1.75 mg/L. In 2019, two incidents occurred when the in-creek concentration was estimated to be above the maximum concentration of 5 mg/L (R. Kusch, Teck, pers. comm):

- August 21 for 13 seconds the maximum effluent concentration was 125 mg/L with a subsequent in-creek concentration of 18.5 mg/L; the volume of effluent released during this incident was 12.5 mL.
- August 29 for 31 seconds the maximum effluent concentration was 250 mg/L with a subsequent in-creek concentration of 32.5 mg/L; the volume of effluent released during this incident was 30 mL.

Scaletrol PDC9317 is a proprietary formulation recommended for use as a water-based corrosion inhibitor/deposit control agent. It is stable and composed of an organic compound (a polycarboxylic acid), an inorganic salt, and water. Teck learned from the vendor of the antiscalant that molybdate is part of the production process for making the antiscalant, resulting in a molybdenum concentration of 0.19% in the final product. Therefore, a measurable change in aqueous molybdenum concentration is expected downstream of antiscalant addition, but monitoring has confirmed that molybdenum concentrations in the effluent and the receiving environment remain below the long-term BC water quality guideline of 1 mg/L for the protection of aquatic life (Minnow 2018, 2019, 2020). At the maximum antiscalant concentration in effluent (250 mg/L) the expected molybdenum concentration (0.48 mg/L) would be below the BC water quality guideline.

The maximum antiscalant concentration in effluent (250 mg/L) has remained below the lowest acute toxicity datum obtained from site-specific testing (LC_{50} >400 mg/L). Less than 50% acute lethality to *Daphnia magna* and rainbow trout was observed at the highest concentration of antiscalant tested (400 mg/L) in Fording River water collected from GH_FR1 (Nautilus 2017a). The maximum antiscalant concentration in the receiving environment (32.5 mg/L) remained below the lowest chronic toxicity datum (LC_{25} and IC_{25} >50 mg/L) for early life stage (embryo-alevin) rainbow trout. No adverse effects on survival, development, or growth were observed at the highest concentration tested (50 mg/L) in GH_FR1 water (Nautilus 2017b).

Because antiscalant concentrations have remained below acute and chronic toxicity values in lower Greenhills Creek prior to discharge into the Fording River, and antiscalant has not been used in the upper Fording River until January 2020 (Swift-Cataract Creek), antiscalant is not expected to have contributed to or caused the WCT population decline.

3.2.2 Flocculant

Teck uses settling ponds at FRO to keep TSS below permit levels (50 mg/L TSS) but may occasionally apply flocculant to help aid settling when TSS is elevated. Flocculant is used per an ENV approved FRO flocculant management plan, as summarized below (Teck 2019a). There are 12 settling ponds at FRO, which are considered to have either low or moderate sediment potential with very rare to periodic dependence on flocculant use. Both liquid flocculant and flocculation blocks (or ''floc blocks") are used at FRO and were evaluated separately below. Flocculant (liquid or blocks) was not used at FRO in 2015 and 2016 (Teck 2016, 2017).

Flocculants have the potential to affect aquatic life because of the unintended presence of uncomplexed or residual flocculant that may be discharged from a settling pond. Available information indicates that flocculants are less toxic once complexed with suspended sediments. Toxicity information reported on SDS are generally for the uncomplexed form of flocculant. The objective of the flocculant management plan is to manage application rates for efficiency of TSS settling, while minimizing the potential for residual flocculant to leave the system.

3.2.2.1 Liquid Flocculant

Depending on the TSS concentrations at the inlet of a settling pond, liquid flocculants are pumped neat into the pond inlets using a mobile flocculant trailer. FRO uses Cytec Industries products, usually added in both anionic (CYFLOC A-1849RS) and cationic (CYFLOC C-591) forms to reduce residual cationic flocculant being released from the pond system. Current dosing for CYFLOC C-591 and A-1849RS is between 0 and 8 mg/L, with the maximum dosage only used when TSS concentrations are greater than 500 mg/L. Flocculant concentrations are controlled by manual adjustment of pumps. Liquid flocculants are stored in secondary containment at the Environmental Warehouse until required. The secure flocculant trailer is equipped with secondary containment to prevent discharge in the event of a spill. Both flocculants include a polymer that is not readily biodegradable but is considered to have a molecular volume too large to be bioavailable (Solvay 2017, 2018).

Acute toxicity testing of flocculants in municipal water (without TSS) conducted in 2014 by Nautilus Environmental Inc. (Nautilus) indicated greater toxicity (i.e., lower LC_{50} for rainbow trout and *D. magna*) than reported by the manufacturer (i.e., for zebrafish and *D. magna*; Teck 2019a). These Nautilus results were relied upon instead of the manufacturer data because they were conducted under known test conditions. Nautilus reported 96-h LC_{50} values for rainbow trout of >3 mg/L for anionic flocculant and 0.85 mg/L for cationic flocculant. Nautilus also tested a flocculant mixture (10:3 cationic:anionic) in site water with TSS from Goddard Creek that showed lower toxicity than the cationic flocculant alone in municipal water and decreasing toxicity of the flocculant mixture (rainbow trout 96-h LC_{50} of 1.8 to 14 mg/L) with increasing TSS (16 to 436 mg/L). These tests in site water with TSS were considered to be more representative of site-specific conditions under which flocculant is used (i.e., a mixture of cationic and anionic flocculants and use only when TSS is elevated). Chronic toxicity data for fish have not been reported for the two flocculants.

As reported in Teck's annual monitoring reports for FRO (Teck 2018, 2019b), liquid flocculants were only added to the Lake Mountain Creek Sediment Pond system in the channel that connects the primary and secondary ponds in response to TSS permit exceedances in 2017 (115 mg/L TSS) and 2018 (72 mg/L TSS). Anionic and cationic flocculants were added at a total dosage concentration up to 2 mg/L in 2017 (~7 to 12 hours/day from May 5-8, 2017 [outside of the decline window]; Teck 2018) and 3 mg/L in 2018 (~10 to 24 hours/day from April 26-30, 2018; Teck 2019b). In 2019, flocculants were only added to the Post Sediment Pond system in the channel that connects the primary and secondary ponds. Flocculants were added at a total dosage concentration of 2 mg/L (~18 hours on March 23, 2019) in response to a TSS permit exceedance (59 mg/L TSS) in the newly constructed pond (Teck 2020).

Flocculant dosing in 2018 was higher than in 2017 (outside of the decline window) and 2019 (within the decline window) based on total dosage concentration and duration but occurred at a lower maximum TSS concentration than in 2017. This suggests that there could have been the potential for an increase in residual flocculant to be discharged from the settling ponds in 2018. Both Lake Mountain Creek and Post Sediment Pond were inaccessible to fish in the decline window, so WCT were not exposed at the point of application. Therefore, the first place of potential exposure of fish would be downstream in the Fording River mainstem (~500–600 m from ponds). Flocculant was applied in early spring during freshet (late March to late April) for periods ranging from less than one day (2019) up to five days (2018) within the decline window. Therefore, fish would most likely experience only short-term potential exposure to residual flocculant downstream from the pond discharge. Early life stages of fish are present in the upper Fording River from mid-May to late August and would not be expected to be present during the period when flocculant dosing occurred. Therefore, evaluation of potential effects of flocculant focused on acute toxicity to juvenile or adult fish (i.e., as represented by standard rainbow trout 96-h LC_{50}).

The maximum dosage concentration used at FRO Lake Mountain Creek Sediment Pond in 2018 (3 mg/L) occurred on April 30, 2018 (on the last day of treatment when TSS was 46 mg/L), when only the cationic flocculant was dosed because of pump issues for the anionic flocculant. This concentration was greater than the rainbow trout 96-h LC_{50} of 0.85 mg/L for cationic flocculant in the absence of TSS but it is not known if the concentration would have been greater than an effects concentration for cationic flocculant in the presence of TSS (i.e., TSS reduces the toxicity of the flocculant dose). The maximum dosage concentration when both flocculants were added to the pond (1-2 mg/L on April 26-29, 2018) was less than the rainbow trout 96-h NOEC of 2.5 mg/L and LC_{50} of 3.5 mg/L (10:3 cationic:anionic mixture) at a TSS of 71 mg/L (Teck 2019b), which was the TSS concentration tested by Nautilus that approximated the TSS conditions when dosing of ponds occurred. The maximum dosage concentrations are the total flocculant concentrations added to the pond and would be an overestimate of residual flocculant potentially discharged from the pond following TSS removal and dilution downstream of the pond. No acute toxicity to rainbow trout (96-h) and *D. magna* (48-h) was observed in water samples collected at the sediment pond discharge location (FR_LMP1) during flocculant use in 2018 (April 26, 28-30), and shortly thereafter (May 3 and 7; Teck 2019b, Nautilus 2018a,b,c,d,e,f). These results confirm the expectation that residual flocculant potentially discharged from the pond was not present at concentrations that would cause acute toxicity. Therefore, liquid flocculant is not expected to have caused acute toxicity to WCT at FRO.

There is residual uncertainty regarding the potential for chronic effects from flocculant. Flocculant usage was consistent with the approved management plan and is used at other operations. However, no chronic toxicity data have been reported for these substances and there are no methods to measure or accurately estimate aqueous concentrations of residual flocculant. Flocculant use was limited to short-term durations in early spring and residual flocculant discharged from the settling ponds would be expected to be diluted downstream during freshet flows. Therefore, it is unknown whether liquid flocculant may have contributed to chronic effects to WCT at FRO, but liquid flocculant is not expected to have caused acute effects to WCT.

3.2.2.2 Flocculant Blocks

Floc blocks are used as a proactive control to treat TSS in ditches and drainages where permanent flocculent stations are impractical due to site conditions and/or remoteness of locations. FRO uses the Clearflow products Water Lynx (WL) 360 and WL 494, which are stable, anionic flocculants contained within solid polymer blocks, with a proprietary composition. These blocks are added when the watercourse is carrying sediment (i.e., freshet or heavy rain events) and as the sediment scours the block the co-polymer is slowly dissolved, releasing some anionic flocculent into the water, which binds to sediment and aids settling. The blocks are typically placed near the inlet of settling ponds to allow the sediment to drop out in the pond. The blocks are deployed based on monitoring of flows and TSS and are expected to last 21 to 60 days if sediment is present in the watercourse. Remaining blocks are removed by late October each year from all stations prior to the winter because freezing makes the blocks ineffective and can damage them. The product is not expected to bioaccumulate and is expected to fully degrade through environmental exposure to ultraviolet light (Clearflow 2016, 2018).

As reported in Teck's annual monitoring reports for FRO, floc blocks were used at two locations between 2017 and 2018 (Teck 2018, 2019b):

- Upstream of the primary sediment pond and between the primary and secondary sediment ponds on Lake Mountain Creek in 2017 (42 WL 360 added April 17-20 and removed April 27; 22 WL 360 and 20 WL 494 added May 9 and 19 and removed May 25 [outside of the decline window]) and 2018 (11 WL 360 and 22 WL 494 added May 2; 60 WL 360 and 32 WL 494 added May 5; all removed July 30 [inside the decline window]).
- Upstream of the primary sediment pond on Swift Creek in 2017 (8 WL 360 and 14 WL 494 added May 17 and removed May 31; 6 WL 360 added July 25 and removed July 26 [outside of decline window]).

FRO did not require the use of floc blocks in 2019 (Teck 2020). Per the manufacturer's recommendations, WL 494 blocks were always installed upstream of WL 360 blocks (Teck 2019b). Blocks were only used as an alternative to liquid flocculant and were not used during application of liquid flocculant.

Floc block use in 2018 at Lake Mountain Creek Sediment Pond was 1.1- to 2.7-fold higher in the total number of floc blocks and blocks were deployed longer (~3 months) compared to 2017 (outside of the decline window). This suggests that there could have been the potential for an increase in residual flocculant to be discharged from the settling ponds in 2018. It is plausible that the dissolved flocculant could enter a downstream watercourse if it passed through the settling ponds and that organisms could be exposed for periods longer than those in acute test methods. However, based on the expected mechanism of release and interaction with sediment particles, residual flocculant concentrations would be expected to be low, if at all present. Lake Mountain Creek Sediment Pond was not accessible to fish in the decline window, so WCT were not exposed at the point of application. Therefore, the first place of potential exposure of fish would be downstream in the Fording River mainstem (~500–600 m from ponds). Early life stages of fish are present in the upper Fording River from mid-May to late August and could be present in the downstream receiving environment during the period when floc blocks were deployed at the ponds within the decline window (May to July 2018).

As described in the FRO flocculant management plan (Teck 2019a), the blocks are designed to be slow-release without exceeding 30 mg/L of flocculant in water. Block dosing based on manufacturer recommendations (1 block per 114 litres per minute [LPM]) is expected to achieve average aqueous concentrations of 0.2 to 0.6 mg/L. However, the actual concentration of the anionic flocculent varies on a site-specific basis because the rate of dissolution from the blocks increases with temperature, flow, and TSS. Therefore, it is not possible to determine a definitive aqueous concentration of flocculant associated with block usage. Teck observed that the WL 360 blocks deployed in 2018 were mostly eroded when removed after 3 months. The expected average concentrations of flocculant based on manufacturer recommendations are below the manufacturer-reported acute LC_{50} values for *D. magna* (>1,500 mg/L WL 360 and 418 mg/L WL 494) and rainbow trout (148 mg/L WL 360 and 210 mg/L WL 494). Chronic toxicity data have not been reported for these flocculants.

There is uncertainty relying upon the manufacturer-reported release rates; however, the estimate of maximum concentrations would be an overestimate of residual flocculant potentially discharged from the pond following TSS removal and dilution. No acute toxicity to rainbow trout and *D. magna* was observed in water samples collected at the sediment pond discharge location (FR_LMP1) on May 3 and 7, 2018, shortly after blocks were deployed (Nautilus 2018e,f). Trials of floc blocks at GHO in 2012 and 2013 also showed no acute toxicity to rainbow trout in discharge downstream of blocks (Teck 2013a,b). These results confirm the expectation that residual flocculant potentially discharged from the FRO pond was not present at concentrations that would cause acute toxicity. Therefore, floc blocks are not expected to have caused acute toxicity to WCT at FRO.

There is residual uncertainty regarding the potential for chronic effects from floc blocks. Floc block usage was consistent with the approved management plan and with usage at other operations. However, no chronic toxicity data have been reported for these substances and there are no methods to measure or accurately estimate aqueous concentrations of flocculant dissolved from blocks and residual flocculant. Based on the expected mechanism of release and interaction with sediment particles, residual flocculant concentrations would be expected to be low downstream of the settling ponds discharge. Therefore, it is unknown whether floc blocks may have contributed to chronic effects to WCT at FRO, but floc blocks are not expected to have caused acute effects to WCT.

3.3 Residual Uncertainty and Data Gaps

The evaluation of the potential for industrial chemicals to have contributed to or caused the WCT population decline had the following residual uncertainties or data gaps:

- There were data gaps regarding the storage, containment, and unknown product types in the storage tank databases for FRO and GHO, which limited initial screening approaches.
- The evaluation assumed that all spills were accurately recorded and that there were no unreported spills for the chemicals listed in the storage tank data.
- There is uncertainty in the estimates of exposure concentrations used for both liquid flocculant and dissolved from floc blocks, but these estimates were conservative in that they did not account for removal of flocculant with TSS and dilution downstream of the sediment ponds. Therefore, the concentrations evaluated are overestimates of exposure of WCT to residual flocculant following discharge from the sediment ponds.
- There is uncertainty associated with the potential for chronic toxicity for liquid flocculant and floc blocks because no chronic toxicity data have been reported for these products. Potential exposure to residual liquid flocculant was expected to be limited to short-term durations based on use.
- The evaluation looked at the chemical itself and not the materials that the parent compound could break down to. To the extent that the resulting material is routinely analyzed in water chemistry samples, potential effects of the resulting material was assessed in the surface water quality report (Costa and de Bruyn 2021).

3.4 Summary and Conclusions

An evaluation was undertaken of the potential for industrial chemicals to have contributed to or caused the WCT population decline. Results of this evaluation are summarized below and in Table 1:

- Most industrial chemicals (except MIBC, kerosene, antiscalant, and flocculant) were used and stored in a manner that prevented release to the environment (e.g., no discharge to fish accessible waters, secondary containment, stored far away from any watercourse) and no releases were documented. Documented spills are evaluated in Section 4.0.
- MIBC and kerosene used in coal processing are discharged in wet tailings slurry into tailings ponds where release would only occur if there was potential infiltration to downgradient watercourses. However, available information on persistence and monitoring data indicated that these chemicals had a low likelihood of reaching a watercourse where exposure of WCT could occur.
- Antiscalant and flocculants were evaluated in detail because their intended and approved uses results in the chemical being directly released to creeks or settling ponds so there is a high likelihood of exposure for WCT.
- Antiscalant concentrations at GHO were below acute and chronic toxicity values prior to discharge into the Fording River, and antiscalant has not been used at FRO during the decline window. Therefore, antiscalant was not expected to have contributed to or caused the WCT population decline.
- Maximum dosage concentrations of liquid flocculant and estimated concentrations dissolved from floc blocks were typically less than acute toxicity values, except for April 30, 2018 when only the cationic liquid flocculant was dosed at a concentration above the associated acute toxicity value. No acute toxicity was observed in water samples collected from the sediment pond discharge location during flocculant use, which confirmed the expectation of no acute toxicity. Therefore, flocculants were not expected to have caused acute effects to WCT. It is unknown if flocculants may have contributed to chronic effects because no chronic toxicity information is available for these products. However, concentrations of residual flocculant in the receiving environment are expected to have been low, if at all present, because of flocculant interaction with TSS, settling in the ponds, and subsequent dilution downstream.

Table 1: Framework Summary for Industrial Chemicals

Inputs to Plan the Analysis						Findings: Evaluate Overarching Hypothesis #1				Preliminary Assessment: Strength of Current Evidence to Evaluate Overarching Hypothesis #2		
Stressor	Potential Causal Pathway(s)	Impact Hypothesis	Relevant WCT life-stage, habitat, location, temporal info	Endpoints	What are the requisite Conditions?	Are the requisite conditions met?	Uncertainties or Data Gaps	Summary of Findings	What is the strength of the evidence to support this impact hypothesis as the potential sole cause?	Strength of evidence for contribution to the WCT population decline?	Judgement on relative contribution to the WCT population decline?	If judged to be a potential contributor, what other impact hypothesis(es) is this hypothesis likely to be combined with?
Industrial chemicals	Direct lethal or sub-lethal effects	Did exposure to industrial chemicals contribute to or cause the WCT population decline?	Not restricted with respect to life stages, locations, or timing; depends on when and where industrial chemicals were used relative to where WCT were located in time and in space.	Depends on chemical, but generally included: 1) Hazard and likelihood of exposures (e.g., storage and potential release mechanisms). 2) Available information for each chemical regarding use, monitoring, toxicity testing, transport, and fate.	To contribute: a chemical with moderate or high potential for exposure that indicated a potential for acute or chronic effects. To cause: a chemical or finding that indicated a potential for acute or chronic effects in the majority of habitat (magnitude ratings of moderate to high in the majority of habitat).	To contribute: No for most chemicals /Uncertain for flocculant To cause: No for all chemicals	1) Assumes that all spills were accurately recorded. 2) Data gaps regarding storage containment and unknown product type. 3) Chronic toxicity information for flocculant.	Most industrial chemicals were used and stored in a manner that prevented release to the environment (e.g., no discharge to fish accessible waters, secondary containment, stored far away from any watercourse) and no releases were documented. MIBC and kerosene had low likelihood of reaching a watercourse where exposure of WCT could occur. Antiscalant concentrations were below acute and chronic toxicity values. Flocculant was not expected to be the cause of WCT decline but unknown if may have contributed to decline.	Weak/none	Not applicable (not identified as a potential contributor) for most industrial chemicals, including antiscalant. Uncertain for flocculant due to limited information on potential for chronic effects from residual flocculant.	Not applicable (not identified as a potential contributor) for most industrial chemicals, including antiscalant. Uncertain for flocculant due to limited information on potential for chronic effects from residual flocculant.	Not applicable (not identified as a potential contributor) for most industrial chemicals, including antiscalant. Uncertain for flocculant due to limited information on potential for chronic effects from residual flocculant.

4.0 EVALUATION OF POTENTIAL EFFECTS OF SPILLS

4.1 Screening and Identification of Spills

Teck has an internal reporting procedure for environmental incidents[7] that outlines what and when to report, how to report, and to whom to report (Teck 2015). All environmental incidents within Teck are recorded in an incident tracking system and incidents that require external reporting to regulatory authorities are reported in accordance with those requirements (Teck 2015). Environmental incidents tracked by Teck include spills of mine-related substances such as industrial chemicals, process waters, or tailings. These documented spills are the subject of this section.

Teck provided Golder with an Excel file exported from Teck's tracking system that summarized environmental incidents (including spills) recorded in the decline window (Appendix C). Appendix C contains supporting information for each incident, including but not limited to the substance that was spilled, a description of the incident (when and where, including distance to the nearest surface watercourse that connects to the upper Fording River), the surface type that the material was spilled to (e.g., ground or surface water), the volume of spilled and recovered material, and clean-up actions that were undertaken. Information in Appendix C was supplemented with details provided in Teck's annual water quality reports.

There were 119 incidents that occurred in the decline window (Attachment C). Of the 119 incidents, 33 were not evaluated further herein based on the following rationale:

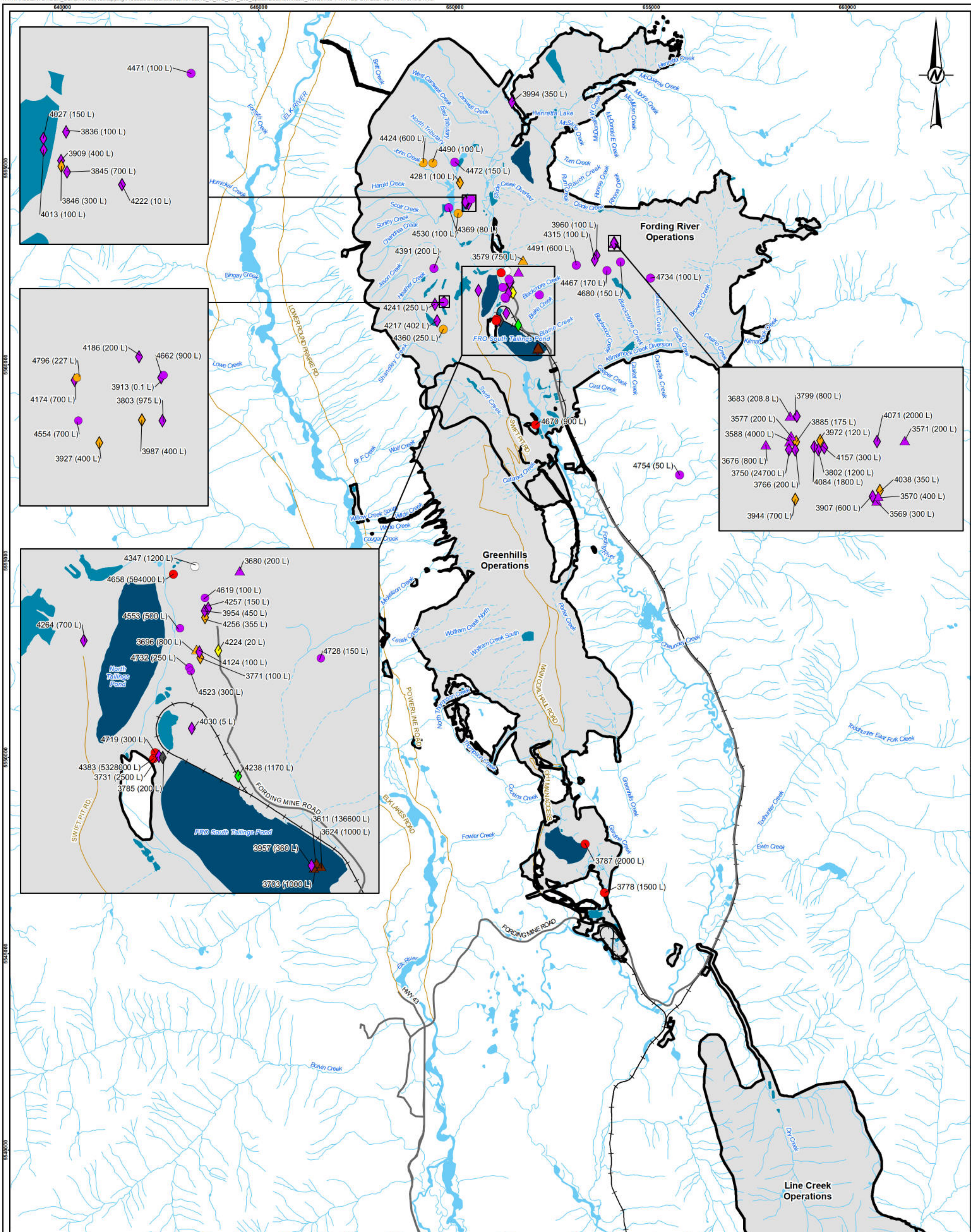
- Six incidents were related to non-compliances (water quality concentrations or toxicity testing results above permitted levels). Potential acute and chronic effects of relevant monitoring data were evaluated in the surface water quality repot (Costa and de Bruyn 2021).
- Nine incidents had a substance name of 'TSS' or a spill description related to road runoff. TSS was evaluated in Ganshorn et al. (2021).
- Seven incidents were not evaluated further because the substance was potable water or fresh water, which were assumed to be non-toxic to fish.
- One incident was related to 6 m^3 of soil from the soil treatment facility that did not meet allowable discharge requirements. The soil was estimated to be <3% of the total discharge pile.
- One incident was related to fly rock that was recorded at FRO's Lake Mountain Pit. Water chemistry samples that were collected for this event were evaluated in Costa and de Bruyn (2021).
- Nine incidents were categorized as having a negligible probability of affecting WCT because the total volume recovered (cleaned up) was equal to or greater than the spilled volume, per Section 1.3.

[7] An environmental incident is defined as "an undesirable event arising from company activities that is both unplanned and uncontrolled, regardless of severity of consequences".

The remaining 86 spills are mapped on Figure 1 and were carried forward for further evaluation.

- Eighty-one (81) spills had a release to ground or into a tailings ponds from which there could be potential infiltration to downgradient watercourses. Additional information for these spills was reviewed in the subsections below to further evaluate the potential for transport to and persistence in a watercourse. At the end of each section, a rating is provided for exposure potential, per Section 1.3.
- Four spills had a direct release to fish accessible waters or waters with a surface connection to fish accessible waters. Accordingly, they were categorized as high likelihood of exposure and retained for detailed evaluation in Section 4.2.
- One additional spill, called the Maxam event, was carried forward to Section 4.2.1 because Teck identified this event as a high-potential incident.

The following subsections evaluate the 81 spills noted in the first bullet above, grouped by substance types with similar chemical and toxicological properties.



LEGEND

INDIVIDUAL SPILLS

2017
- ANTIFREEZE/COOLANT
- PETROLEUM HYDROCARBONS
- TAILINGS

2018
- ANTIFREEZE/COOLANT
- FOAM RESIN
- FOOD GRADE GLYCERIN
- PETROLEUM HYDROCARBONS
- WATER, GLYCOL, SODIUM NITRATE

2019
- ANTIFREEZE/COOLANT
- PETROLEUM HYDROCARBONS
- PROCESS WATER
- TIRE LIFE

- RAILWAY
- ROAD - PAVED
- ROAD - UNPAVED
- SURFACE FLOW WATERCOURSE
- SUBSURFACE FLOW WATERCOURSE
- COAL MINING OPERATION
- WASTE WATER/SEDIMENT POND
- TAILINGS POND
- WATERBODY

0 1,500 3,000
1:95,000 METRES

REFERENCE(S)
HYDROGRAPHY AND ROADS OBTAINED FROM TECK COAL LIMITED. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 11 DATUM: NAD 83

CLIENT
TECK COAL LIMITED

PROJECT
EVALUATION OF UNINTENDED RELEASES— SME REPORT FOR EVALUATION OF CAUSE: UPPER FORDING RIVER WESTSLOPE CUTTHROAT TROUT POPULATION DECLINE

TITLE
SPILLS IN THE DECLINE WINDOW

CONSULTANT
GOLDER

YYYY-MM-DD	2021-02-04
DESIGNED	EJC
PREPARED	DR
REVIEWED	JVG
APPROVED	AdB

PROJECT NO.	CONTROL	REV.	FIGURE
19136042	M_WQ_001	0	1

4.1.1 Antifreeze and Coolant

A total of 19 spills of antifreeze or coolant (16 ethylene glycol, one propylene glycol, and two coolant[8]) were recorded at 18 FRO locations and one LCO location. Spills at FRO were recorded at Eagle 6, Lake Mountain Pit, North Yard, spoils (8 stock to 9 stock), Swift (shovel, spoils, marshalling area), Tire Bay Pad, and warehouse/maintenance building. The spill at LCO was recorded at Mount Michael Pit. None of the spills occurred directly into water. Recorded surface types were gravel, ground, or mud. Spills occurred in 2017 (October, December), 2018 (February, March, April [2], May [2], June [2], July, November, December), and 2019 (January [2], March, April, September [2]).

Figure 2 shows spill volumes in relation to the distance from the spill to surface water. Spill volumes ranged from 80 L to 800 L. Most spill locations (14 of 19) were more than 500 m from surface water (range: 641 to 1,940 m). At the remaining locations (5 of 19), spill locations were between 195 and 422 m from surface water. Most of the recorded spills (14 of 19) were contained or cleaned up using sorbent pads, berms, removal of contaminated material, and/or vacuum trucks (Appendix C), limiting the amount of time the product had to potentially infiltrate into the ground surface. For example, incident 3579 was a 750 L spill of ethylene glycol and water that occurred 338 m from surface water; a berm was created to contain the spill and spill pads were applied. Based on Appendix C, five of the spills either did not have clear cleanup actions or no clean up actions were undertaken; the distance of these five spills to surface water ranged from 195 to 1,562 m. For example, incident 3696 was an 800 L spill of ethylene glycol that occurred 198 m from surface water; no cleanup could be undertaken because the spill occurred underground below the concrete floor at FRO's warehouse/maintenance building. Clean-up would have required the maintenance building to be torn down and rebuilt.

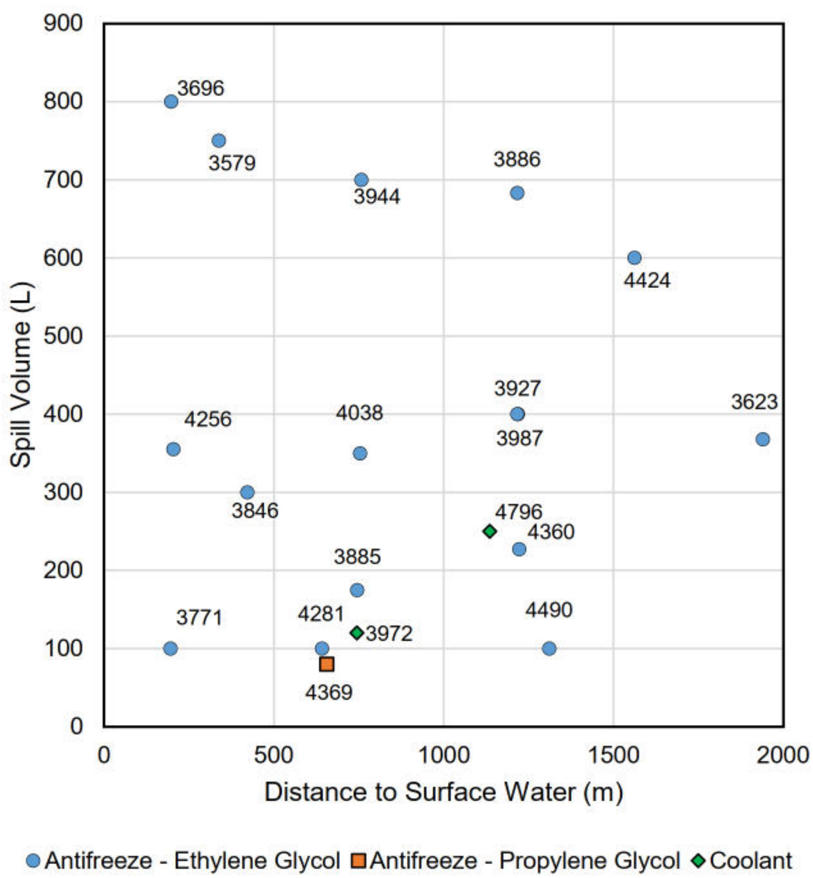
Environmental fate properties for ethylene glycol were obtained from NCBI (2020a). In terrestrial environments (i.e., the environment of recorded spills), NCBI (2020a) concluded that ethylene glycol has high mobility (estimated K_{OC} of 0.2) and low volatilization (Henry's Law constant of 6×10^{-8} atm m^3/mol). However, ethylene glycol is readily biodegradable, with 97% to 100% biodegraded in 2 to 12 days depending on the soil type and conditions (aerobic versus anaerobic). If ethylene glycol reaches water, then NCBI (2020a) concluded that the potential for bioconcentration is low, based on a BCF of 10 for the fish species Golden Ide (*Leuciscus idus melanotus*) after 3 days of exposure. NCBI (2020a) provided six 96-hour LC_{50} values for rainbow trout: 17,760 mg/L, 18,500 mg/L, 41,000 mg/L, 45,510 mg/L, 56,484 mg/L, and 60,829 mg/L.

Environmental fate properties for propylene glycol were obtained from NCBI (2020b). In terrestrial environments (i.e., the environment of recorded spills), NCBI (2020b) concluded that propylene glycol has high mobility (estimated K_{OC} of 1) and low volatilization (Henry's Law constant of 1.3×10^{-8} atm m^3/mol). With respect to degradation, one study showed that propylene glycol in soil was mineralized 73% to 78% over 51 days, indicating biodegradation is an important process. ATSDR (1997a) notes that, assuming first order kinetics, the half-life of propylene glycol in water is estimated to be 1 to 4 days under aerobic conditions and 3 to 5 days under anaerobic conditions; the half-life of propylene glycol in soil is expected to be equal to or slightly less than that for water. If propylene glycol reaches water, then NCBI (2020b) considers the potential for bioconcentration to be low based on an estimated BCF of 3. NCBI (2020b) provided two 96-hour LC_{50} values for rainbow trout: 51,600 mg/L and 45,760 mg/L.

[8] Coolant is generally comprised of 50% antifreeze and 50% water (Total United Kingdom 2019).

In summary, antifreeze and coolant spills occurred to ground, and most often at a distance of greater than 500 m from surface waters. Cleanup actions were undertaken at most of the spills (14 out of 19). The five spills that were not cleaned up occurred at distances of between 198 and 1,562 m from surface water. However, environmental fate properties indicate that degradation is likely fast in soil and/or water. Based on the above information, antifreeze was considered to have a low likelihood of reaching a watercourse and was not evaluated further.

Figure 2: Antifreeze Spills: Spill Volume in Relation to Distance to Surface Water



Notes: units are litres (L) and meters (m). Symbols are annotated with incident number. Information obtained from Table C-1.

4.1.2 Petroleum Hydrocarbons

A total of 54 petroleum hydrocarbon (PHC) spills were recorded at FRO locations only. Of the hydrocarbon spills, 20 were diesel fuel, 1 was "dyno gear grease", 1 was engine oil, 32 were hydraulic oil, 1 was mineral oil, and 1 was transmission oil. The count for diesel fuel and hydraulic oil includes two spills that contained both substances; these spills were included in both sections below. An overview of petroleum hydrocarbons is provided below, followed by an evaluation of potential effects by hydrocarbon type.

Petroleum hydrocarbons are mixtures of organic compounds, of varying proportions, and are comprised primarily of carbon and hydrogen (CCME 2008). Petroleum hydrocarbons contain several hundred compounds derived from crude oil and each petroleum product contains its own mixture and composition of compounds

(ATSDR 1999). CCME (2008) groups hydrocarbons broadly into four subfractions: PHC fraction 1 (F1) (>C6 to C10), PHC F2 (>C10 to C16), PHC F3 (>C16 to C34), and PHC F4 (>C34).

Releases of PHCs to the environment and subsequent transport are governed by several factors. A summary of the ATSDR (1999) discussion on PHC fate and transport is as follows. When PHCs are released to soil, they infiltrate the soil and individual compounds will start to dissolve in air or groundwater as the product moves through the subsurface. The following factors can affect the rate of infiltration: soil moisture, vegetation, terrain, climate, rate of release, soil particle size, and product viscosity. Chemical properties such as volatility, solubility, and sorption potential affect which compounds separate from the mixture. Lighter PHC fractions tend to have higher volatility, higher solubility, and lower sorption potential than heavier PHC fractions. Therefore, lighter PHCs may reach groundwater more readily than heavier fractions where they then could be potentially transported to surface water, whereas heavier PHCs stay relatively immobile (near the point of release) but can persist in the environment. Biodegradation is another factor that governs the fate of PHCs in the environment. Microbes naturally present in soil, groundwater, and surface water can break down PHCs to carbon dioxide and water. The rate of biodegradation is dependent on the product released and site-specific factors (e.g., oxygen content, pH, moisture, temperature, nutrient concentrations, microbes present).

4.1.2.1 Diesel Fuel

A total of 20 diesel fuel spills were recorded at FRO.[9] Spills were recorded at Bridge Fuel Island, Castle South, Eagle 4, Eagle 6, Fuel Island South, Heavy Duty Shop, Lake Mountain Pit, Maxam Bulk Explosive Plant Site, Rail North Loop Pond, South Tailings Pond, Swift (pit and 1885 spoil), and Tire Bay Pad. One spill (incident 3957) occurred in the South Tailings Pond, which has no surface water discharge, and one (incident 4030) occurred directly to the North Loop Pond. The remainder of the spills occurred on ground, asphalt, gravel, or mud.[10] Spills occurred in 2017 (September, October, December), 2018 (January, April, June, July, August, October, November [3], December), and 2019 (April, May [2], July, August [2], September).

There are four types of diesel fuel (diesel fuel [general], diesel fuel No. 1, diesel fuel No. 2, and diesel fuel No. 4), each with slightly different chemical properties (WHO 1996). Diesel fuel (general) is made up of carbon ranges C9 to C28, diesel fuel No. 1 is made up of carbon ranges C4 to C16, and diesel fuel No. 4 is made up of carbon ranges C10 to C30. The carbon ranges for diesel fuel No. 2 were not reported. It is unknown which type of fuel was spilled. Diesel fuel (general), diesel fuel No. 1, and diesel fuel No. 2 are typically used for automobile engines (WHO 1996), so it is likely one of these that were spilled on site. Diesel fuel No. 4 is used for low to medium speed engines such as ships, so is less likely to be one of the products spilled on site.

Figure 3 shows spill volumes for diesel fuel in relation to the distance from the spill to surface water. Spill volumes ranged from 5 L to 4,000 L. Most spills (13 of 20) occurred at a distance of more than 500 m from surface water (range: 534 to 2,164 m). At the remaining locations, spill locations were between 80 m and 365 m from surface water. All but three of the recorded spills, including all of those with the highest volume and closest distance to surface waters, were contained or cleaned up using sorbent pads, berms, removal of contaminated material, and/or vacuum trucks (Appendix C), limiting the amount of time the product had to potentially infiltrate into the ground surface. For example, the 500 L diesel fuel spill at 80 m from surface water (incident 4553) was contained and the environmental department was contacted for clean up guidance. Clean up actions were not specified for

[9] As discussed in Section 4.1.2, two of the 20 spills were a combination of hydraulic oil and diesel fuel. These two spills were assessed in both sections.

[10] Surface types recorded as coal in pit or stockpile were assumed to represent spills to ground.

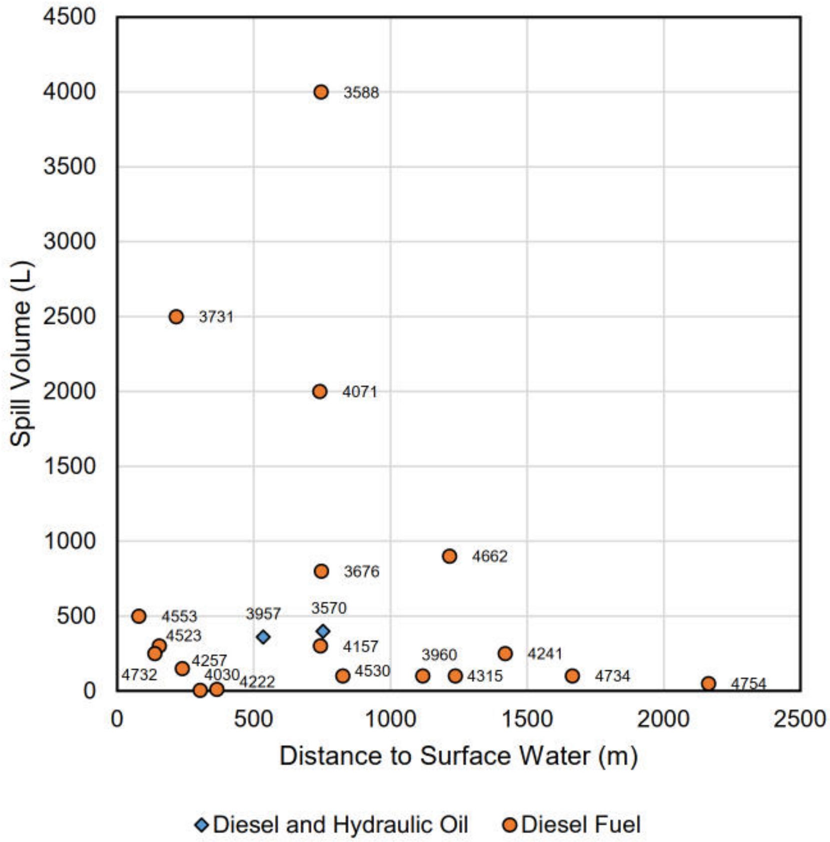
the two spills to water and for one of the spills to ground, it was unknown whether the recommended cleanup action has been completed as the description states “once the dozer is removed from the area will need to remove all contaminated soil/ coal”. For the spill to the South Tailings Pond, no cleanup actions were initiated because the spill volume (360 L) was negligible relative to the volume of the South Tailings Pond[11]; this pond does not have a surface discharge to fish accessible waters. Similarly, for the spill to the North Loop Pond, no cleanup actions were initiated because the spill volume (5 L) was negligible.

Environmental fate properties for diesel fuel were obtained from ECHA (2020b) and WHO (1996). In terrestrial environments (i.e., the environment of all but the two spills to ponds), diesel fuel constituents have a range of mobilities (WHO 1996). Larger polycyclic aromatic hydrocarbons, such as phenanthrene, have low mobility, while smaller constituents, such as benzene, have high mobility. The log K_{OC} reported for the different fuel types ranged from 3 to 6.7 (WHO 1996). Diesel fuel has a percolation rate in soil roughly 4 to 5 times slower than water (WHO 1996). Since diesel fuel is comprised of compounds with varying carbon lengths and molecular weights, some components of diesel fuel are likely to be adsorbed onto soil and unlikely to leach to groundwater, whereas others that are lighter and more mobile may reach the water table. If diesel fuels reached water, models summarized by ECHA (2020b) predict primary biodegradation of most diesel fuel components within days, with ultimate degradation between days and weeks. Bioconcentration factors were not reported in ECHA (2020b) or WHO (1996); however, lighter PHC fractions are more readily metabolized and higher PHC fractions tend to be less soluble, indicating actual bioaccumulation may be low (WHO 1996). The 96-hour LC_{50} for rainbow trout reported in WHO (1996) was 2,186 to 3,017 mg/L.

In summary, all but two diesel fuel spills occurred to ground, typically at a distance greater than 500 m from surface waters. Cleanup actions were undertaken at most of the spills to ground (16 of 18). The two spills to water were considered have negligible impacts to the environment due to the relatively low volume of release compared to the size of the ponds. The two spills to ground that may not have been cleaned up occurred at 747 m and 744 m from surface water. Although some diesel fuel constituents are more mobile than others, biodegradation is expected once constituents reach water. Based on the above information, diesel fuel was considered to have a low likelihood of reaching a watercourse and was not evaluated further.

[11] Spill volume was <0.0003% of pond volume based on maximum storage capacity of 128,628 m^3 in June 2018 (Patrick 2021).

Figure 3: Diesel Fuel Spills: Spill Volume in Relation to Distance to Surface Water



Notes: units are litres (L) or meters (m). Symbols are annotated with incident number. Information obtained from Table C-1.

4.1.2.2 Dyno Gear Crease

One dyno gear grease spill was recorded at FRO's Warehouse/Maintenance Building on 8 September 2018 (incident 4124). The 100 L spill occurred on a concrete pad 197 m from the nearest watercourse. Cleanup actions for this spill were vague but indicated that another company was undertaking cleanup.

The brand and type of gear grease spilled at the site is unknown. Environmental fate properties for representative types of gear grease were obtained from SDS documents for the following brands: Pennzoil, MotoMaster, and Royal Purple. Of the three SDS documents, MotoMaster SDS was the only one that lists ingredients.[12] The Pennzoil multi-purpose grease SDS (Shell Oil Products US 2015) describes the product as "a lubricating grease containing highly refined mineral oils and additives". The Royal Purple SDS indicates that "the manufacturer lists no ingredients as hazardous according to OSHA 29 CFR 1910.1200".

[12] The MotoMaster multi-purpose grease SDS (CITGO 2018) lists the following ingredients: distillates, petroleum, hydrotreated heavy paraffinic; residual oils, petroleum, solvent-dewaxed; distillates, petroleum, hydrotreated heavy naphthenic.

Estimated K_{OC}, Henry's Law constant, and BCF were not available in the SDS documents. In terrestrial environments (i.e., the environment of recorded spill), gear grease will adsorb to soil particles and remain immobile, is not expected to readily biodegrade (e.g., its major constituents are expected to degrade but some constituents may persist in the environment) and is made up of constituents that have the potential to bioaccumulate (Shell Oil Products US 2015). The 96-hour LC_{50} for fish (species not specified) is estimated at 50,000 mg/L (Industry Uptime 2015).

Although gear grease is not expected to degrade and is comprised of some constituents that have the potential to bioaccumulate, the spill occurred to ground and is expected to adsorb to soil and remain immobile. Therefore, gear grease was considered to have a low likelihood of reaching a watercourse and was not evaluated further.

4.1.2.3 Engine Oil

One engine oil spill was recorded at FRO's Swift Creek Soil Salvage on 10 May 2018. The 0.1 L spill was estimated to be 1,216 m from surface water. Environmental fate properties were not obtained for this spill because at this far distance and low volume, the engine oil spill is interpreted to have a negligible likelihood of reaching a watercourse and was not evaluated further.

4.1.2.4 Hydraulic Oil

A total of 32 hydraulic oil spills were recorded at FRO.[13] Spills were recorded at 1795 Free Dump Spoil, Breaker, Causeway Spoil, Eagle 6, Eagle Pit, Lake Mountain Pit, Lake Pit, Lee's Lake Stockpile, South Tailings, Spawn Marshalling Area, Swift, Swift South, Tire Bay, and UFR1 (Tank Farm). One spill occurred in the South Tailings Pond (no surface water discharge). One spill occurred onto an unspecified "other" surface type and could not be categorized based on the spill description. Three surface types were not specified but were interpreted to be to ground surface based on the description. The remainder of the spills occurred on concrete pad, ground, gravel, mud, or waste rock. Spills occurred in 2017 (September [2], October, December [2]), 2018 (January, February [3], March [2], April, May [2], June [2], July [2], August, October [2], November [2]), and 2019 (February, March [3], April, May, June, August [2]).

Figure 4 shows spill volumes for hydraulic oil in relation to the distance from the spill to surface water. Spill volumes ranged from 100 L to 1,800 L. The distance from spill locations to surface water ranged from 136 m to 1,475 m. Most spills (22 of 32) occurred at a distance of more than 500 m from surface water, with the remaining occurring between 136 and 440 m from surface water. All but five of the recorded spills, including all of those with the highest volume and closest distance to surface waters, were contained or cleaned up using sorbent pads, berms, removal of contaminated material, and/or vacuum trucks (Appendix C), limiting the amount of time the product had to potentially infiltrate into the ground surface. For example, the 350 L hydraulic oil spill at 136 m from surface water (incident 3994) was contained with spill pads and a clean up crew and vacuum truck was called to empty the containment and dispose of the material accordingly. The five spills without cleanup actions or with delayed cleanup actions are as follows. For the spill to the South Tailings Pond (incident 3957), no cleanup actions were initiated because the spill volume (360 L) was negligible relative to the volume of the South Tailings Pond (<0.0003% based on maximum storage capacity of 128,628 m^3 in June 2018 [Patrick 2021]); this pond does not have a surface discharge to fish accessible waters. Of the remaining four spills, one was not cleaned up because it dispersed over a long length of the haul road (incident 3799) and cleanup actions were initiated at

[13] As discussed in Section 4.1.2, two of the 32 spills were a combination of hydraulic oil and diesel fuel. These two spills were assessed in both sections.

three of the spills (using spill pads or by containing the spill) but were not be cleaned up right away due to the presence of equipment (incidents 3845, 3907, 4391).

The brand and type of hydraulic oil spilled at the site is unknown. There are three main types of hydraulic oil: mineral oil, organophsphate ester, and polyalphaolefin (ATSDR 1997b). Environmental fate properties for hydraulic oil were obtained from ATSDR (1997b) and several SDSs for hydraulic oil and hydraulic oil components (Chevron 2004; Klondike 2016; Wakefield, 2015).[14]

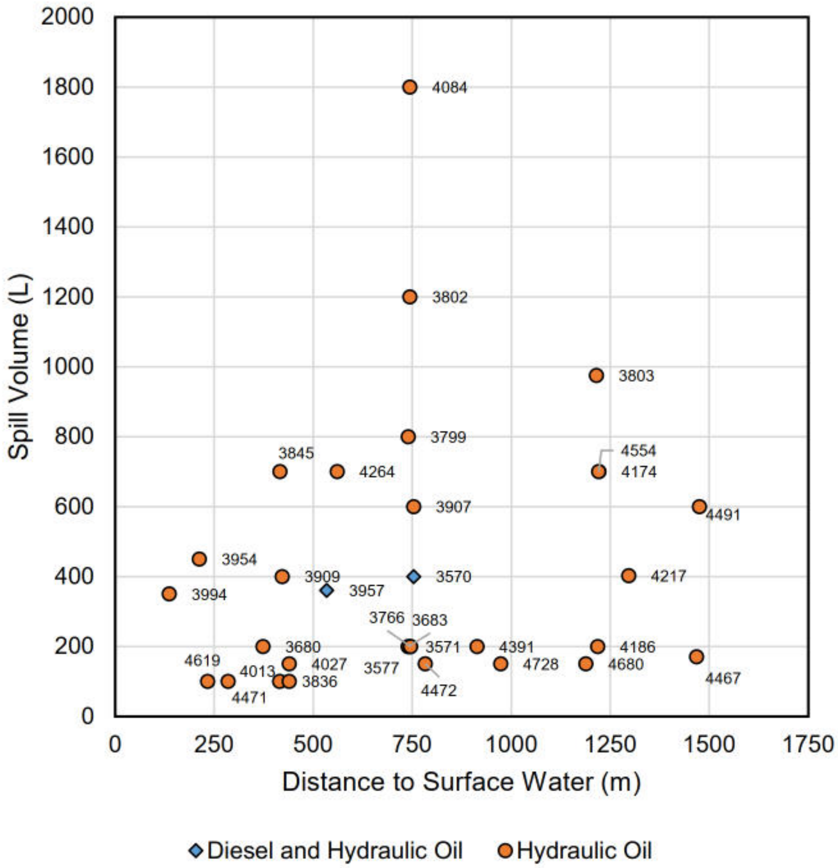
Estimated K_{OC}, Henry's Law constant, and BCF were not available for the hydraulic oil products. One hydraulic oil component (hydrotreated heavy paraffinic distillate) has a log K_{OW} ranging from 3.9 to 6 (Klondike 2016). Chemicals with a log K_{OW} >5 have the potential to bioaccumulate (Environment Canada 2003) and will partition to soil or sediment (ATSDR 1997b). Hydraulic oil is not readily degradable (Klondike 2016). A 96-hour LC_{50} value for rainbow trout was not available for hydraulic oil, but the SDS documents consulted identified 96-hour LC_{50} values in rainbow trout for constituents of hydraulic oil >5,000 mg/L[15]. Chevron (2004) identified a 96-hour LC_{50} >1,000 mg/L for rainbow trout.

All but one of the hydraulic oil spills occurred to ground (31 of 32), in most cases at a distance of greater than 500 m from surface waters (21 of 31). Cleanup actions were undertaken for most spills to ground (27 of 31); the four spills to ground without cleanup actions or with delayed cleanup actions occurred at distances between 416 and 913 m. At these distances, spills of this material were considered unlikely to reach a watercourse because the chemical properties of hydraulic oil indicate partitioning to soil. The single spill to water (South Tailings Pond; 534 m from surface water) was considered unlikely to represent a potential exposure to WCT due to the relatively low volume of release compared to the size of the pond, which has no surface water discharge. Based on the above, hydraulic oil was considered to have a low likelihood of reaching a watercourse and was not evaluated further.

[14] The SDSs list several ingredients for hydraulic oil, including (but not limited to): lubricating oils, petroleum, hydrotreated spent; distillates, petroleum, solvent-refined heavy paraffinic; distillates, petroleum, hydrotreated heavy paraffinic; residual oils, petroleum, hydrotreated; residual oils, petroleum, solvent dewaxed; residual oils, petroleum, solvent-refined; mineral oil.

[15] Constituents were distillates, petroleum, hydrotreated heavy paraffinic; distillates, petroleum, solvent-refined heavy paraffinic; residual oils, petroleum, solvent-refined; residual oils, petroleum, solvent dewaxed.

Figure 4: Hydraulic Oil Spills: Spill Volume in Relation to Distance to Surface Water



Notes: units are litres (L) or meters (m). Symbols are annotated with incident number. Information obtained from Table C-1.

4.1.2.5 Mineral Oil

One mineral oil spill was recorded at FRO's Eagle 6 on 25 January 2018. The 24,700 L spill occurred on the ground 746 m from the nearest surface water. A vacuum truck was used to remove the initial spilled material and then a small loader was used to clear the uncontaminated snow and scrape up the contaminated snow. A labor crew cleaned up around the tanks using shovels and spill pads and placed contaminated material in a bin to be disposed of off site. Approximately 6% of the spill was recovered (1,500 L of the 24,700 L spilled).

The brand and type of mineral oil spilled at the site is unknown. Environmental fate properties for mineral oil were obtained from two SDS (Shell UK Oil Products Ltd 2016a,b), one for a product used for machine oil and the other for heat transfer oil. The SDSs describe the product as "highly refined mineral oil" (the machine oil also includes additives). The heat transfer oil lists a Chemical Abstracts Service number for distillates, petroleum, solvent-dewaxed heavy paraffinic.

Estimated K_{OC}, Henry's Law constant, and BCF were not available. Mineral oil (machine oil) is not expected to biodegrade but mineral oil (heat transfer oil) is expected to biodegrade; both may have the potential to bioaccumulate (Shell UK Oil Products Ltd 2016a,b). A log K_{OW} >6 was reported for both products. Chemicals with a log K_{OW} >5 have the potential to bioaccumulate (Environment Canada 2003). In terrestrial environments (i.e., the environment of recorded spill), mineral oil will adsorb to soil particles and remain immobile. The mineral oil products contain mixtures of non-volatile substances and therefore are not expected to volatilize to air. A 96-hour LC_{50} of greater than 100 mg/L for fish (species not specified) was listed in the SDS.

The spill occurred to ground surface at a distance of 746 m from the nearest watercourse. At this distance, and given that mineral oil is not very mobile in soil, the likelihood for mineral oil to reach surface water is interpreted to be low.

4.1.2.6 Transmission Oil

One transmission oil spill was recorded at FRO at Eagle 6 on 28 September 2017. The 300 L spill occurred on the ground 753 m from surface water. Cleanup actions indicated this spill "will be taken to landfarm".

The brand and type spilled at the site is unknown. Environmental fate properties for transmission oil were obtained from several SDS documents for transmission oil or components of transmission oil (Chevron 2019; Kleen 2017; Pennzoil 2018).[16]

Estimated K_{OC}, Henry's Law constant, and BCF were not available for the hydraulic oil products. Transmission oil is not expected to be degradable (Chevron 2019; Pennzoil 2018) and contains constituents that may have the potential for bioaccumulation (Pennzoil 2018). A log K_{OW} >6 was reported by Pennzoil (2018). Chemicals with a log K_{OW} >5 have the potential to bioaccumulate (Environment Canada 2003). Transmission oil is expected to adsorb to soil particles and remain immobile (Pennzoil 2018). A 96-hour LC_{50} value for rainbow trout was not available for transmission oil. However, Kleen (2017) reported 96-hour LC_{50} values for five combinations of components of transmission oil; all tests resulted in 96-hour LC_{50} values >5,000 mg/L.[17]

In summary, the single transmission oil spill occurred to ground at a distance of 753 m from the nearest watercourse, a clean up plan was identified, and environmental fate properties indicate it is expected to adsorb to soil and remain immobile. Therefore, transmission oil was considered to have a low likelihood of reaching a watercourse and was not evaluated further.

4.1.3 Foam Resin

One foam resin spill was recorded at FRO at the General Office parking lot on 9 November 2018. The 20 L spill occurred on the ground, 309 m from the nearest watercourse. The spill was cleaned up with sorbent pads and the ground was scraped, limiting the amount of time the product had to infiltrate into the ground surface.

The spill was identified as BASF Walltite® foam resin. A search of the BASF webpage returned three results for Walltite® resin. The type of foam resin spilled at the site is unknown. Environmental fate properties for foam resin

[16] The SDSs list several ingredients for transmission oil, including (but not limited to): highly refined mineral oil (C15 to C50) (and additives); lubricating oils, petroleum, hydrotreated spent; mixture of severely hydrotreated and hydrocracked base oil (petroleum); substituted alkyl phosphite.

[17] Components tested with rainbow trout were 1) distillates, petroleum, hydrotreated heavy naphthenic, 2) distillates, petroleum, hydrotreated heavy paraffinic, 3) lubricating oils, petroleum, C20-50, hydrotreated neutral oil-based, high-viscosity, 4) lubricating oils, petroleum, C15-30, hydrotreated neutral oil-based, and 5) lubricating oils, petroleum, C20-50, hydrotreated neutral oil-based.

were obtained from three SDS documents (BASF 2018a,b, 2019). Foam resins can be made up of several different compounds.[18]

Estimated K_{OC}, Henry's Law constant, and BCF were not available in the SDS documents. In terrestrial environments (i.e., the environment of recorded spill), foam resin is not expected to adsorb to soil particles or readily biodegrade and does not significantly bioaccumulate (BASF 2018a,b, 2019). A 96-hour LC_{50} for rainbow trout was not provided in the SDS or for the product as a whole. A 96-hour LC_{50} was provided for fathead minnow exposed to tris(2-chloro-1-methylethyl)phosphate and alkyl halide phosphate (51 mg/L; BASF 2018a, 2019).

Although foam resin is not expected to adsorb to soil particles or readily biodegrade, the single foam resin spill occurred to ground at a distance of 309 m from the nearest watercourse and spill mitigation measures were implemented. Based on the distance and spill clean up, it was considered unlikely that the foam resin spill reached a watercourse and was not evaluated further.

4.1.4 Glycerin

One glycerin spill was recorded at FRO's Rail Loop on 15 November 2018. The 1,170 L spill occurred on the ground 652 m from the nearest watercourse. For cleanup, Teck vacuumed the free water, glycerin, and snow from the area.

Environmental fate properties for glycerin (synonym: glycerol) were obtained from NCBI (2020c). In terrestrial environments (i.e., the environment of recorded spills), NCBI (2020c) concluded that glycerol has high mobility (K_{OC} of 1) and low volatilization from wet soil and higher volatilization in dry soil (Henry's Law constant of 1.73×10^{-8} atm m^3/mol). If glycerol reaches water, NCBI (2020c) concluded the potential for bioconcentration is low, based on a BCF of 3 for aquatic organisms (species not specified). A 96-hour LC_{50} for fish species was not provided. The only toxicity datum for fish was a 24-hour LC_{50} for goldfish of >5,000 mg/L.

Given the distance to surface water and that cleanup actions were undertaken, glycerin was considered to have a low likelihood of reaching a watercourse and was not evaluated further.

4.1.5 Mixture of Water, Glycol, and Sodium Nitrate

One spill was recorded at FRO's Maxam Bulk Explosive Plant on as a mixture of water, glycol, and sodium nitrate. On 10 February 2018, approximately 200 L of the mixture spilled to a concrete pad outside. The spill location was estimated to be 216 m from surface water. Spill pads were applied to the affected area and a loader was used to scrape up the spill. Contaminated material was removed from the area and taken offsite as hazardous waste.

Glycol is a group of organic compounds characterized by two hydroxyl groups attached to different carbon atoms. Glycol commonly refers to the simplest form in the group, ethylene glycol, which is discussed in more detail in Section 4.1.1. In brief, ethylene glycol was characterized as having high mobility, high degradability, and a low potential for bioconcentration.

Environmental fate properties for sodium nitrate were obtained from the Fischer Scientific (2014) SDS. Estimated K_{OC}, Henry's Law constant, and BCF were not available for sodium nitrate. In terrestrial environments (i.e., the environment of recorded spill), sodium nitrate has high mobility, has no bioaccumulative potential, and is readily

[18] The SDSs list several ingredients for BASF Walltite® resin, including (but not limited to): tris(2-chloro-1-methylethyl)phosphate; ethanol, 2-((2-aminoethyl)amino)-, polymer with methyloxirane; diethylene glycol; 2-((2-(dimethylamino)ethyl)methylamino)ethanol; ethanol, 2,2',2'',2'''-(1,2-ethanediyldinitrilo)tetrakis-; 1,2-dimethylimidazole; C.I. basic violet; butane, 1,1,1,3,3-pentafluoro-; propane, 1,1,1,3,3-pentafluoro-; 1,1,1,2,3,3,3-heptafluoropropane; glycerol; diethylene glycol; trade secret ingredients.

biodegradable (Fischer Scientific 2014). The 96-hour LC_{50} value for rainbow trout is estimated at 381 mg/L nitrate as nitrogen (Appendix C of Costa and de Bruyn 2021).

In summary, the spill occurred to ground and spill mitigation measures were implemented. The relatively far distance to surface water (216 m) and high degradability of the material indicates a low likelihood of reaching a watercourse and was not evaluated further.

4.1.6 Process Water and Tailings

Spills of process water and tailings are discussed separately below because the composition of the water, although not always characterized, is expected to be unique to each spill.

4.1.6.1 Incident 4719

On 22 August 2019, approximately 300 L of wash water was spilled from FRO's Maxam Yard to rocky ground. The estimated distance from the spill location to surface water was 171 m. The spilled contents flowed to a low spot on the access road and nearby ditch that subsequently retained the spill (Appendix C). As described in Teck (2020), "a vacuum truck was immediately dispatched to clean up the spilled contents".

Because of the spill volume and distance, and that cleanup actions were initiated immediately, process water from this event was considered to have a low likelihood of reaching a watercourse and was not evaluated further.

4.1.6.2 Incident 3611

The map (Figure 5) and text in *italics* below were provided from Teck's internal review of incident 3611, which involved approximately 136,600 L of tailings spilled from the South Tailings Pond into a containment trench. This incident occurred 535 m from surface water.

On 29 October 2017, FRO had a tailings spill occur on the north end of our South Tailings Pond (STP). For clarification, FRO has provided an overview map of the general area to help explain the incident. Essentially, there are three pipes that come into the STP on the north end. FRO has a tailing line that comes from the processing plant and enters the north end of the STP. Directly south of this tailings line is a make-up water line that brings additional water into the STP for the processing plant. The third line is an overflow culvert that allows any spills along the tailings line to be contained within the containment trench (see map) and flow into the overflow culvert and into the STP.

In this incident, FRO staff observed a small leak coming from our overflow culvert into the containment trench outside the STP at approximately 14:30 on October 29th. This leak was a result of our tailings solids being deposited into the STP in such a way that it forced some of the tailings water to flow back towards our overflow culvert. This back flow eventually flowed out the overflow culvert towards the containment trench which was 100% contained.

As described in Teck (2018), immediate mitigation actions consisted of 1) berming the discharge end of the overflow culvert to prevent further back flow from migrating through the overflow culvert, and 2) additional excavating to redefine a channel through the tailings, allowing a more effective discharge further out into the South Tailings Pond.

Because the material was contained to the trench, tailings from this event was considered to have a low likelihood of reaching a watercourse and was not evaluated further.

Figure 5: Map for Incident 3611

4.1.6.3 Incident 3624

On 31 October 2017, approximately 1,000 L of tailings slurry was observed flowing from the North Abutment of the South Tailings Pond. This event, which occurred 535 m from surface water, occurred during the cleanup for incident 3611 (described in previous section). Teck (2018) described the event as follows:

As part of the cleanup to the October 29, 2017 incident above, tailings material was being excavated from within the tailings pond and placed on the road surface at the north end of the pond in order to allow tailings to flow freely away from the discharge line. This material had a relatively high water content and while the material was sitting in place, water began to seep out into a small depression on the road surface. As more material was excavated, water seeping out of the excavated material exceeded the capacity of the depression and 750-1000 L of this water flowed 100 m on the hard road surface and then into approximately 10 m of ditch. Liquid was still present in low points on the road surface and in the ditch, so there was no significant seepage to ground. No waterways were involved and the water did not reach any sumps or other water bodies. Cleanup involved collecting all standing water and returning it to the tailings pond. Samples were collected from the spilled water as well as adjacent sumps and the Fording River upstream and downstream of the spill location. No detectable effects were evident in any of these downstream water bodies and it was therefore determined that none of the contacted water reached any of these sumps or the river. FRO immediately notified EMBC. Extensive efforts were made to remove residual spill materials from ditch lines and road surfaces.

Based on the conclusion of limited groundwater seepage, the observation of no water connection to sumps or other waterbodies, and the undertaking of "extensive" cleanup actions, tailings from this event was considered to have a low likelihood of reaching a watercourse and was not evaluated further.

4.1.6.4 Incident 3703

On 25 December 2017, approximately 1,000 L of tailings spilled from the South Tailings Pond into a containment trench (see map provided in Section 4.1.6.2). This incident occurred 534 m from surface water. No water chemistry samples were collected for this event. Cleanup actions for this event included excavating loose materials and putting barriers in place (Appendix C). Because the spilled material entered the containment trench and that cleanup actions were undertaken, tailings from this event was considered to have a low likelihood of reaching a watercourse and was not evaluated further.

4.1.7 Tire Life

On 17 January 2019, approximately 1,200 L of tire life spilled at FRO's North Yard (incident 4347). The spill occurred on the ground 133 m from the nearest surface water. Spill pads were used, and a vacuum truck was mobilized to remove residue (Appendix C). Information summarized below was obtained from two SDS provide by Teck: one for a product called "Tire Life PSD Plus" (Fuller Brothers 2015a) and one for a product called "Tire Life High Temp, Tire Life 20%, Tire Life All Weather, & Tire Life Arctic" (Fuller Brothers 2015b).

Tire Life is used as a rust inhibitor (both SDSs), sealer (both SDSs), and coolant (Fuller Brothers 2015b only). Both SDSs note that tire life is comprised of proprietary ingredients, so the exact composition is unknown. Estimated K_{OC}, Henry's Law constant, and BCF were not available. Both SDSs state that the product is rapidly degradable, and Fuller Brothers (2015b) indicates that the product is readily biodegradable, although neither SDS provides degradation rates. No fish toxicity data were provided in Fuller Brother (2015a). In Fuller Brothers (2015b), a 96-hour LC_{50} for fathead minnow of 7,000 mg/L is provided for testing using a "similar mixture".

The spill occurred to ground surface at a distance of 133 m from the nearest watercourse. At this distance, and given that Tire Life is reported to be rapidly degradable, the likelihood for Tire Life to reach surface water is interpreted to be low.

4.2 Evaluation of Potential Effects

As discussed in Section 4.1, five events were retained for a detailed evaluation because they were categorized as high likelihood of exposure or, in the case of the Maxam event, because Teck identified this event as a high-potential incident. These events are discussed in the subsections below.

4.2.1 Incident 4383 (Maxam Event)

The text in italics below was provided from Teck's internal review of incident 4384, which involved the release of an unknown volume of wash water containing ammonium nitrate from the Maxam Facility to the ground.

On approximately Feb 3, 2019 the Maxam yard sump (CIL sump) discharge line froze resulting in no flow from the sump to the south tailings pond. Water from the Maxam facility continued to flow into the sump resulting in the sump backing up into the collection sump which filled up and overflowed to the swale located across the road to the south. Water from the sump continued to overflow to the swale until the overflow was observed on Feb 5, 2019 resulting in corrective actions being taken. Between Feb 5, 2019 and Feb 26, 2019, there were three days where vactor trucks were not used to maintain low sump levels. It is considered possible that there were additional backups and undocumented spills during these days.

Teck estimated that the release volume was likely to have been approximately 61,300 L using circumstantial evidence, but that the release volume may have been as high as 1,578,000 L[19]. Humphries and Henry (2020, 2021) conducted an investigation into the Maxam event, including a review of pathways to the receiving environment, groundwater modelling of the spilled substance through those pathways, and screening against generic WQGs to evaluate potential effects of groundwater quality at the point of discharge to the receiving environment. As part of this investigation, Humphries and Henry (2020) concluded that the upper-end release volume was more conservative since only circumstantial evidence supported the low-end estimate; therefore, Humphries and Henry (2020) used the volume of 1,578,000 L released over 22.5 days as a 'base-case' scenario for their simulations. The groundwater modelling conducted by Humphries and Henry (2020, 2021) indicated that ammonia concentrations were predicted to be below the long-term BC WQG at the point of release to fish accessible waters under the base-case scenario, and that the maximum concentrations would have occurred outside the decline window. Ammonia concentrations were predicted to marginally exceed the long-term BC WQG within the decline window under alternate scenarios that were simulated. However, the predicted concentrations would meet the long-term BC WQG when factoring in dilution that occurs within the mixing zone between groundwater and surface water[20]. Moreover, the alternate release scenarios were considered by Humphries and Henry (2020, 2021) to be highly conservative and unlikely. Therefore, the Maxam event is not expected to have contributed to or caused the WCT population decline.

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[19] The spill volume was initially estimated to be 5,328,000 L. Teck used circumstantial evidence to conclude that the spill volume was most likely 61,300 L.

[20] A dilution factor of 10 times is assumed within the mixing zone, which is considered to be within 10 m of the high water mark of a surface water body according to the BC Contaminated Sites Regulation (CSR) Technical Guidance (TG) 15 (ENV, 2017).

4.2.2 Incident 4658

From 20 to 21 July 2019, approximately 594,000 L of water discharged from the FRO site near Liverpool pond to the Fording River as a result of a receiving 49 mm of rain over the previous 24 hours.[21] As outlined in the spill description (Attachment C), the water originated from the haul road drainage that goes into a series of designed sumps on the west side of the Fording River, approximately 200 m downstream of the multi-plate culvert. These sumps were temporarily overwhelmed due to the intense rainfall and water reported to the Fording River. The discharged material flowed to the Fording River subsurface from the sump through the riverbank and directly into the river (Burroughs 2020).

In response to this event, Teck collected water chemistry samples on 20 July 2019 from the Fording River directly where the turbid water was entering (FR_FRDSLP1), the Fording River approximately 30 m upstream of the discharge (FR_30MUSLP1), and the Fording River approximately 2.8 kilometers downstream of the discharge (FR_FR2) (Burroughs 2020). On 21 July 2019, a second sample was collected from the Fording River directly where the turbid water was entering (FR_FRDSLP1), although this sample had fewer constituents analyzed (conventional parameters, nutrients, and major ions). Because the discharged material was flowing subsurface through the riverbank and directly into the river, the discharged material itself could not be sampled (Burroughs 2020). Sample locations are shown on Figure 6.

Chemistry results in these samples are compared to generic water quality guidelines and screening values for fish in Appendix D, Table D1. This event occurred over two days, so emphasis was placed on evaluating potential acute effects, per Section 1.3.

Concentrations were below short-term WQGs for all constituents (Fording River upstream sample and Fording River ~2.8km downstream sample) or all constituents except iron (Fording River where water was entering). For iron, the concentration in the Fording River sample collected where water was entering was below the acute screening value for fish (Table D1). Therefore, acute effects would not be expected from this event. Based on these results, this event did not meet the requisite conditions to contribute to or cause the WCT decline. This interpretation is further supported by the fact that the event occurred at the end of the decline window (July 2019).

[21] The Excel file provided by Teck indicated that this incident occurred on 21 July 2019, but Burroughs (2020) clarified that the incident occurred on 20 July 2020. Appendix C indicates that the event stopped at 9:00 AM on 21 July 2020.

Figure 6: Map for Incident 4658 (Provided by Burroughs 2020)

4.2.3 Incident 4670

On 20 July 2019, approximately 900 L of process water discharged to the Fording River via Swift Creek.[22] The event was preceded by snow followed by rain, which temporarily overwhelmed a local sump and silt fence.

In response to this event, Teck collected water chemistry samples on 20 July 2019 of the spilled material (FR_LP1UD03162019), from Swift Creek downstream of the discharge (GH_SC3), in the Fording River upstream of the Swift Creek confluence (FR_FR3), and in the Fording River approximately 30 m downstream of the Swift Creek confluence (FR_DSSWFTCRBRDG) (Burroughs 2020; Teck 2020). Sample locations are shown on Figure 7.

Chemistry results in these samples are compared to generic water quality guidelines and screening values for fish in Appendix D, Table D2. This event occurred on one day, so emphasis was placed on evaluating potential acute effects, per Section 1.3.

Concentrations were below short-term WQGs for all constituents (Fording River samples) or all constituents except iron (spilled material and Swift sample). For iron, concentrations in the spilled material and Swift sample were below the acute screening value for fish (Table D2). Therefore, acute effects would not be expected from this event. Based on these results, this event did not meet the requisite conditions to contribute to or cause the WCT decline. This interpretation is further supported by the fact that the event occurred at the end of the decline window (July 2019).

[22] The Excel file provided by Teck indicated that this incident occurred on 21 July 2019, but Burroughs (2020) clarified that the incident occurred on 20 July 2020.

Figure 7: Map for Incident 4670 (Provided by Burroughs 2020)

4.2.4 Incident 3778

On 12 August 2019, approximately 1,500 L of process water from the overland clean conveyer at GHO was spilled to rocky ground. Although the spill location is estimated to be approximately 116 m from surface water, the washing and cleaning around the conveyer resulted in water flowing across the road and into Greenhills Creek (Appendix C).

Water chemistry samples were collected two to three days after the spill at station GH_GH1 (sediment pond decant upstream of event; 15 August 2019) and in two samples labelled as GH_GH1B (upstream and downstream point of entry; 14 August 2019). The sample collected from GH_GH1B at 10:00 AM is upstream of the point of entry, and the sample collected from GH_GH1B at 10:17 AM is downstream the point of entry.

Chemistry results in incident 3778 samples are compared to generic water quality guidelines and screening values for fish in Appendix D, Table D3. Because there was a temporal disconnect between the event and water sampling, chemistry data were reviewed to evaluate if the spill had a long-lasting effect on water quality. A comparison of water chemistry data in Table D3 to that evaluated for Greenhills Creek in the surface water quality report (Costa and de Bruyn 2021) indicated general alignment. This finding supports the interpretation that spills are transient events, but this finding also indicates that the chemistry samples collected for this event may not be appropriate to evaluate potential effects of the spilled material. Therefore, water chemistry samples collected for this event were not considered appropriate to evaluate potential effects to WCT.

In summary, it is uncertain whether concentrations in these samples reflect the event because there was a temporal disconnect between the event (12 August 2019) and the sample collection dates (14 or 15 August 2019). In addition, no water chemistry samples were collected of the spilled material itself. Therefore, this event could not be ruled out as a potential contributor. Evidence for contribution is interpreted to be weak given that the spill occurred in the lower end of the watershed and at the end of the decline window (August 2019). The role of this event in the WCT decline is interpreted to be negligible to minor with uncertainty dependent on the composition of the spilled material.

4.2.5 Incident 3787

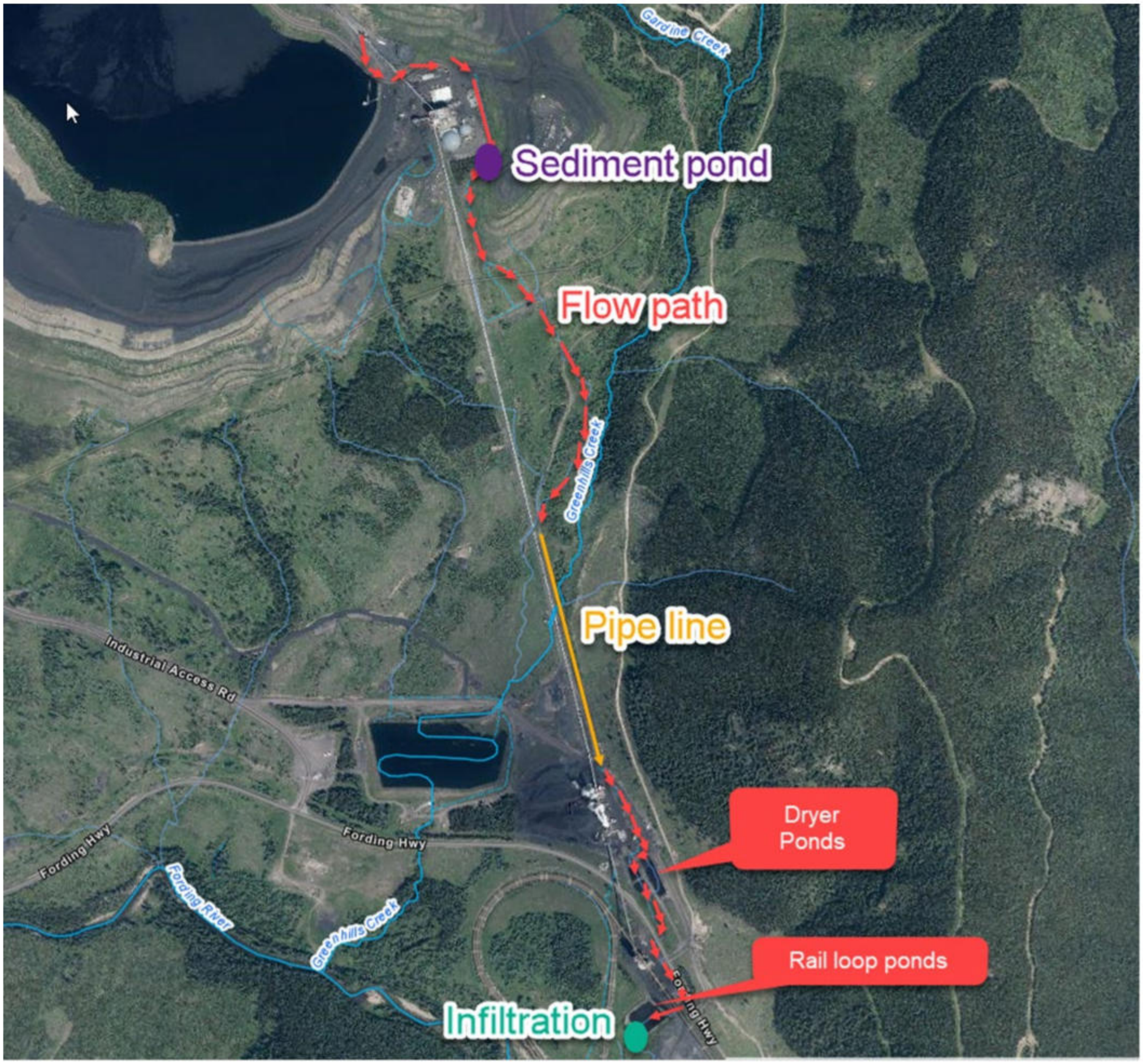
On 23 August 2019, approximately 2,000 L of process water from Frozen Coal Building at GHO was spilled to into the ditch system on the northeast side of the wash plant, which discharges into the Site A sediment pond. The estimated distance from the spill location to surface water was 662 m.

Water chemistry samples were not collected for this event. However, it is expected that the spilled material would enter the Site A pond where it would stay until there was a significant rainfall or flush (Stickney 2020a). At that point, water would be most likely conveyed to one of the following: 1) dryer ponds and then the Rail Loop Pond near the GHO Dryer where there is permitted monitoring, or 2) the Site C basin and then flow overland to Greenhills Creek upstream of the ponds where there is permitted monitoring (Stickney 2020a).

Figure 8 shows the first flow path described above (to Rail Loop Pond), as Stickney (2020b) expects this to be the most likely path. This expectation is based on the pathway being open at this time of year (August) and that inspection records indicate that the pipe (yellow on Figure 8) was functioning normally on July 11, August 8, and September 5 (Stickney 2020b). Under this flow path, the spill would "not have directly impacted Gardine or Greenhills creek[s]" (Stickney 2020b). Following this pathway, if this spill reached surface water, it would have passed through the Rail Loop Pond which was assessed in the surface water quality report (Costa and de Bruyn, 2021). Rail Loop Pond infiltrates via ground to the Fording River.

In summary, the lack of chemistry data precluded an evaluation of potential acute or chronic effects of the material itself. Therefore, this event could not be ruled out as a potential contributor. Evidence for contribution is interpreted to be weak given that the spill is expected to dilute in intermediate watercourses, as well as that the spill occurred in the lower end of the watershed and at the end of the decline window (August 2019). The role of this event in the WCT decline is interpreted to be negligible to minor with uncertainty dependent on the composition of the spilled material.

Figure 8: Map and Flow Path for Incident 3787 (Provided by Stickney 2020b)



Note: red arrows show expected flow path.

4.3 Residual Uncertainty and Data Gaps

Uncertainties or data gaps associated with the evaluation of the potential for spills to have contributed to or caused the WCT population decline are discussed as follows:

- The evaluation assumed that all spills were accurately recorded and that there were no unreported spills. The spill descriptions were not all provided with the same level of detail and the assessment was conducted using available information for each event.

- For some of the spills, the exact product or the composition of the spill was not specified and/or SDS documents did not contain information to allow for assessment of mobility in soil (K_{OC}), bioaccumulation in aquatic life (BCF), or volatilization potential (Henry's Law Constants). Therefore, chemical properties and toxicity information were obtained for constituents that were readily available. For PHCs, the spills were separated by product type (e.g., diesel fuel, engine oil, etc.) to narrow down the substances spilled; however, PHCs are complex mixtures of hundreds of organic compounds in varying proportions and it was not possible to evaluate each constituent. Many products are also made up of proprietary constituents, which could not be evaluated in this assessment. For example, there may be additives to antifreeze and coolant products (i.e., corrosion inhibitors, surfactants, buffers etc.) that were not evaluated. This uncertainty is partially offset by availability of other information on the event that was used to characterize exposure potential, including the spill volume, distance to surface waters, and cleanup actions that were undertaken.
- Rainbow trout was selected as a surrogate for WCT and 96-hour LC_{50} values were summarized, where available. Some SDS documents did not specify the fish species or did not provide toxicity information for rainbow trout. In many cases, LC_{50} values were provided for a specific constituent of the product and not the product as a whole.
- For spills carried forward for a detailed evaluation, one event did not have water chemistry samples collected (incident 3787) and one event had water chemistry samples that were collected two to three days after the event, but not of the spilled material (incident 3778).
- Estimates to the nearest surface watercourse were based on a linear path from the spill to the nearest surface water that drains into the upper Fording River watershed. For spills to ground, this implies a linear groundwater pathway between the two points (spill to surface water). This is expected to be a conservative assumption, with the actual pathway expected to be longer.
- The evaluation looked at the spilled substance itself and not the materials that the parent compound could break down to. To the extent that the resulting material is routinely analyzed in water chemistry samples, potential effects of the resulting material was assessed in the surface water quality report (Costa and de Bruyn 2021).

4.4 Summary and Conclusions

An evaluation of the potential for spills to have contributed to or caused the WCT population decline was undertaken. Results of this evaluation are summarized below and in Table 2:

- Most spills were to ground surface, several hundred metres from the nearest watercourse, and were contained or cleaned up using sorbent pads, berms, removal of contaminated material, and/or vacuum trucks, limiting the amount of time the product had to potentially infiltrate into the ground surface. These spill details, in addition to available information on mobility and degradation, indicated that these substances had a negligible or low likelihood of reaching a watercourse where exposure of WCT could occur.

- Five spills were evaluated in detail because they involved a direct release to fish accessible waters or waters with a surface connection to fish accessible waters, or, for the Maxam event, because Teck identified the event as a high-potential incident. As summarized in the bullets below, three of these spills (incidents 4383, 4658, and 4670) were not expected to have contributed to or caused the WCT decline. For the remaining two spills (incidents 3778 and 3787), it could not be ruled out that the spilled material may have contributed to the WCT decline:
  - For incident 4383 (Maxam event), groundwater modelling conducted by Humphries and Henry (2020) indicted that concentrations were below acute and chronic water quality guidelines at the point of release. Therefore, this event was not expected to have contributed to or caused the WCT decline.
  - For incidents 4670 and 4658, concentrations were below acute screening values for fish, indicating no acute effects. Based on these results, these events did not meet the requisite conditions to contribute to or cause the WCT decline. This interpretation is further supported by the fact that these events occurred at the end of the decline window (July 2019).
  - For incidents 3778 and 3787, either no water chemistry samples were collected (3787) or samples were collected two to three days after the event (3778). For incident 3778, concentrations in event samples were similar to the long-term monitoring dataset from Greenhills Creek, potentially indicating that the samples did not reflect the spill event. In consideration of the above uncertainty, these events could not be ruled out as a potential contributor. Evidence for contribution is interpreted to be weak given that the spills occurred in the lower end of the watershed and at the end of the decline window (August 2019). In addition, for incident 3787, the spill material is expected to dilute in intermediate watercourses. The role of these events in the WCT decline is interpreted to be negligible to minor with uncertainty dependent on the composition of the spilled material.

Table 2: Framework Summary for Spills

Inputs to Plan the Analysis						Findings: Evaluate Overarching Hypothesis #1				Preliminary Assessment: Strength of Current Evidence to Evaluate Overarching Hypothesis #2		
Stressor	Potential Causal Pathway(s)	Impact Hypothesis	Relevant WCT life-stage, habitat, location, temporal info	Endpoints	What are the requisite Conditions?	Are the requisite conditions met?	Uncertainties or Data Gaps	Summary of Findings	What is the strength of the evidence to support this impact hypothesis as the potential sole cause?	Strength of evidence for contribution to the WCT population decline?	Judgement on relative contribution to the WCT population decline?	If judged to be a potential contributor, what other impact hypothesis(es) is this hypothesis likely to be combined with?
Spills	Direct lethal or sub-lethal effects	Did exposure to spills contribute to or cause the WCT population decline?	Not restricted with respect to life stages, locations, or timing; depends on when and where spills occurred relative to where WCT were located in time and in space.	Depends on spill, but generally included: 1) Hazard and likelihood of exposure (e.g., details of event such as spill volume, distance to surface water, and cleanup actions). 2) Available information for each spill regarding material, transport, and fate.	To contribute: a spill with moderate or high potential for exposure that indicated a potential for acute or chronic effects. To cause: a spill or finding that indicated a potential for acute or chronic effects on a large fraction of the population (magnitude ratings of moderate to high in the majority of habitat).	To contribute: No for most spills /Possible for two spills (incidents 3778, 3787) To cause: No for all spills	1) Assumes that all spills were accurately recorded. 2) Data gaps regarding water chemistry samples of spilled material. 3) Exact product or composition of spilled material.	Most spills were to ground surface, several hundred metres from the nearest watercourse, and were contained or cleaned up. This information and environmental fate properties indicated that these substances had a negligible or low likelihood of reaching a watercourse where exposure of WCT could occur. Three spills with high likelihood of exposure (4383, 4658, 4670) were below short-term WQGs and/or acute screening values. Two spills with high likelihood of exposure (incidents 3778, 3787) could not be ruled out as contributors.	Weak / None	Not applicable (not identified as a potential contributor) for most spills. Weak for two spills (incidents 3778, 3778) because events occurred in the lower end of the watershed and at the end of the decline window.	Not applicable (not identified as a potential contributor) for most spills. Negligible to minor, with uncertainty because water chemistry samples were not collected for the spilled material.	Not applicable (not identified as a potential contributor) for most spills.

5.0 CLOSURE

We trust that the information provided in this report is sufficient for your present needs. Should you have any questions, please do not hesitate to contact the undersigned.

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APPENDIX A

Stressor Evaluation—Sewage (Prepared by Azimuth Consulting Group Inc.)

Azimuth Consulting Group Inc.
218-2902 West Broadway
Vancouver, BC
Canada V6K 2G8

Phone: 604-730-1220
www.azimuthgroup.ca

Memorandum

Date: **April, 2021**

To: **Teck Coal Limited**

From: **Azimuth Consulting Group Inc.**

Contract: **Evaluation of Cause: Upper Fording River WCT Population Decline**

RE: **Stressor Evaluation – Sewage**

Introduction

This document is one of a series of Subject Matter Expert (SME) documents that support the overall Evaluation of Cause into the upper Fording River Westslope Cutthroat Trout population decline. The overall report (Evaluation of Cause Team, 2021) should be referred to for background information.

Azimuth has prepared this memo in response to the question: Is it possible that unauthorized discharges from the Fording River Operations (FRO) Sewage Treatment Facility caused or contributed to the decline of the local Westslope Cutthroat Trout (WCT) that occurred during the Decline Window, i.e., the two-year-period between September 2017 and September 2019? Consistent with other SME reports in the Evaluation of Cause, a Framework Table was completed (Appendix A).

Background

Population monitoring in September 2017 reported a high abundance of WCT juveniles and adults relative to historic levels (Cope, 2020). No unauthorized discharges of sewage were reported by Teck Coal Limited during the Decline Window. This document reviews the potential for WCT to have been exposed to discharge from the Sewage Treatment Facility that could have impacted the population. Sewage is known to be acutely toxic to fish, often from anoxia or ammonia exposure which, in the event of an unauthorized release, would have the potential to affect all WCT life stages, at least in the immediate vicinity of the spill.

Evaluation

For this review, Teck Coal provided records of two, relatively recent, unauthorized discharges. One occurred before the Decline Window and one occurred after it, as described briefly below. Neither the timing of these discharges, nor their specific characteristics with respect to size, location and potential impacts on water quality, are consistent with the potential for WCT to have been exposed to, or negatively impacted by, the discharges.

- August 8, 2017 — Approximately 20 litres of human waste came up to ground when an existing well bore was accidentally drilled at Swifter Interceptor Road and affected an area of just under one square metre (Teck Coal internal database, 2020). This event occurred prior to the fish monitoring in September 2017 that reported high abundance of WCT. The timing of this discharge is, therefore, inconsistent with the potential for it to have impacted the WCT population. Moreover, there is no plausible mechanism/pathway for this limited discharge to have reached the river or its tributaries.

- February 16, 2020 — FRO reported (Appendix B) a non-compliance event when effluent was observed discharging from the emergency basin and slowly migrating to the Swift Access Road. The effluent was contained in a natural depression in the road, and vacuum trucks captured all the discharged effluent, totaling 155 m^3 (Roughead, 2020). Given the timing of this unauthorized discharge, i.e., that it occurred outside the Decline Window, and spill clean-up actions there is no potential for it to have caused or contributed to the WCT population decline. Moreover, this event did not result in exceedances of British Columbia Water Quality Guidelines for Biochemical Oxygen Demand or Total Suspended Solids in samples collected at either the discharge location or at locations upstream and downstream of the discharge location.

Suggested citation:

Branton, M. & B. Power. 2021. Stressor Evaluation – Sewage. In Van Geest et al. 2021. Subject Matter Expert Report: Industrial Chemicals, Spills and Unauthorized Releases. Evaluation of Cause – Decline in Upper Fording River Westslope Cutthroat Trout Population. Report prepared for Teck Coal Limited. Prepared by Golder Associates Ltd.

PROFESSIONAL STATEMENT AND SIGNATURES

The following signatories are the principal authors of this report and affirm the following:

I am an applied scientist specializing in an applied science applicable to the duty or function performed and have demonstrable experience in biology and toxicology.

I am registered and in good standing with the indicated professional accrediting body.

Through suitable education, experience, accreditation and knowledge, I may be reasonably relied on to provide advice within my area of expertise.

The data analysis and interpretation performed by me, and reported herein, has been performed to the best of my ability in accordance with approved protocols, guidance, procedures, policies, methods and standards of professional practice.

The information used in the performance of the data analysis, interpretation, conclusions and recommendations (if any) reported herein are true and accurate based on my current knowledge as of the date completed.

Name	Accreditation	Accrediting Body	Signature	Date completed
Maggie Branton	Professional Agrologist (PAg)	B.C. Institute of Agrologists	BRITISH COLUMBIA INSTITUTE OF AGROLOGISTS 3131 Margaret A. Branton P.Ag.	March 30, 2021
Beth Power	Registered Professional Biologist (RPBio)	B.C. College of Applied Biology	COLLEGE OF APPLIED BIOLOGY Elizabeth A. Power R.P. Bio #571 CAB	March 30, 2021

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APPENDICES

APPENDIX A:
EVALUATION OF CAUSE: FRAMEWORK FOR OVERARCHING HYPOTHESIS #1

	DETAILED METHODS AND RESULTS FOR ANALYSES	INPUTS TO PLAN THE ANALYSES						FINDINGS: EVALUATE OVERARCHING HYPOTHESIS #1				PRELIMINARY ASSESSMENT: STRENGTH OF CURRENT EVIDENCE TO EVALUATE OVERARCHING HYPOTHESIS #2		
SME	**Citation for SME's Analysis**	**Stressor**	**Potential Causal Pathways** (= pathway of effect that could be the cause of the observed effect)	**Impact Hypotheses** (= an overarching way to describe how a stressor may have influenced the WCT population)	**Relevant WCT life-stage, UFR location, habitat, or temporal information (duration/frequency)**	**Endpoints** (= measure, observation or the like that provides evidence. These are the data sources and methods used in the analysis)	**What are the "requisite conditions" for this impact hypothesis to be explanatory?** (= the conditions that would have needed to occur for the impact hypothesis to have resulted in the observed decline of the UFR WCT, including spatial extent, duration, location, timing, intensity)	**Are the requisite conditions for this impact hypothesis met?** (Based on information the SME has and professional judgement)	**Uncertainties or Data Gaps** (Uncertainties may include aspects such as: natural variability, random measurement error, systematic measurement error, structural or model uncertainty, and ignorance)	**Summary of Findings**	**What is the strength of the evidence to support this impact hypothesis as the potential sole cause (without considering other potential impact hypotheses, could this impact hypothesis explain the WCT population decline)?** (strong, possible, weak/none, indeterminant)	**If not solely explanatory (column M), could this impact hypothesis be a contributing causal factor to the WCT population decline?**	**If yes (column N), what is the SME's best professional judgement on the relative contribution of this impact hypothesis to the WCT population decline?** (major, moderate, minor/negligible)	**If judged to be a potential contributing factor, what other impact hypothesis(es) is this hypothesis likely to be combined with?**
Maggie Branton (Azimuth Consulting Group & Branton Environmental Consulting)	Branton, M. & B. Power. 2021. Stressor Evaluation – Sewage. In Van Geest et al. 2021. Subject Matter Expert Report: Industrial Chemicals, Spills and Unauthorized Releases. Evaluation of Cause – Decline in Upper Fording River Westslope Cutthroat Trout Population. Report prepared for Teck Coal Limited. Prepared by Golder Associates Ltd.	Unauthorized Sewage Discharge	Reduced Water Quality due to TSS, reduced oxygen or potentially toxic levels of chemicals in sewage.	1. Did the unauthorized sewage discharges result in an acutely toxic event that resulted in the WCT population decline?	Given the timing of the discharges (August and February), the life stages that would be present in the UFR would be egg/alevin and fry (August 2017), or juveniles and adults (February 2020). The discharge would have to reach tributary or mainstem habitat where WCT may occur.	1. Map with the location of the February 2020 unauthorized discharge. 2. Water quality data from discharge location and upstream and downstream monitoring locations including TSS, BOD and chemical parameters - compared to discharge permit and BCWQG for the February 2020 discharge. 3. Record of August 2017 spill from Teck Coal site specific database "Siteline".	<u>Spatial extent:</u> Large sections of UFR mainstem, lentic areas downstream of the discharge point. <u>Duration:</u> Sufficient to cause acute or chronic effects to juvenile and adult WCT (varies by BOD, TSS and chemical). <u>Location:</u> Rearing or overwintering habitat. <u>Timing:</u> Effluent would need to reach rearing or over-wintering habitats with a large aggregation of early-life stages/ juveniles and adults. <u>Intensity:</u> At the point it reaches the habitat, diluted effluent would need to have concentrations of TSS, BOD and COPCs high enough to result in adverse acute (< 7 days)or chronic (>7 days exposure) effects on WCT.	Spatial extent: No. Duration: No. Location: No. Both discharges were contained on land. Timing: No. Neither discharge occurred during the Decline Window Intensity: No. Neither discharge occurred during the Decline Window.	Based on the documented timing and extent of the unauthorized discharges there are no uncertainties with respect to their potential to impact the WCT population in the Decline Window.	Teck Coal provided records of two relatively recent unauthorized discharges, one which occurred before the Decline Window and one after. The timing of each of these discharges, as well as their specific characteristics with respect to size, location and potential impacts on water quality, is not consistent with the potential for WCT to be exposed to, or negatively impacted by, the discharges	None. There is no evidence that this unauthorized discharge caused the decline in WCT in the UFR.	No.	NA.	NA.

APPENDIX B: PERMIT 424; SEWAGE TREATMENT FACILITY UNAUTHORIZED DISCHARGE

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Non-Compliance Update Report

To: Ben.McKinnon@gov.bc.ca

Date: February 30, 2020

From: Scott Roughead

Cc: ENVSECoal@gov.bc.ca
PERMRECL@gov.bc.ca
landscompliance@ktunaxa.org

Subject: **2020-FEB-16; Permit 424; Sewage Treatment Facility Unauthorized Discharge**

Attention: Non-Compliance Update Report for Authorization 424
2020-02-16 Sewage Treatment Facility Unauthorized Discharge

Date of Non-compliance: 2020-02-16 11:00

Location of Non-compliance: Fording River Operations Sewage Treatment Facility

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Hi Ben,
Fording River Operations (FRO) has completed the internal investigation to understand the factors that contributed to this non-compliance event and is providing this letter report as an update to the information reported on February 16, 2020.

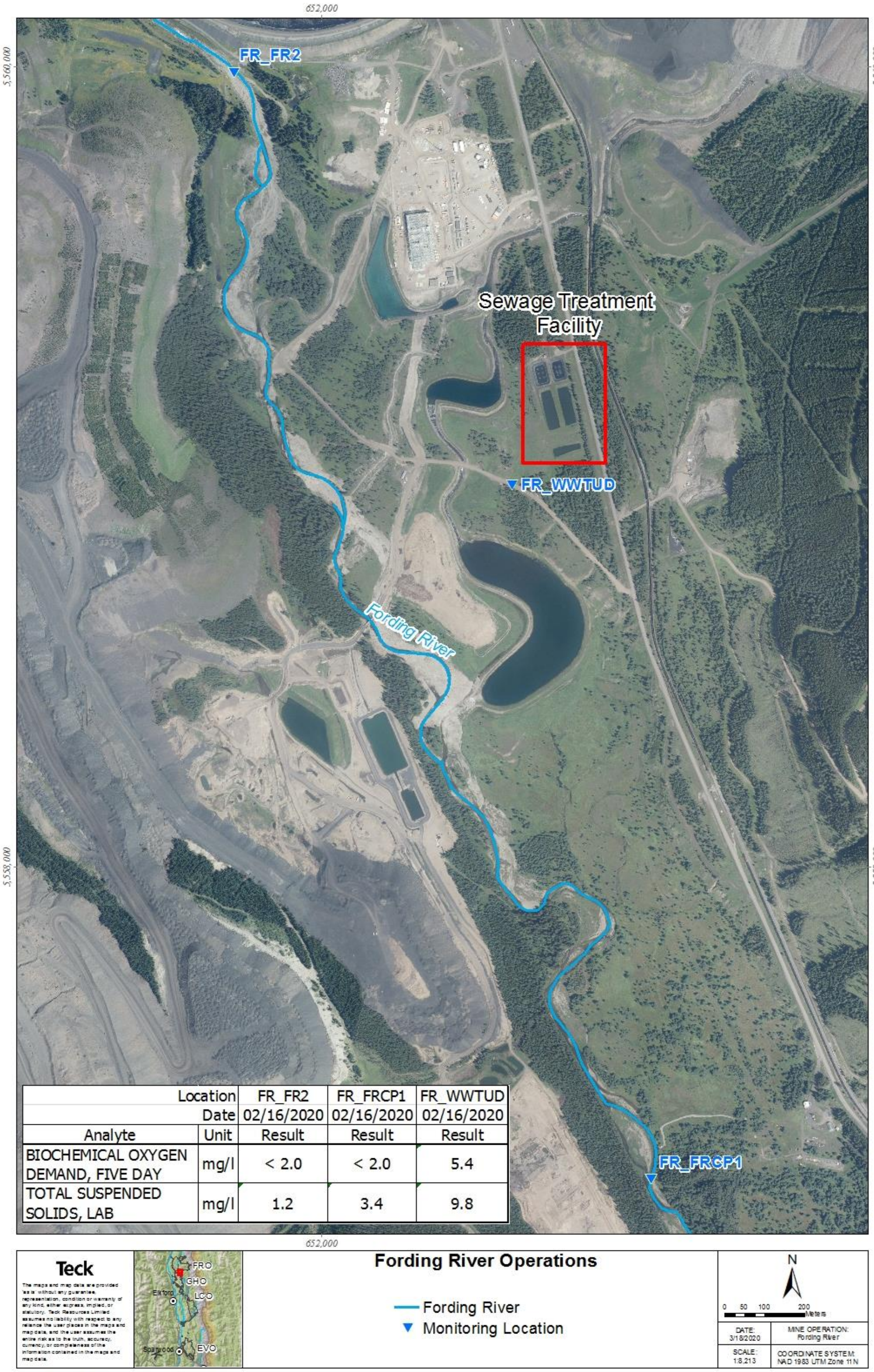
Background

On February 16, 2020 at approximately 11:00, water was observed flowing onto the Swift Access Road. Upon further investigations, the water originated from our Sewage Treatment Facility. It appears that the effluent was flowing through all the authorized works within the Sewage Treatment Facility which consist of two aeration basins, three infiltration basins and an emergency basin. The effluent was discharging out of the emergency basin and slowly migrating south to our Swift Access Road where it was contained by a natural depression in the road. This event was reported to Ministry of Environment and Climate Change Strategy (ENV) and Emergency Management British Columbia (EMBC) on February 16, 2020 (DGIR #194113).

Sample Result Summary

In response to the unauthorized discharge, emergency sampling was conducted at the unauthorized discharge location (FR_WWTUD), and samples were collected in the Fording River upstream and downstream of the discharge location. The ALS Environmental Analytical Report sample ID is L2418201.

The sample collected at the unauthorized discharge was well below the permitted limits for the Sewage Treatment Facility and did not exceed any British Columbia Water Quality Guidelines (BCWQG). Measured results for Biochemical Oxygen Demand (BOD) at FR_WWTUD was 5.4 mg/L (Permit Limit 130 mg/L), and Total Suspended Solids (TSS) was 3.4 mg/L (Permit Limit 130 mg/L). No adverse effects were observed in the Fording River with an upstream sample taken at FR_FR2 measuring <2.0 mg/L BOD and 1.2 mg/L TSS, and a downstream sample collected at FR_FRCP1 measuring <2.0 mg/L BOD and 9.8 mg/L TSS. No analysed parameters exceeded the BCWQG in the Fording River. Sampling locations and results are presented below in Figure 1, and an image of the unauthorized discharge found on the road can be seen in Photograph 1 below.



Location		FR_FR2	FR_FRCP1	FR_WWTUD
Date		02/16/2020	02/16/2020	02/16/2020
Analyte	Unit	Result	Result	Result
BIOCHEMICAL OXYGEN DEMAND, FIVE DAY	mg/l	< 2.0	< 2.0	5.4
TOTAL SUSPENDED SOLIDS, LAB	mg/l	1.2	3.4	9.8

Figure 1 - Monitoring locations and results

Photograph 1- Unauthorized Discharge located in the low lying depression on the Swift Creek access road.

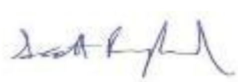
Measures Taken to Stop the Event and Reduce Risk

Upon identification of the unauthorized discharge, FRO staff organized vacuum trucks to pump the spill from the low lying depression in the road back into the primary aeration basins. The vacuum trucks captured all of the discharged effluent from outside of the facility, totalling 155 m3.

The sewage treatment facility was closely monitored following the incident, and the suspected frozen or blocked pipe appeared to have cleared as water levels have returned to normal operating elevations. The FRO Facilities Department has resumed discharge of the sewage treatment facility and FRO is continuing its evaluation of the authorized works.

If you require anything further, please do not hesitate to contact me directly.

Thank you,



Scott Roughead, AScT.
Lead, Environment (Water)
Fording River Operations – Teck Coal Limited

APPENDIX B

Table B-1: Screening of Chemicals from FRO and GHO Storage Tank Databases

Table B-1: Screening of Chemicals from FRO and GHO Storage Tank Databases

Operation	ObjectID	Equipment ID (in AX)	Product Type	)							
FRO	242	N/A	Antifreeze	TBD	Dormant: Ready for Permanent Disposal	Bone Yard	Outdoor	Single	N/A	not evaluated further	not added to media with pathway to water
FRO	245	N/A	Emulsion	23,000	Disposed	Bone Yard	Outdoor	TBD	N/A	not applicable	tank status
FRO	243	N/A	Unknown	TBD	Disposed	Bone Yard	Outdoor	TBD	N/A	not applicable	tank status
FRO	293	N/A	Unknown	TBD	Disposed	Bone Yard	Outdoor	TBD	N/A	not applicable	tank status
FRO	241	N/A	Empty - Fabricated for Flammable Liquids	25,000	Dormant: Temporarily Out of Service	Bone Yard	Outdoor	Double	None	not applicable	product and tank status
FRO	244	N/A	Methanol	95,000	Disposed	Bone Yard	Outdoor	Double	N/A	not applicable	tank status
FRO	247	N/A	Freeze Conditioning Agent (Glycol)	50,000	Disposed	Box Yard	Outdoor	Double	None	not applicable	tank status
FRO	257	TANK210	Methanol	50,000	Dormant-Empty	Carwash	Outdoor	Double	None	not applicable	tank status
FRO	289	N/A	Water	TBD	Dormant: Temporarily Out of Service	Eagle 6 View Point	Outdoor	TBD	None	not applicable	water
FRO	290	N/A	Water	TBD	Dormant: Temporarily Out of Service	Eagle 6 View Point	Outdoor	TBD	None	not applicable	water
FRO	292	N/A	Water	TBD	Dormant: Temporarily Out of Service	Eagle 6 View Point	Outdoor	TBD	None	not applicable	water
FRO	291	N/A	Water	TBD	Dormant: Temporarily Out of Service	Eagle 6 View Point	Outdoor	TBD	None	not applicable	water
FRO	N/A	N/A	Gasoline	TBD	Active	Elkford Bus Barn	Outdoor	Double	Underground	negligible likelihood	secondary containment
FRO	297	N/A	Unknown	TBD	Dormant: Ready for Permanent Disposal	Fossil Yard	Outdoor	TBD	N/A	cannot assess	product unknown
FRO	282	LUBE487	Diesel Fuel	95,000	Active	Fuel Station-South 2 Station	Outdoor	Double	None	negligible likelihood	secondary containment
FRO	281	TBD	Diesel Fuel	95,000	Dormant: Ready for Permanent Disposal	Fuel Station- 1925/Eagle 6	Outdoor	Double (Damaged)	None	not evaluated further	not added to media with pathway to water
FRO	272	LUBE488	Diesel Fuel	95,000	Active	Fuel Station- New 1925 Station	Outdoor	Double	None	negligible likelihood	secondary containment
FRO	279	LUBE486	Diesel Fuel	95,000	Active	Fuel Station- Bridge 2 Station	Outdoor	Double	Lined Fuel Station	negligible likelihood	secondary containment
FRO	255	LUBE472	Gasoline-Clear	50,000	Active	Fuel Station- Gas Station	Outdoor	Double	Lined Fuel Station	negligible likelihood	secondary containment
FRO	285	LUBE489	Diesel Fuel	95,000	Disposed	Fuel Station- Lower Henretta	Outdoor	Double	Lined Fuel Station	not applicable	tank status
FRO	288	LUBE480	Diesel Fuel	95,000	Disposed	Fuel Station- Upper Henretta	Outdoor	Double	Lined Fuel Station	not applicable	tank status
FRO	321	LUBE490	Diesel Fuel	95,000	Active	Fuel Station-Swift Fuel Station	Outdoor	Double	None	negligible likelihood	secondary containment
FRO	258	BLD00039	Nalco DVS4U021	56,000	Active	Kerosene Tank Farm (South of GO)	Outdoor	Single	Concrete Containment	negligible likelihood	secondary containment
FRO	259	BLD00039	Nalflote 9899	90,000	Active	Kerosene Tank Farm (South of GO)	Outdoor	Single	Concrete Containment	negligible likelihood	secondary containment
FRO	280	LUBE477	Diesel Fuel	95,000	Dormant: Temporarily Out of Service	Laydown Behind Clode Fuel Station	Outdoor	Double	None	negligible likelihood	secondary containment
FRO	309	BLD00260	Engine Oil (Mobil Delvac 1300 Super 15W-40)	54,500	Active	Lube Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
FRO	310	BLD00260	Gear Lube (Dynagear Extra)	54,500	Active	Lube Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
FRO	311	BLD00260	Gear Lube (Dynagear SL)	54,500	Active	Lube Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
FRO	312	BLD00260	Gear Oil (Mobil 680 OH)	54,500	Active	Lube Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
FRO	313	BLD00260	Glycol (Antifreeze R824M 55/45 Solution)	54,500	Active	Lube Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
FRO	314	BLD00260	Grease (XHP 100 Mine)	44,500	Active	Lube Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
FRO	315	BLD00260	Grease (XHP 321 Mine)	44,500	Active	Lube Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
FRO	317	BLD00260	Multigrade Hydraulic Oil (Mobil Trans AST-30)	54,500	Active	Lube Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
FRO	318	BLD00260	Multigrade Hydraulic Oil (Mobil Trans AST-30)	54,500	Active	Lube Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
FRO	316	BLD00260	Multigrade Hydraulic Oil (Mobil Trans AST-30)	54,500	Active	Lube Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
FRO	320	BLD00260	Spare	54,500	Active	Lube Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
FRO	319	BLD00260	Transmission Fluid (Mobil Trans HD 50)	54,500	Active	Lube Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
FRO	261	BLD00032	Diesel Fuel	90,000	Active	Main Fuel Tank Farm	Outdoor	Single	Concrete Containment	negligible likelihood	secondary containment
FRO	264	BLD00032	Diesel Fuel	90,000	Active	Main Fuel Tank Farm	Outdoor	Single	Concrete Containment	negligible likelihood	secondary containment
FRO	265	BLD00032	Diesel Fuel	90,000	Active	Main Fuel Tank Farm	Outdoor	Single	Concrete Containment	negligible likelihood	secondary containment
FRO	263	BLD00032	Diesel Fuel	90,000	Active	Main Fuel Tank Farm	Outdoor	Single	Concrete Containment	negligible likelihood	secondary containment
FRO	260	BLD00032	Gasoline-Dyed	90,000	Active	Main Fuel Tank Farm	Outdoor	Single	Concrete Containment	negligible likelihood	secondary containment
FRO	266	BLD00032	Used Oil	94,000	Dormant: Temporarily Out of Service	Main Fuel Tank Farm	Outdoor	Single	Concrete Containment	negligible likelihood	secondary containment
FRO	268	BLD00032	Used Oil	94,000	Active	Main Fuel Tank Farm	Outdoor	Single	Concrete Containment	negligible likelihood	secondary containment
FRO	267	BLD00032	Used Oil	73,000	Dormant: Temporarily Out of Service	Main Fuel Tank Farm	Outdoor	Single	Concrete Containment	negligible likelihood	secondary containment
FRO	262	BLD00032	Used Oil	45,000	Active	Main Fuel Tank Farm	Outdoor	Single	Concrete Containment	negligible likelihood	secondary containment
FRO	269	N/A	Liquid Oxygen	4,000	Active	Maintenance Bay 31	Outdoor	TBD	None	negligible likelihood	refrigerated gas
FRO	270	N/A	Water (with Chlorine)	TBD	Active	Maintenance by Steam Bay	Indoor	TBD	Indoor	negligible likelihood	secondary containment
FRO	248	N/A	Ammonium Nitrate Prill	TBD	Active	Maxam	Outdoor				
FRO	249	N/A	Ammonium Nitrate Prill	TBD	Active	Maxam	Outdoor				
FRO	250	N/A	Ammonium Nitrate Prill	TBD	Active	Maxam	Outdoor				
FRO	251	N/A	Ammonium Nitrate Prill	TBD	Active	Maxam	Outdoor				
FRO	252	N/A	Ammonium Nitrate Prill	TBD	Active	Maxam	Outdoor				
FRO	301	N/A	Ammonium Nitrate Solution	80,000	Active	Maxam	Outdoor	TBD	Concrete Containment	negligible likelihood	secondary containment
FRO	304	N/A	Ammonium Nitrate Solution	80,000	Dormant: Ready for Permanent Disposal	Maxam	Outdoor	TBD	Concrete Containment	negligible likelihood	secondary containment
FRO	302	N/A	Ammonium Nitrate Solution	65,000	Active	Maxam	Outdoor	TBD	Concrete Containment	negligible likelihood	secondary containment
FRO	303	N/A	Ammonium Nitrate Solution	65,000	Active	Maxam	Outdoor	TBD	Concrete Containment	negligible likelihood	secondary containment
FRO		N/A	Emulsion: High Energy Fuel	20,000 kg	Active	Maxam	Outdoor	TBD	None	not evaluated further	not added to media with pathway to water
FRO	296	N/A	Lubrizol	90,000	Active	Maxam	Outdoor	Double	None	negligible likelihood	secondary containment
FRO	306	N/A	Lubrizol	23,000	Active	Maxam	Outdoor	TBD	None	cannot assess	product unknown
FRO		N/A	Mineral Oil	90,000	Active	Maxam	Outdoor	Double	None	negligible likelihood	secondary containment
FRO		N/A	Mineral Oil & Diesel Mixing Tank	50,000	Active	Maxam	Outdoor	Double	None	negligible likelihood	secondary containment
FRO	307	LUBE492	Diesel Fuel	50,000	Active	Maxam	Outdoor	Double	None	negligible likelihood	secondary containment
FRO	256	N/A	Freeze Conditioning Agent	63,600	Active	Near Dryer	Outdoor	TBD	None	not evaluated further	not added to media with pathway to water
FRO	273	N/A	Diesel Fuel	N/A	Dormant: Ready for Permanent Disposal	NOHELS (Sunshine)	Outdoor	Single	Metal Containment	not evaluated further	not added to media with pathway to water
FRO	274	N/A	Unknown	N/A	Dormant: Ready for Permanent Disposal	Old Bone Yard	Outdoor	TBD	Metal Containment	cannot assess	product unknown
FRO	286	N/A	Unknown	N/A	Dormant: Ready for Permanent Disposal	Old Bone Yard	Outdoor	TBD	N/A	cannot assess	product unknown
FRO	287	N/A	Unknown	N/A	Dormant: Ready for Permanent Disposal	Old Bone Yard	Outdoor	TBD	Metal Containment	cannot assess	product unknown
FRO	308	N/A	Unknown	N/A	Dormant: Ready for Permanent Disposal	Old Bone Yard	Outdoor	TBD	N/A	cannot assess	product unknown
FRO	299	N/A	Unknown	N/A	Disposed	Old Landfill	Outdoor	TBD	N/A	not applicable	tank status
FRO	278	N/A	Ammonium Nitrate Prill	TBD	Active	R4	Outdoor				
FRO		N/A	Ammonium Nitrate Prill	TBD	Active	R4	Outdoor				
FRO	275	N/A	Emulsion: High Energy Fuel	65,000 kg	Active	R4	Outdoor	TBD	None	not evaluated further	not added to media with pathway to water
FRO	276	LUBE491	Diesel Fuel	90,000	Dormant: Temporarily Out of Service	R4	Outdoor	Double	Concrete Containment	negligible likelihood	secondary containment
FRO	300	LUBE483	Diesel Fuel	TBD	Disposed	South of STP Pontoon	Outdoor	Double	TBD	not applicable	tank status
FRO	254	N/A	Freeze Conditioning Agent	6,000	Dormant: Ready for Permanent Disposal	STP Train Loop	Outdoor	TBD	Lined Metal Containment Structure	not evaluated further	not added to media with pathway to water
FRO	253	N/A	Unknown	TBD	Dormant: Ready for Permanent Disposal	STP Train Loop	Outdoor	TBD	None	cannot assess	product unknown
FRO	246	N/A	Water	TBD	Dormant: Temporarily Out of Service	SW of NTP	Outdoor	TBD	N/A	not applicable	water
FRO		LUBE473	Diesel Fuel	TBD	Dormant: Temporarily Out of Service	TBD	Outdoor	Double	None	negligible likelihood	secondary containment
FRO	271	N/A	Tire Life	2,000	Active	Tire Bay	Outdoor	TBD	None	not evaluated further	not added to media with pathway to water
FRO	283	N/A	Water	TBD	Disposed	Turn Creek Spoil	Outdoor	TBD	None	not applicable	tank status
FRO	284	N/A	Water	TBD	Disposed	Turn Creek Spoil	Outdoor	TBD	None	not applicable	tank status
FRO	285	TBD	Diesel Fuel	2,140	Active	Near Dryer	Outdoor	Double	None	negligible likelihood	secondary containment
FRO	286	TBD	Glycerin	63,595	Active	Gatehouse	Outdoor	Double	None	negligible likelihood	secondary containment
FRO	n/a	TBD	Diesel Exhaust Fluid	24,000	Active	Outside LV Car Wash	Outdoor	Double	None	negligible likelihood	secondary containment
GHO	n/a	870	Waste Oil	1,892	Active	Crane Shop	Indoor	Single	Indoor	negligible likelihood	secondary containment

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Table B-1: Screening of Chemicals from FRO and GHO Storage Tank Databases

Operation	ObjectID	Equipment ID (in AX)	Product Type	)						
GHO	n/a	871	Waste Oil	1,892	Active	Crane Shop	Indoor	Single	Indoor	negligible likelihood	secondary containment
GHO	n/a	864	Diesel Fuel	4,220	Active	Dryer	Outdoor	Double		negligible likelihood	secondary containment
GHO	n/a	91	Caustic Soda	40,000	Active	Dryer	Outdoor	Double		negligible likelihood	secondary containment
GHO	n/a	865	Optimer 83949 (floc)	37,474	Active	Dryer Spray Shack		Single		negligible likelihood	dry product, no reported release
GHO	n/a	96	Waste Oil/Diesel Blend	90,000	Active	East Spoil	Outdoor	Single		not evaluated further	not added to media with pathway to water
GHO	n/a	94	Prill	60 tonnes	Active	East Spoil	Outdoor	Single		negligible likelihood	dry product, no reported release
GHO	n/a	92	Prill		Active	East Spoil	Outdoor				
GHO	n/a	93	Prill		Active	East Spoil	Outdoor	Single		negligible likelihood	dry product, no reported release
GHO	n/a		Emulsion		Active	East Spoil/Raven Flats	Outdoor			not evaluated further	not added to media with pathway to water
GHO	n/a	95	Emulsion	40,000 kg	Active	East Spoil/Raven Flats	Outdoor	Single		not evaluated further	not added to media with pathway to water
GHO	n/a	866	Aviation Fuel	4,600	Active	Gate 66	Outdoor	Double		negligible likelihood	secondary containment
GHO	n/a		Diesel Fuel	90,000	Active	West Fuel Island				not evaluated further	not added to media with pathway to water
GHO	n/a		Flocculant Mixed		Active	Clean Coal Loadout	Indoor		Indoor	negligible likelihood	secondary containment
GHO	n/a	75	Diesel Fuel	225,000	Active	Main Fuel Island - North	Outdoor	Single		not evaluated further	not added to media with pathway to water
GHO	n/a	76	Diesel Fuel	225,000	Active	Main Fuel Island - South	Outdoor	Single		not evaluated further	not added to media with pathway to water
GHO	n/a	78	Gasoline	70,000	Active	Main Fuel Island	Outdoor	Single		not evaluated further	not added to media with pathway to water
GHO	n/a	79	Propane	3,785	Inactive	Main Fuel Island	Outdoor	Single		not evaluated further	not added to media with pathway to water
GHO	n/a		Propane	1,892	Active	General Office				not evaluated further	not added to media with pathway to water
GHO	n/a		Propane	1,892	Active	General Office				not evaluated further	not added to media with pathway to water
GHO	n/a		Diesel Fuel		Active	North Fuel Island	Outdoor			not evaluated further	not added to media with pathway to water
GHO	n/a	87	Diesel Fuel	4,220	Active	Pit Control	Outdoor	Double		negligible likelihood	secondary containment
GHO	n/a	867	Nalco 8882	45,000	Not Yet Active	Plant	Outdoor	Double		not applicable	tank status
GHO	n/a		Diesel Fuel	40,000	Active	Plant		Double		negligible likelihood	secondary containment
GHO	n/a	100	Gasoline	4,550	Active	Plant	Outdoor	Double		negligible likelihood	secondary containment
GHO	n/a	88	Kerosene	26,498	Inactive	Plant	Outdoor	Single		low to moderate likelihood for use	discharged into tailings ponds for use
GHO	n/a	89	Kerosene	26,498	Active	Plant	Outdoor	Single		low to moderate likelihood for use	discharged into tailings ponds for use
GHO	n/a	90	MIBC (Methyl Isobutyl Carbinol)	40,000	Active	Plant	Outdoor	Double		negligible likelihood for storage, low to moderate likelihood for use	secondary containment for storage, discharged into tailings ponds for use
GHO	n/a		Flocculant Concentrate		Active	Plant	Outdoor			not evaluated further	not added to media with pathway to water
GHO	n/a		Flocculant Mixed Head		Active	Plant	Outdoor			not evaluated further	not added to media with pathway to water
GHO	n/a	869	Diesel Fuel	567	Active	Potable Building	Indoor	Single	Indoor	negligible likelihood	secondary containment
GHO	n/a	863	Antifreeze	63,494	Active	Rail Loop	Outdoor	Double		negligible likelihood	secondary containment
GHO	n/a		Diesel Fuel	1,133	Active	Room beside MCC room				not evaluated further	not added to media with pathway to water
GHO	n/a		Waste Oil	22,899	Active	Maintenance - Outdoor	Outdoor			not evaluated further	not added to media with pathway to water
GHO	n/a	80	Waste Oil	32,000	Active	Tank Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
GHO	n/a	81	Mobile Trans AST 30 (Lubricant Oil)	57,000	Active	Tank Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
GHO	n/a	83	GX Extra 80W-140	32,000	Active	Tank Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
GHO	n/a	84	Coolant	32,000	Active	Tank Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
GHO	n/a	85	MoBil Delvac 1ESP-5W-40	32,000	Active	Tank Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment
GHO	n/a	82	Mobile Trans 30	32,000	Active	Tank Farm	Indoor	Single	Indoor	negligible likelihood	secondary containment

APPENDIX C

Screening of Unintended Releases

Table C-1: Screening of Spills

CorpCode	IncidentNum	IncidentDate	Location	Location Description	UTM E	UTM N																		
FRO	3831	March 13, 2018	Maxam Bulk Explosive Plant Site	North Loop pond discharge pipe under the Maxam Yard.	651097	5561122	215	Fording River	Yes	At approximately 10:20am, discharge water from the North Loop Pond overwhelmed the discharge pipe underneath the Maxam Yard and forced an estimated 10,000L of water to back up into the surface of the Maxam Yard. All water migrated to an existing sump within the Maxam Yard and was pumped back to the South Tailings Pond.	DGIR: 174258	Water Treatment	Pumpback water		Ice on Ground	10000	Litres -(l)			Pump water back to South Tailings Pond	10000	Litres -(l)	100% recovered	negligible likelihood
FRO	4368	January 29, 2019	Maintenence	Warehouse/Maintenance Building its the pump room located by the diesel farm.	651314	5561725	166	Fording River	Yes	waste oil spill at the waste oil pump room BLDG 00032 During my safety tour around the diesel loading side I notice oil on the ground. stopped the safety tour and use the people in the group to help contain the oil.	18398	Oil/Petroleum	Used Oil		Rocky ground	500	Litres -(l)	10	Sq. Feet	BearsPaw was called in on Jan 29 with the vac truck to suck up the contained waste oil and the driver gave me the estimate of 500L and layed down soaker pads for the night of Jan 29 and BearPaw will be back on Wednesday to clean up soaked pads and clean up the pump room.	500	Litres -(l)	100% recovered	negligible likelihood
FRO	4515	February 23, 2019	NPA	Mid-eastern portion of the North Swift Spoil (please note that the coordinates provided are approximate only)	649999	5565075	754	Fording River	Yes	Approximately 4,013 BCM of the Morrisey Formation (MF) was unintentionally mined between February 23rd and 24th in the south end of Lake Mountain Pit. This material was hauled to the two lower east portions of the Swift North Spoil. Within the same time period 50,576 BCM of non-PAG material was hauled to the same spoil, MF is approximately 7% of this. In total these spoils have ~622,000 BCM of non-PAG material, the material mined from the the MF is 0.01%. At this time these spoils are intended to contain 27.6 BCM of non-PAG. This event occurred due to a gap in the understanding of the geology in the south end of Lake Mountain Pit, as well as the complex faulting in the area. Three samples of the MF were collected April 4th and sent to GHO for laboratory fizz testing. This test is non-negative in nature, that is if the samples fizzed the material would be non-PAG, but if they were to fizz the result would be inconclusive. None of the three collected samples fizzed, and additional testing is required. The samples were collected on April 11th, and the results have not et been determined. The exposure of the MF was discovered on March 8th by geology. Initial inspections of the exposed face indicated that it had not been excavated, however subsequent reviews (initiated March 28th) showed that it was. This incident was brought to the attention of ENV via spill report on April 4, and EMPR via verbal discussion during meetings in Victoria on April 3rd (formal notifications were sent April 11).	190-049	Other	Other Solid (describe)	Morrisey Formation (potentially PAG) note that the units are BCM (not available in drop down).	Waste Rock in Pit or Storage	4013	Litres -(l)			Upon initial review by a QP it has been determined that if the results of the ABA conclude that the mined portion of the MF are PAG it is currently combined with enough non-PAG in the spoil that their is minimal risk for ML/ARD to occur. No additional clean up actions have been taken.	4013		100% recovered	negligible likelihood
FRO	4567	May 29, 2019	Maxam Bulk Explosive Plant Site	Maxam Sump line to South Tailings Pond	651077	5560984	203	Fording River	Yes	The temporary line that pumps our Maxam Facility effluent from the Maxam Sump to the South Tailing Pond was not adequately pumping all the effluent as the pump was at too low of an idle. As a result the sump overflowed into a nearby ditch. The ditch was immediately pumped down and is no longer overflowing. Estimated volume of effluent was 500 Litres. EMBC was notified at 13:00 (DGIR#190-676).	DGIR # 190-676	Process Water/Solutions	Process Water		Sump	500	Litres -(l)			Increase pumping capacity to pump down overflow effluent in nearby ditch.	500	Litres -(l)	100% recovered	negligible likelihood
LCO-UFR	3529	July 7, 2019	Pits	Pits - Mount Michael	659969	5537822	1849	Line Creek	Yes	60 truck had a brake cooler line get damaged by a rock the tire kicked up. Approx 40 liters was captured and rest went to ground spread out over a few KM of haul road.	191156	Alcohol (noncombustible)	Propylene Glycol		Rocky ground	508	Litres -(l)	112	Sq. Metres	Scraped up and hauled to the landfarm blue bins.	508	Litres -(l)	100% recovered	negligible likelihood
FRO	4737	September 2, 2019	In - Pit Fuel Islands	Tank Farm beside the Warehouse & Facilities Maintenance Shop	651274	651274	139	Fording River	Yes	Approximately 150L of Dyed Diesel overflowed from the Drainage Containment tank at Diesel Farm. Seaboard drivers contained the spill with soaker pads from the Spill Kit at the Fuel Island and reported the spill immediately after to Warehouse Supervisor.	191873	Oil/Petroleum	Diesel Fuel		Soil	150	Litres -(l)	500	Sq. Feet	Contractors contained spill with containment booms. Vac truck used to clean up excess fuel around Diesel Farm.	150	Litres -(l)	100% recovered	negligible likelihood
FRO	3841	March 14, 2018	Maxam Bulk Explosive Plant Site	North Loop Pond discharge pipe under the Maxam Yard	651097	5561122	215	Fording River	Yes	At approximately 17:40, discharge water from the North Loop Pond overwhelmed the discharge pipe underneath the Maxam Yard and forced an undetermined amount of pond water to back up into the Maxam Yard. All water was contained within the Yard and was pumped to the permitted discharge location for the North Loop pond which is located on the south end of the Maxam Yard. Final spill volume updated to 8,900 litres.	DGIR # 174283	Process Water/Solutions	Discharge Water		Ice on Water	8900	Litres -(l)		Sq. Metres	Pump overflow water to the permitted North Loop Pond discharge location.	10000	Litres -(l)	112% recovered	negligible likelihood
FRO	4225	November 10, 2018	North Yard	North Yard 50.11'13" / 114.52'41"	651332	5562359	155	Fording River	Yes	Zoomboom operator was offloading a tote of Tire Life in 928G in the north yard. When placing the tote in that location the forks of the zoomboom punctured the back tote of Tire Life (AX 284178) approx 1050 L onto the ground. Called my supervisor Then the operator started to control the spill.	182888	Other	Other Liquid (describe)	Tire Life	Ice on Ground	1225	Litres -(l)	5	Sq. Metres	contain and clean up. dispose of absorbent pads sand booms, remove top layer of soil and dispose in landfarm	1500	Litres -(l)	122% recovered	negligible likelihood
FRO	4361	January 29, 2019	Shovel 5	Eagle pit by 5 shovel	654050	5563366	482	Clode Creek	Yes	Supervisor drove up to 4 drill and noticed that its compressor had spilled approx. 200L of hydraulic oil. mechanical in nature but supervisor is not certain on the reason for the spill.	DTIR183973	Oil/Petroleum	Compressor Oil		Ice on Ground	200	Litres -(l)	2	Sq. Metres	cover area in crush and dirt to absorb, and haul crush to landfarm	350	Litres -(l)	175% recovered	negligible likelihood
FRO	3579	October 6, 2017	Spoils	8 stock to 9 stock.	651739	5562654	338	Eagle Creek	No	Right front boarding walkway broke free and rolled underneath the haul truck. It was then driven over, the walkway flipped up and then punctured the radiator line causing a coolant spill to ground.	172304	Mixture	Ethylene Glycol and Water		Rocky ground	750	Litres -(l)	1	Hectares	Spill pads and Socks. Berm was created to contain the spill.			Antifreeze	low likelihood
FRO	3696	December 20, 2017	Warehouse/Maintenance Building (XXXX)	Warehouse/Maintenance Building Bay 63	651365	5561809	198	Fording River	Yes	Bay 63 underground heating pad heating system took 800L of automotive antifreeze, to top it up.	DGIR173235	Alcohol (noncombustible)	Ethylene Glycol (antifreeze/coolant)		Rocky ground	800	Litres -(l)			Under investigation			Antifreeze	low likelihood
FRO	3771	February 1, 2018	Warehouse/Maintenance Building (XXXX)	Tire Bay Pad	651363	5561809	195	Fording River	Yes	The heating system at the tire bay concrete pad was topped up with 100Ltrs of glycol. it is suspected there is a leak within glycol lines. It is leaking approx. 2.3Ltrs per day. Last time it was topped up was Dec 21 2017.	DGIR173792	Mixture	Ethylene Glycol and Water			100	Litres -(l)			No cleanup actions at this time. The area of the pad suspected of leaking has been isolated.			Antifreeze	low likelihood
FRO	3846	March 22, 2018	Lake Mountain Pit	Lake Mountain Pit	650282	5564111	422	Fording River	Yes	Worker was driving 538 HT when the truck came to a stop . It wasn't until then that the worker noticed that the truck lost all of the coolant.	DGIR 174 370	Alcohol (noncombustible)	Ethylene Glycol (antifreeze/coolant)		Rocky ground	300	Litres -(l)			contaminated soil taken to landfarm, soaker pads and spill pool will be disposed of in proper contaminates bin.			Antifreeze	low likelihood
FRO	3885	April 19, 2018	Eagle 6	1850 Spoil	654052	5563093	746	Clode Creek	No	A coolant line ruptured causing a spill to ground. A spill pool was deployed and contaminated ground put into a pile.	180263	Alcohol (noncombustible)	Ethylene Glycol (antifreeze/coolant)		Rocky ground	175	Litres -(l)			Spill pool deployed. Contaminated ground scrapped and piled up. Contaminated material taken to the land farm.			Antifreeze	low likelihood
FRO	3886	April 21, 2018	Swift	Swift	649724	5561588	1217	Fording River	Yes	669 HT was getting loaded at the shovel , when another operator noticed the truck was leaking coolant.	DGIR 180284	Alcohol (noncombustible)	Ethylene Glycol (antifreeze/coolant)		Rocky ground	683	Litres -(l)			spill pools placed, soaker pads in place and once the truck is moved the contaminated soil wilkl be taken to the land farm			Antifreeze	low likelihood
FRO	3927	May 16, 2018	Swift	Swift 7 shovel area	649721	5561586	1219	Fording River	Yes	Coolant pipe was crushed on a 980 HT #952 resulting in a spill to ground. It is unknown how the line was crushed.	DGIR180625	Alcohol (noncombustible)	Ethylene Glycol (antifreeze/coolant)			400	Litres -(l)			Pool and drums were placed under the haul truck to catch the coolant. Soaker pads were placed for the coolant spilled on the pit floor			Antifreeze	low likelihood
FRO	3944	May 27, 2018	Eagle 6	Eagle 6	654052	5563081	758	Clode Creek	No	Radiator cracked in HT 533	180761	Alcohol (noncombustible)	Ethylene Glycol (antifreeze/coolant)		Rocky ground	700	Litres -(l)			Absorbent pads, RT to dig up contaminated material			Antifreeze	low likelihood
FRO	3987	June 21, 2018	Swift	6 Shovel	649724	5561588	1217	Fording River	Yes	HT 670 working in Swift, spill approx. 400L of coolant onto rocky ground/mud in 6 shovel area. A weld in the manifold caused the failure.	181-063	Alcohol (noncombustible)	Ethylene Glycol (antifreeze/coolant)		Rocky ground	400	Litres -(l)			Spill pads placed down. Will get a scraper to dig up, put into barrels and taken to hazardous waste			Antifreeze	low likelihood
FRO	4038	July 16, 2018	Eagle 6	Eagle 6 - 1910 Clode Spoil	654071	5563082	753	Clode Creek	No	583 HT was hoisting his box to dump load on the spoil when his upper rad hose failed.	181373	Alcohol (noncombustible)	Ethylene Glycol (antifreeze/coolant)		Rocky ground	350	Litres -(l)			Contaminated material scraped into a pile with a dozer - staked by supervisor - will be transferred to hazardous waste disposal in the morning			Antifreeze	low likelihood
FRO	4256	November 22, 2018	Tire Bay Pad	Tire Bay GPS location of exact spill was guessed based on Tire Bay Pad location.	651395	5562073	204	Fording River Side Channel	Yes	Worker went to check the glycol tank amount and noticed that it was significantly low. It was determined that a under ground glycol line, for the tire pad had ruptured.	183030	Alcohol (noncombustible)	Ethylene Glycol (antifreeze/coolant)		Rocky ground	355	Litres -(l)			Glycol spill is under the tire pad, no clean up action possible			Antifreeze	low likelihood
FRO	4281	December 6, 2018	Lake Mountain Pit	Lake Mountain Pit Reach 4 spoil 50.215940, -114.8957001	650128	5564625	641	Fording River	Yes	Coolant hose broke on HT 545	183222	Alcohol (noncombustible)	Ethylene Glycol (antifreeze/coolant)		Rocky ground	100	Litres -(l)			Truck stopped, pool placed under leak. Material taken to the landfarm on Dec 12 once the truck was able to be moved.			Antifreeze	low likelihood
FRO	4369	January 30, 2019	Lake Mountain Pit	Lake Mountain Pit	650091	5563844	656	Lake Mountain Creek	Yes	HT 547 blew a lower radiator hose, spilling antifreeze.	183985	Alcohol (noncombustible)	Propylene Glycol (non-toxic antifreeze/coolant)		Ice on Ground	80	Litres -(l)	2	Sq. Metres	antifreeze was mostly contained with a pool, however repairs to the equipment are underway in order to move the machine, to perform cleanup which will be done with a vac truck.,			Antifreeze	low likelihood
FRO	4424	March 6, 2019	Lake Mountain	Lake Mountain Pit	649196	5565134	1562	Fording River	Yes	Haul truck 571 became stuck in some soft ground and sheared off a 3 inch coolant hose.	184432	Alcohol (noncombustible)	Ethylene Glycol (antifreeze/coolant)			600	Litres -(l)			Truck is still stuck.			Antifreeze	low likelihood
FRO	4490	April 8, 2019	Swift 1885	1885 Swift Spoils	649449	5565124	1311	Fording River	Yes	Piston on Haul truck 673 Blew while pulling away from the berm at 1885 Swift Spoil.	DGIR 190083	Alcohol (noncombustible)	Ethylene Glycol (antifreeze/coolant)		Mud	100	Litres -(l)			spill pads and spill pool placed around area. Haul truck is currently parked on top of spill.			Antifreeze	low likelihood
LCO-UFR	3623	September 14, 2019	Pits	Pits - Mount Michael	659846	5537437	1940	Line Creek	Yes	70 truck was empty traveling from the BRN spoil back up the MTM haul road to 2 shovel when a coolant line failed causing a 346 liter coolant spill. Soaker pads were used underneath the truck but the majority of the spill was spread for appox 1.5km up the haul road.	192-032	Mixture	Ethylene Glycol and Water		Rocky ground	368	Litres -(l)	5000	Sq. Feet	Soaker pads used under truck. Barell placed underneath truck.	75	Litres -(l)	Antifreeze	low likelihood

Table C-1: Screening of Spills

CorpCode	IncidentNum	IncidentDate	Location	Location Description	UTM E	UTM N																		
FRO	4796	September 27, 2019	Swift Marshalling Area	SWIFT MARSHALLING AREA	649720	5561591	1222	Fording River	Yes	LOADER WAS LEAVING SHOP TOWARDS SWIFT PIT, WHEN IT WENT DOWN FOR COOLANT LEAK, MECHANIC WAS DISPATCHED TO SCENE AND FOUND THAT RADIATOR CAP WAS INSTALLED IMPROPERLY. RE INSTALLED RAD CAP AND RELEASED AFTER COOALNT WAS TOPPED UP. LOADER THEN PROCEEDED TO SWIFT PIT WHEN IT WENT DOWN AGAIN FOR COOLANT LEAK. MECHANIC WAS DISPATCHED AND FOUND THAT THE SIGHT GLASS ON THE TOP COOLANT TANK HAD BLOWN OUT. ALSO FOUND THAT THE WATER PUMP WAS LEAKING OUT OF THE SEAL AND THERE WAS AN BLOWN COOLANT LINE THAT FAILED FROM ROTTING.	192188	Mixture	Ethylene Glycol and Water		Gravel	227	Litres -(l)	0	Sq. Feet	THERE WAS NO COOLANT LEFT IN LOADER AT DOWN SITE, THE COOLANT WAS DISPERSED OVER APPROXIMATELY 2.5 KILOMETERS OF ROAD. THERE WAS NO EVIDENCE OF SPILL ANYWHERE ON THE ROAD, AS IT WAS RAINING/SNOWING AND THE GRADERS HAD ALREADY BEEN OVER SPILL LINE.	0	Litres -(l)	Antifreeze	low likelihood
FRO	3659	October 25, 2017	Turnbull	Turnbull near the old clode fuel island.	651284	5565166	108	Fording River	Yes	While clearing space in the soil treatment facility, 6m3 of soil from the soil treatment facility that did not meet the allowable discharge requirements was discharged. The exceedance was overlooked prior to disposal. All parameters were below the BC Contaminated Sites Regulation except for benzene, which was sampled at 35 mg/kg with a limit of 25 mg/kg. This was discovered on November 23 while going through data. The incident has been reported as a spill to EMBC and as a non-compliance to the MOE. The soil was placed in an active mine location within FRO's allowable discharge locations referenced in Appendix B of our EMA Refuse Permit. On October 25 and 26, 2017, 11 other remediated piles that met the BC Contaminated Sites Regulation Discharge Criteria, summing an estimated 230m3, were discharged to the same location. The discharge location is sitting on approximately 80m of spoil material, and approximately 200m E of the Turnbull South Pit, which is now the Turnbull South Pit Tailings Storage Facility. The piles at the discharge location are not distinguishable from each other, and the contaminated soil pile is estimated at <3% of the total discharge pile, which is why recovery of the pile in question is very low.	172984	Other	Other Solid (describe)	Discharge of soil contaminated with hydrocarbons from previous spill (from a previous 400L hydraulic oil spill)	Rocky ground	6000	Litres -(l)			No clean up actions were possible. The pile was cleaned up from a previous spill.			Contaminated Soil	not evaluated further
FRO	3972	June 12, 2018	Eagle 6	5 Shovel Marshalling area in Eagle N	654058	5563093	744	Clode Creek	No	07:00 June 12 a coolant spill of approx 120L at 5 shovel marshalling area was found by the Eagle N pit supervisor. The spill was captured in a pool, with some on the ground with spill pads, left by the previous shift. The actual time and date of spill is UNKNOWN. Details of incident is UNKNOWN.	180-955	Other	Other Liquid (describe)	Coolant	Rocky ground	120	Litres -(l)			Coolant was found pooled, and with spill pads. It will be barreled and taken to hazardous waste.			Coolant	low likelihood
FRO	4360	January 26, 2019	North Yard	6 Shovel	649710	5560896	1135	Fording River	Yes	Cap on Coolant was wore out, causing it to blow out. Spilling approximately 250 L onto the pit floor.	183-939	Other	Other Liquid (describe)	Coolant		250	Litres -(l)			Pool & Pads placed down. Scraper to come and scoop up all material, barreled and taken to hazardous waste			Coolant	low likelihood
FRO	3570	September 28, 2017	Eagle 6	Eagle South 2	654071	5563082	753	Clode Creek	No	Failed hydraulic hose on 5 Drill	172211	Oil/Petroleum	Diesel and Hydraulic Oil		Rocky ground	400	Litres -(l)	1	Sq. Feet	Contaminated soil taken to landfarm			Diesel and Hydraulic Oil	low likelihood
FRO	3957	April 9, 2018	South Tailings	South Tailings Pond - south end	652126	5560400	534	Fording River	Yes	The excavator was tramming in open water, approximately 3 to 4 metres deep, towing the fuel barge out to refuel the dredge. When the excavator arrived at the dredge, Pat got out to untie the fuel barge rope from the excavator. The excavator drifted forward under momentum on open water. Evidence shows there was direct interaction with the dredge cable and the excavator was very close to the dredge cutting head. There was also direct evidence of interaction with a rope, however the origin of the rope is unknown. Evidence shows that Pat got back inside the excavator cab and may have reacted to being in contact with the cable and in close proximity to the cutting head. The excavator cab and boom turn left and the tracks are pointing to the right towards to dredge. There was a spill of hydraulic oil and diesel fuel to the South Tailings Pond.	DGIR180126	Oil/Petroleum	Diesel and Hydraulic Oil		Other	360	Litres -(l)			There was no visible sheen on the pond and no recovery of oil and fuel from the pond. The pond has no surface discharge and water is recycled to the washplant, so no impacts to the receiving environment are anticipated. The spilled oil and fuel to ground were captured with a tarp and cleaned up with spill pads and booms. These were disposed at the waste Transfer station and taken off site.			Diesel and Hydraulic Oil	low likelihood
FRO	3588	October 13, 2017	Eagle 6	Eagle 6 north by 8 shovel	654052	5563093	746	Clode Creek	No	Haul truck 674 drove over a rock puncturing the diesel fuel tank causing a spill at eagle 6 north 8 shovel.	DGIR172376	Oil/Petroleum	Diesel Fuel		Rocky ground	4000	Litres -(l)	100	Sq. Feet	Hoe, Scrapper and grader picking up contaminated soil and taking to land farm.			Diesel Fuel	low likelihood
FRO	3676	December 8, 2017	Eagle 6	Eagle 6	654046	5563093	747	Clode Creek	No	The 955 dozer was was operating in the 3 shovel area. The operator was cleaning waste off of the N11-0n1 coal. He was pushing towards the east. He called the excavator operator that was working below him and told him that he was going to change the angle of push and then backed and rolled the dozer onto his left hand side. This resulted in a spill of hydraulic oil and diesel fuel to the ground.	173099	Oil/Petroleum	Diesel Fuel		Rocky ground	800	Litres -(l)	20	Sq. Feet	Once the dozer is removed from the area will need to remove all contaminated soil/ coal			Diesel Fuel	low likelihood
FRO	3731	January 11, 2018	Maxam Bulk Explosive Plant Site	Maxam Bulk Explosive Plant Site	651098	5561122	216	Fording River	Yes	The on site Seaboard driver was taking a load of diesel to Maxam bulk plant. While transferring product from tanker to tank, the driver failed to put on Velcro hose straps to ensure the camlocks were secured, the result was a flex hose coming off the fitting and spilling approx. 2500 liters of fuel onto the ground.	173443	Oil/Petroleum	Diesel Fuel		Asphalt	2500	Litres -(l)		Sq. Metres	contacted BPI and RBW for clean up. BPI vac sucked the diesel and placed in totes for offsite shipment. Transcendent scraped snow, and placed diesel contaminated snow in WWC. RBW provided bins for the used spill pads and Vallen restocked the spill pads that day.			Diesel Fuel	low likelihood
FRO	3960	June 6, 2018	In - Pit Fuel Islands	Bridge Fuel Island	653612	5562775	1119	Clode Creek	No	Operator was fueling 543 HT when the overflow switch didn't kick in. Causing 100L of Diesel fuel to spill out.	180-879	Oil/Petroleum	Diesel Fuel		Rocky ground	100	Litres -(l)			Spill pads placed, and picked up. Scraper picked up soiled material and brought to land farm			Diesel Fuel	low likelihood
FRO	4030	July 11, 2018	Rail Loop	Rail Loop	651315	5561305	304	MS Ponds Discharge	No	Spill of diesel to water at North Loop Pond. Spill originated from a diesel water pump that had no secondary containment	DGIR 181317	Oil/Petroleum	Diesel Fuel		Water	5	Litres -(l)	50	Sq. Metres				Diesel Fuel	low likelihood
FRO	4071	August 7, 2018	Eagle 6	Eagle 6 - Pushback	654070	5563094	742	Clode Creek	No	A previously repaired steel elbow on Fuel truck 530 cracked causing approx. 2000L of diesel fuel to spill to ground.	DGIR 181651	Oil/Petroleum	Diesel Fuel		Coal in Pit or Stockpile	2000	Litres -(l)			Fuel truck 530 was full when failure occurred, haul trucks filled up off the tank to minimize the amount spilled. Spill was contained with a coal berm while determining best means of clean up.			Diesel Fuel	low likelihood
FRO	4157	October 2, 2018	Eagle 6	Eagle 6	654058	5563093	744	Clode Creek	No	Hose ripped off of fuel tank of 1925 fuel station (north) and proceeded to spill approx. 300L	182390	Oil/Petroleum	Diesel Fuel		Coal in Pit or Stockpile	300	Litres -(l)	20	Sq. Feet				Diesel Fuel	low likelihood
FRO	4241	November 16, 2018	Swift Pit	Swift	649490	5561532	1420	Fording River	Yes	Tire blew on HT668 causing debris to hit the fuel tank resulting in 250 L of Diesel spilled onto the ground	182-957	Oil/Petroleum	Diesel Fuel		Rocky ground	250	Litres -(l)			Spill pads, boom, and pools placed down. To be scraped up and taken to Landfarm on nightshift			Diesel Fuel	low likelihood
FRO	4257	November 25, 2018	Tire Bay Pad	Tire Bay yard	651424	5562098	239	Fording River Side Channel	Yes	Tire Manipulator was idling and when the operator approached, he noticed diesel underneath it. Later discovered that the fuel filter had split.	183062	Oil/Petroleum	Diesel Fuel		Gravel	150	Litres -(l)			Absorbent pads. Contaminated material to be scraped up and taken to landfarm.			Diesel Fuel	low likelihood
FRO	4315	December 22, 2018	Bridge Fuel Island	Bridge fuel island 50.1961965, -114.8484685	653560	5562660	1237	CI												Sucker trailer to suck up ice and pick up contaminated ice.			Diesel Fuel	low likelihood
FRO	4523	April 28, 2019	Fuel Island South	Fuel Island South 50.188 -114.8806	651292	5561685	154	Fording River	Yes	Over flowing of fuel truck 502 By watch ing video footage worker was filling up fuel truck and set the auto sill lock on. While out of camera the operator didnt notice that the fuel was spray out the top of the truck and all over the lube island slab,	190318	Oil/Petroleum	Diesel Fuel		Rocky ground	300	Litres -(l)	3	Sq. Metres	absorbal Steam off pad Build berms Sucker truck Scraped to land farm			Diesel Fuel	low likelihood
FRO	4530	May 5, 2019	Swift	Swift	649848	5563990	826	Lake Mountain Creek	Yes	Fuel truck sprung a leak near 4 shovel @ 7:10 AM. Approximately 100L spilled.	DGIR 190388	Oil/Petroleum	Diesel Fuel		Other	100	Litres -(l)			Fuel pads put down. Berm created. Contaminated soil will be taken to land farm.			Diesel Fuel	low likelihood
FRO	4662	July 28, 2019	Swift 1885 Spoil	Swift 1885 spoil	649726	5561591	1216	Fording River	Yes	During recovery of haul truck 525 after suspension failure worker was cutting tie rod off ht525 before completely cutting through tie rod broke free falling and swing striking worker in the right leg.	DGIR 191412	Oil/Petroleum	Diesel Fuel		Waste Rock in Pit or Storage	900	Litres -(l)			BPI was called in to clean up area of spill with a Vac Truck WO 604962			Diesel Fuel	low likelihood
FRO	4732	August 30, 2019	In - Pit Fuel Islands	SOUTH TANK FARM PUMP #2 PIN DROP INDICATES 50.1882330 / -114.8807167	651283	5561709	138	Fording River	Yes	FUEL TRUCK OPERATOR WAS FUELLING UP SRVC511 AT #2 FUEL ISLAND SOUTH OF HEAVY DUTY SHOP. OPERATOR WAS IN PROGRESS OF FUEL ISLAND WHEN HE GOT CALLED AWAY FROM PUMP. OPERATOR LEFT FUEL NOZZLE UNATTENDED AND THE FUEL KICKOUT DID NOT WORK TO SHUT FUEL OFF ONCE TANK WAS FULL. OPERATOR SEEN FUEL SPILLING ONTO GROUND AND GOT BACK TO EQUIPMENT TO SHUT OFF NOZZLE. FOREMAN WAS NOTIFIED AND SCENE WAS FROZEN FOR INVESTIGATION.	191844	Oil/Petroleum	Diesel Fuel		Concrete Floor/Pad	250	Litres -(l)	400	Sq. Feet	quick response with grey soaker pads to contain pool flow, approximately 80 pads were used, as well as 10 bags of spill absorbant to soak up fuel on ground. absorbant and pads were disposed of in soil bin.	248	Litres -(l)	Diesel Fuel	low likelihood
FRO	4734	August 31, 2019	Eagle 4	Eagle 4	654985	5562198	1666	Clode Creek	No	3 loader fuel leak	191861	Oil/Petroleum	Diesel Fuel		Gravel	100	Litres -(l)			contaminates shoveled and brought to land farm			Diesel Fuel	low likelihood
FRO	4754	September 10, 2019	Castle South	Castle South Foxtrot road Drill pad 3469	655731	5557188	2164	Greenhouse Side Channel	Yes	Foraco drill rig 106 Supervisor identified some sheen on the Castle ridge road and at the 106 drill pad 3469 on Foxtrot road	DGIR 191970	Oil/Petroleum	Diesel Fuel		Gravel	50	Litres -(l)		Hectares	Soaker pads put down in heavy pooling areas			Diesel Fuel	low likelihood
FRO	4222	November 7, 2018	Lake Mountain Pit	NE corner of pit floor - 8 Shovel	650347	5564091	365	Fording River	Yes	While filling 21 EX with Diesel Exhaust Fluid, the fitting on the nozzle broke. Causing Approximately 10 L to spill onto ground.	182-841	Other	Other Liquid (describe)	DEF - Diesel Exhaust Fluid	Mud	10	Litres -(l)			Valve off, spill pads down. To be scooped up, barreled and taken to hazardous waste.			Diesel fuel (exhaust)	low likelihood
FRO	4553	May 19, 2019	Heavy Duty Shop	HD Shop - outside 58 Bay	651221	5561967	80	Fording River Side Channel	Yes	Moving a plastic container of DEF with a forklift and container was punctured	190559	Other	Other Liquid (describe)	Diesel Exhaust Fluid	Gravel	500	Litres -(l)			Supervisor has contained spill and is contacting Environmental department for guidance on clean up			Diesel fuel (exhaust)	low likelihood
FRO	4124	September 8, 2018	Warehouse/Maintenance Building (XXXX)	Warehouse/Maintenance Building	651365	5561811	197	Fording River	Yes	Lube Truck Driver attempted to fill lube truck from lube station. upon activation of the pump, grease pumped through an opened pressure release bypass valve, overfilling the drum reservoir & spilling onto the ground. Previous unknown worker left pressure release valve open in error. upon interview it was determined the incident occurred between 3pm on 09/07/18 and 10 am on 09/08/18 according to lube truck drivers that use the area.	182090	Other	Other Liquid (describe)	Dyno gear grease	Concrete Floor/Pad	100	Litres -(l)			Bearpaw will be cleaning up grease			Dyno gear grease	low likelihood
FRO	3913	May 10, 2018	Swift	Swift Creek Soil Salvage at Swift Creek Sediment Ponds	649726	5561591	1216	Fording River	Yes	Residual hydrocarbons were washed from a pump contained within secondary containment at the Swift Creek Soil Salvage. The secondary containment was overwhelmed with the previous nights rain and water overflowed the containment and caused a sheen within the sump that the pump was within. There was no connection to the Fording River or the sediment pond system. The total volume was described as residual and less than 100 mL.	DGIR180569	Oil/Petroleum	Engine Oil		Water	0.1	Litres -(l)	5	Sq. Feet	Used soaker pads to capture any hydrocarbons in the visible sheen. Plan to install a small boom at discharge of sump to capture any residual hydrocarbons if sum discharges to Swift Creek.			Engine Oil	negligible likelihood
FRO	4537	May 3, 2019	Cataract Creek Sediment Ponds	Cataract Creek Sediment Ponds	652467	5557529	7.3	Cataract Creek	No	Additional testing for antiscalant effects of varying concentrations was conducted on May 3, 2019 at GH_CC1 (Cataract Creek Sediment Ponds Decant). The preliminary result of the 48hr pass/fail D. magna single concentration test resulted in 77% mortallity which is in exceedance of permit 107517 limits for allowable tox effects. (limit 50%)	DGIR190423	Other	Other Solid (describe)	calcite percipitate	Water	1	Litres -(l)						Exceedance - D. magna toxicity test	not evaluated further
FRO	3937	May 7, 2018	Wastewater Treatment Facility	Waste Water Cell permitted discharge.	651188	5560969	313	Fording River	Yes	The monthly scheduled sample taken at the permitted discharge location of the Waste Water Cells (E296351) resulted in an Extractable Petroleum Hydrocarbons (EPH) exceedance of 58.9 mg/L (limit 15 mg/L). The finding occurred the evening of May 22nd when the results were received. Exceedance is presumed to be contributed to an addition of a large volume of a water and mineral oil mixture on May 3rd. The morning of May 22nd the waste water cell was skimmed.	DGIR180707	Other	Other Liquid (describe)	Extractable Petroleum Hydrocarbon	Other	1	Litres -(l)			None taken as exceedance was found after the cell stopped decanting. The permitted discharge of the cell is into the South Tailings Pond.			Exceedance - EPH or TEH	not evaluated further

GOLDER
MEMBER OF WSP

Table C-1: Screening of Spills

CorpCode	IncidentNum	IncidentDate	Location	Location Description	UTM E	UTM N																		
FRO	4000	June 5, 2018	Wastewater Treatment Facility	Wastewater Treatment Facility	651185	5560972	310	Fording iver	Yes	Permit 424 Exceedance of Total Extractable Hydrocarbons limit. Limit of 15 mg/L, result was 15.2 mg/L.	DGIR 181164	Other	Other Liquid (describe)	Extractable Petroleum Hydrocarbon	Other	1	Litres -(l)			Wastewater cells were skimmed by BPI on June 29th. The hydrocarbon layer was taken off of the cells.			Exceedance - EPH or TEH	not evaluated further
FRO	3995	June 21, 2018	UFR1	Tank Farm Oil Water Separator	651337	5561976	136.4	Fording River	Yes	Exceedance of Total Extractable Hydrocarbon Permit 424 Limit at Oil Water Separator 2 during routine sampling. EPH result was 28.4 mg/L, while the limit is 15 mg/L.	DGIR 181139	Other	Other Liquid (describe)	Extractable Petroleum Hydrocarbon	Other	1	Litres -(l)			OWS was fully cleaned out by BPI on June 28th 2018 upon receiving results.			Exceedance - EPH or TEH	not evaluated further
FRO	4596	May 29, 2019	South Tailings	Waste Water Treatment Cells	651202	5560914	310	Fording River	Yes	Permit 424 non-compliance due to an exceedance of permitted concentration of total extractable hydrocarbon as discharge from the wastewater treatment cells.	190808	Other	Other Liquid (describe)	Extractable Petroleum Hydrocarbon (mg/L)	Other	148	Litres -(l)						Exceedance - EPH or TEH	not evaluated further
FRO	4250	November 1, 2018	Turnbull Tailings Storage Facility	Turnbull-FRO TSTSF Location: Fording River Operations (FRO) Turnbull South Tailings Storage Facility (TSTSF) [50.217532, -114.875784]	651542	5564977	367	Fish Pond Creek	Yes	WLC AWTF 424 - NC – November 1, 2018 Disposal of liquids above hazardous waste selenium criteria at FRO TSTSF	DGIR 182902	Water Treatment	Pumpback water		Other	51000	Litres -(l)	51	Sq. Metres				Exceedance - selenium	not evaluated further
FRO	4743	August 26, 2019	Lake Mountain Pit	Lake Mountain Pit	650762	5564075	20	Fording River	Yes	A blast was initiated in the southeast portion of the Lake Mountain Pit at Fording River Operations on August 26, 2019. The initial review of drone video on August 27, 2019 identified one hole that had rifled and it appeared that three pieces of fly rock had landed in the Fording River. Field inspections identified two of the fly rocks and no indication of any other issues resulting from the blast. The fly rock was reported as a spill to EMBC at 12:15 on August 27, 2019. It was also reported through email to the B.C. Ministry of Energy, Mines, and Petroleum Resources, the B.C. Ministry of Environment and Climate Change Strategy, the B.C. Ministry of Forestry, Lands, Natural Recourses Operations and Rural Development, the Ministry of Environment and Climate Change Canada, the Department of Fisheries and Oceans Canada, and the Ktunaxa Nation Council.	191804	Other	Other Solid (describe)	Fly Rock	Water	5	Litres -(l)			No clean-up required/needed.			Fly Rock	not evaluated further
FRO	4224	November 9, 2018	General Office Parking Lot	General Office Parking Lot N556180 E651493	651483	5561827	309	Fording River	Yes	Contractor (High'r expectations) was pre-heating a foam resin BASF product (wall tight) in their cube truck vehicle while enroute to project location when a valve accidentally slipped into the open position.	182876	Other	Other Liquid (describe)	BASF product- foam resin (Wall Tight)	Ice on Ground	20	Litres -(l)	1	Sq. Metres	spread absorbent & kitty litter to contain spill, scraped up top icey layer of ground as well as absorbent and bailed all contaminated substrate into pails, Sprayed the area with a decontamination fluid and cleaned the truck off..			Foam Resin	low likelihood
FRO	4238	November 15, 2018	Rail Loop	Rail tracks by our orange tank, side spray area	651614	5560998	652	Fording River	Yes	The spray system for the train cars had an "eye" fuse go on the system that starts the spray it thought it was blocked, initiating the automatic spraying system, during this a solenoid valve pipe was cracked, causing the food glycerine to spray out 1170 litres on to the ground. COORDINATES : 5560999N, 651613E, 1640.2	182-942	Other	Other Liquid (describe)	Food Grade Glycerin	Rocky ground	1170	Count			Combo truck to wash and vacuum the free water / glycerine and snow in the area.			Food Grade Glycerin	low likelihood
FRO	4341	January 12, 2019	Castle North	Castle North	654759	5558953	2178	Kilmarnock Creek	No	Drain valve for the front spray bar was left open by day shift, night shift worker went up to fill the drill and did not realize the valve was open. As the truck was filling the drill the worker did not notice the water coming out of the valve until it was almost done filling.	183759	Other	Fresh Water	from water trees on FRO site	Ice on Ground	180	Litres -(l)			Water absorbed into the ground and mixed with melting snow/ice.			Fresh water	not evaluated further
FRO	3571	September 28, 2017	Eagle 6	Eagle 6- Pushback	654076	5563094	740	Clode Creek	No	7 Loader blew possibly a Hydraulic line or cylinder resulting in a spill of hydraulic oil to ground.	172213	Oil/Petroleum	Hydraulic Oil		Rocky ground	200	Litres -(l)			7 Loader was shutdown and secured .Spill pads were placed in and around 7 loader. Loader needs to be repaired in order to move and clean rest of the spill.			Hydraulic Oil	low likelihood
FRO	3577	October 4, 2017	Eagle 6	Eagle 6 North Back Fill	654052	5563093	746	Clode Creek	No	Hydraulic line failure on 3 Drill causing a spill to pit floor	172291	Oil/Petroleum	Hydraulic Oil		Rocky ground	200	Litres -(l)			Soaker pads applied			Hydraulic Oil	low likelihood
FRO	3680	December 15, 2017	Breaker	Breaker at the short reject dump	651626	5562356	373	Fording River	Yes	A main hydraulic line ruptured on 7 loader on the short reject dump causing a spill to ground.	173154	Oil/Petroleum	Hydraulic Oil		Coal in Pit or Stockpile	200	Litres -(l)			Spill pads applied. Contaminated ground was taken to the land farm.			Hydraulic Oil	low likelihood
FRO	3683	December 17, 2017	Eagle 6	Eagle 6 North (5 shovel)	654052	5563099	740	Clode Creek	No	The operator on 16 RTD started to clean up the right side of 5 shovel, as he reversed to set up for his second push he articulated to the right and struck a large rock causing damage to the hydraulic reservoir{transmission).	DGIR173165	Oil/Petroleum	Hydraulic Oil		Rocky ground	200	Litres -(l)			Spill pads were put down. Contaminated soil scraped up and taken to the landfarm for treatment.			Hydraulic Oil	low likelihood
FRO	3766	January 29, 2018	Eagle 6	Eagle 6 East by 9 Shovel (Pushback)	654052	5563093	746	Clode Creek	No	At approximately 1:00 am, 2 loader backed up into 570 haul truck, causing damage to the loader and a spill of hydraulic oil to ground.	173711	Oil/Petroleum	Hydraulic Oil		Rocky ground	200	Litres -(l)			Soaker pads and absorbent were used to contain the material. Contaminated ground was excavated and put into soil bins for offsite transport.			Hydraulic Oil	low likelihood
FRO	3799	February 15, 2018	Eagle 6	Eagle pushback, 9 shovel area.	654052	5563099	740	Clode Creek	No	Left front brake line blew on 572 HT, the operator did not notice, and continued driving between spoil and shovel resulting in the spill dispersed over the haul road.	173-951	Oil/Petroleum	Hydraulic Oil		Rocky ground	800	Litres -(l)			The spill was dispersed over a long length of haul road and could not be cleaned up.			Hydraulic Oil	low likelihood
FRO	3802	February 21, 2018	Eagle 6	Eagle 6	654058	5563093	744	Clode Creek	No	Hydraulic cooler on #2 loader failed resulting in a spill to the pit floor.	DGIR 174009	Oil/Petroleum	Hydraulic Oil		Rocky ground	1200	Litres -(l)			Absorbent pads used, contaminated material was scraped up and taken to landfarm			Hydraulic Oil	low likelihood
FRO	3803	February 21, 2018	Swift	Swift 6 shovel area	649726	5561588	1215	Fording River	Yes	A haul truck experienced a hydraulic oil tank leak resulting in a spill to ground in the pit.	174026	Oil/Petroleum	Hydraulic Oil			975	Litres -(l)			Berm constructed,soaker pads, pillows. Morgan Lypka has been contacted to call Justin Grace for further clean up recommendations			Hydraulic Oil	low likelihood
FRO	3836	March 15, 2018	Lake Mountain Pit	Lake Mountain Pit at 8 shovel.	650287	5564147	415	Fording River	Yes	The hydraulic pump failed on 2 loader causing a spill of 100L of hydraulic oil to ground.	DGIR 174282	Oil/Petroleum	Hydraulic Oil		Rocky ground	100	Litres -(l)	1	Hectares	Spill contained with catch pool, spill pads and berm of dirt. Contaminated soil scraped up and taken to landfarm.			Hydraulic Oil	low likelihood
FRO	3845	March 21, 2018	Lake Mountain Pit	Lake Mountain Pit - 1830 spoil	650288	5564105	416	Fording River	Yes	The wheels came off of 540HT, the axel box was damaged causing hydraulic fluid to leak out.	174365	Oil/Petroleum	Hydraulic Oil			700	Litres -(l)			Spill has been contained however, the truck needs to be removed before spill cleanup can commence.			Hydraulic Oil	low likelihood
FRO	3907	May 5, 2018	Eagle 6	Valley Spoil	654071	5563082	753	Clode Creek	No	The nose cone of HT525 broke, the rear tires left the truck tearing hydraulic lines and causing a spill to ground.	180501	Oil/Petroleum	Hydraulic Oil		Rocky ground	600	Litres -(l)			Spill has been contained. The damaged truck is sitting on the spill so cleanup will not be able to take place until after it is removed.			Hydraulic Oil	low likelihood
FRO	3909	May 6, 2018	Lake Mountain Pit	Lake Mountain Pit - 8 Shovel	650282	5564117	422	Fording River	Yes	HT674 leaked hydraulic fluid after a rock rolled from the rock face into the axel box of the truck	180510	Oil/Petroleum	Hydraulic Oil		Rocky ground	400	Litres -(l)			Applied spill pools and spill pads. Created berm to contain spill			Hydraulic Oil	low likelihood
FRO	3954	June 5, 2018	Tire Bay	Tire Bay	651401	5562082	213	Fording River Side Channel	Yes	While operating the Tire Manipulator a worker hit the hydraulic tank of HT 585. Causing the tank to leak approximately 450L of Hydraulic Oil.	DGIR180864	Oil/Petroleum	Hydraulic Oil		Concrete Floor/Pad	450	Litres -(l)			Spill pads & boom placed down. Container underneath truck to catch oil. To be picked up and brought to disposal			Hydraulic Oil	low likelihood
FRO	3994	June 25, 2018	UFR1	Tank Farm - Inside tank farm.	651337	5561973	136.3	Fording River	Yes	Hydraulic hose fitting failed at lube island. Ball valve behind the pressure fitting was left partially open. Oil filled up the spill tray and overfilled into the tank farm area. Time of incident is unknown at this time but it is presumed that it happened last night/this morning.	181120	Oil/Petroleum	Hydraulic Oil		Other	350	Litres -(l)			Spill was contained, spill pads applied, clean-up crew and vac-truck called.			Hydraulic Oil	low likelihood
										age the Hydraulic drain valve.	DGIR									pools set under HT			Hydraulic Oil	low likelihood
FRO	4027	July 10, 2018	Lake Mountain Pit	Lake Mountain Pit	650263	5564141	440	Fording River	Yes	Blade on 27 grader kicked back and caught a hydraulic line	DGIR 181291	Oil/Petroleum	Hydraulic Oil		Rocky ground	150	Litres -(l)			soaker pads in place, spill pool placed to contain the remainder of the spill. Contaminates will be disposed of accordingly			Hydraulic Oil	low likelihood
FRO	4084	August 18, 2018	Eagle 6	Eagle 6 north 5 shovel area	654058	5563093	744	Clode Creek	No	Operator on 670 haul truck got loaded at 5 shovel and pulled out and went through the arches. Was a couple truck lengths out from the arches and the number one tire blew. The truck stopped immediately and the front windshield cracked.	181-833	Oil/Petroleum	Hydraulic Oil		Rocky ground	1800	Litres -(l)			Spill pads placed down. Mechanics called to scene.			Hydraulic Oil	low likelihood
FRO	4174	October 14, 2018	Swift	Swift 4 shovel area	649720	5561591	1222	Fording River	Yes	a rear tire on 548 HT is separating , a chunk of rubber broke off and broke a cap off causing the hydraulic oil leak.	182554	Oil/Petroleum	Hydraulic Oil		Rocky ground	700	Litres -(l)			SPill contained, spill pool in place, barrels for extra oil released, once truck is repaired the contaminated soil will be taken to the land farm			Hydraulic Oil	low likelihood
FRO	4186	October 19, 2018	Swift	Swift pit south by 4 shovel	649724	5561592	1218	Fording River	Yes	Hydraulic valve on the back of HT 574 broke	182604	Oil/Petroleum	Hydraulic Oil		Rocky ground	200	Litres -(l)			Spill pool and spill pads			Hydraulic Oil	low likelihood
FRO	4217	November 4, 2018	Swift South	Swift south by 6 shovel, GPS Coordinates: 50.1832896 x 114.9052542	649548	5561109	1297	Fording River	Yes	HT 527 Leaving right side of 6 shovel lost steering and released lots of fluid.	182804	Oil/Petroleum	Hydraulic Oil		Mud	402	Litres -(l)			spill pool			Hydraulic Oil	low likelihood
FRO	4264	November 29, 2018	Lee's Lake Stockpile	Lees lake stockpile	650601	5561886	561	Fording River	Yes	Haul truck 587 is leaking hydraulic fluid from the wheel hub (truck is new)	183126	Oil/Petroleum	Hydraulic Oil		Ice on Ground	700	Litres -(l)	3	Sq. Metres	Clean-up actions are underway at present			Hydraulic Oil	low likelihood
FRO	4391	February 8, 2019	Swift	Swift crush site entrance	649467	5562445	913	Lake Mountain Creek	Yes	Haul truck ran over rock compromising tank. Emptied 200L of hydraulic fluid onto ground.	dgir184129	Oil/Petroleum	Hydraulic Oil		Gravel	200	Litres -(l)			once truck is moved pick up contaminated dirt and take to land farm			Hydraulic Oil	low likelihood
FRO	4467	March 28, 2019	Eagle 6	Eagle 6 - West	653874	5562393	1468	Clode Creek	No	Hydraulic oil leak from HT 522 in eagle pit on a ramp	DGIR184730	Oil/Petroleum	Hydraulic Oil		Rocky ground	170	Litres -(l)	6	Sq. Metres	contaminated dirt and oil to land farm			Hydraulic Oil	low likelihood
FRO	4471	March 30, 2019	Lake Mountain Pit	Lake Mountain Pit	650421	5564210	285	Fording River	Yes	Hydraulic oil line failure in 3 Loader causing a spill of 100L to spill on ground of mine pit.	DGIR184748	Oil/Petroleum	Hydraulic Oil		Gravel	100	Litres -(l)			Scrapped up contaminates and disposed of them in the land farm.			Hydraulic Oil	low likelihood
FRO	4472	March 31, 2019	1795 Free Dump Spoil	Spoils 1795 Free Dump Spoil.	649998	5565148	783	Fording River	Yes	Hydraulic line failure on 529 Haul Truck, at 1795 Spoil.	184755	Oil/Petroleum	Hydraulic Oil		Rocky ground	150	Litres -(l)			Absorbent spill pads have been placed on the spill, will scrape up contaminates and dispose in land farm after truck is moved.			Hydraulic Oil	low likelihood
FRO	4491	April 9, 2019	Causeway Spoil	Causeway Spoils	653098	5562531	1475	Clode Creek	No	Left front suspension failure on haul truck 546, at the causeway spoil.	DGIR 190102	Oil/Petroleum	Hydraulic Oil			600	Litres -(l)			truck is stuck ontop of spill, spill pads and barriers placed around area.			Hydraulic Oil	low likelihood
FRO	4554	May 21, 2019	Swift	Swift No Northings or westings given	649720	5561588	1221	Fording River	Yes	Hydraulic evac pump on SH804 was faulty and did not evacuate the hydraulic oil from the coolers resulting in a spill when hose taken off.	190581	Oil/Petroleum	Hydraulic Oil		Rocky ground	700	Litres -(l)	3	Sq. Feet	Spill pools, Soaker Pads			Hydraulic Oil	low likelihood
FRO	4619	June 27, 2019	Tire Bay	North of Tire Pad. Where Tires are stocked.	651387	5562167	233	Fording River	Yes	TowHaul 39 was driving to tire pad when the jumper line got caught up in the tire chains, causing it to be ripped off and leak 100L of Hydraulic Oil.	DGIR - 191031	Oil/Petroleum	Hydraulic Oil		Mud	100	Litres -(l)			Soaker pads and pool placed down. Once equipment is fixed, material to be scraped up and taken to land farm			Hydraulic Oil	low likelihood

Table C-1: Screening of Spills

CorpCode	IncidentNum	IncidentDate	Location	Location Description	UTM E	UTM N																		
FRO	4680	August 2, 2019	Eagle Pit	Eagle 6 South	654226	5562608	1189	Clode Creek	No	575HT was queuing into 3 Shovel in Eagle Pit when the hydraulic line blew and released the entire contents of the hydraulic tank onto the ground.	DGIR# 191-487	Oil/Petroleum	Hydraulic Oil		Waste Rock in Pit or Storage	150	Litres -(l)	100	Sq. Feet	HT was turned off immediately. Spill pads put in place. Material was absorbed by pads, soil was shovelled into bin & removed from the site.			Hydraulic Oil	low likelihood
FRO	4728	August 26, 2019	Spawn Marshallinb Area	spawn marshaling area	652152	5561768	974	Fording River Side Channel	Yes	A drum with hydraulic oil in the spawn marshalling area was driven over causing a spill of approximately 150L.	191798	Oil/Petroleum	Hydraulic Oil		Rocky ground	150	Litres -(l)			spill pads down -> land farm			Hydraulic Oil	low likelihood
FRO	3750	January 25, 2018	Eagle 6	R4 Mineral Oil Tank	654052	5563093	746	Clode Creek	No	On January 25, 2018, a Fording River Operations (FRO) employee noticed signs of a mineral oil spill due to the red colored dye within the snow in and around the mineral oil tank. This mineral oil tank is located at our R4 site which is a bulk explosives storage facility located on the north end of our Eagle Pit operations. The facility is entirely fenced and gated and the closest water source is approximately 500 meters which would be Clode Creek. Upon further investigation it was found the tank started leaked at 7:00PM January 24, 2018, it continued to draw down until 11:00pm where it leveled out. The failure mechanism was the wiggins hose attachment to the pump (photo included). The leak was discovered and reported on January 25, 2018 and cleanup actions stated after that time.	DGIR 173669	Other	Other Liquid (describe)	Dyed Mineral Oil	Gravel	24700	Litres -(l)	150	Sq. Metres	Valve on tank closed. Vac truck used Jan 25 and 26. Vacuumed 500L the 25th and 200L the 26th. There wasn't much recharge on Jan 27. On January 28th a small loader was used to clear the uncontaminated snow and scrap up the contaminated snow for review by the environmental group. A labor crew cleaned up around the tanks using shovels and spill pads on January 28th and placed in RBW contaminated material bin to be taken off site. In total 1500L has been cleaned up.	1500	Litres -(l)	Mineral oil	low likelihood
FRO	3868	April 3, 2018	Spawn Road	Spawn Road	651854	5561854	665	Fording River Side Channel	Yes	Potable water line was leaking subsurface. Resulted in a spill of potable water to ground. Excavation on April 3rd confirmed the leak. Repair is completed.	DGIR180025	Other	Other Liquid (describe)	Potable Water	Rocky ground	189271	Litres -(l)	200	Sq. Metres	As this was potable water there was no clean up. Water drained away to ground during excavation for pipeline repair.			Potable water	not evaluated further
FRO	4016	July 4, 2018	Cathedral	Cathedral	651507	5561413	454	MS Ponds Discharge	No	Loader was moving material at the Cathedral when it made contact with an unknown/unmarked fire hydrant causing the hydrant to open and spill potable water to ground surrounding the cathedral. When isolating the potable water line, it back-pressured an attached line causing an additional leak.	DGIR 181241	Water Treatment	Potable Water		Coal in Pit or Stockpile	700000	Litres -(l)			None taken, as water will be routed through site drainage. Line was isolated to stop the leak.			Potable water	not evaluated further
FRO	4050	July 24, 2018	Pilot plant - Water Treamtment	AWTF- Project	652324	5559701	194	Kilmarnock Creek	No	While conducting a pressure test on the Swift HDPE piping spool a brass ball valve failed and water in piping spool was released to excavation. Water was contained.	DGIR 181510	Other	Other Liquid (describe)	Potable water	Other	500	Litres -(l)	5	Sq. Feet	Potable water was contained in excavation and seeped to thru ground- remaining water was pumped into containment barrels	275	Litres -(l)	Potable water	not evaluated further
FRO	4380	February 5, 2019	Inside General Office	Mine Ops Office - 1st floor west side, below stairwell	651372	5561969	171	Fording River Side Channel	Yes	A sprinkler pipe burst in the Mine Operations building, 1st floor, west side under the stair well. This trigged the fire alarm, the building was evacuatted and fire water containing chlorine spilled wihin the building. The water was mostly contained to the building drainage.	184080	Water Treatment	Potable Water		Concrete Floor/Pad	3200	Litres -(l)	3000	Sq. Feet	Water was controlled to drainages, a vaccum truck was called to remove the remaining water.			Potable water	not evaluated further
FRO	4616	June 25, 2019	Conveyors	Conveyors - Raw coal bench, near stacker	651655	5561367	607	MS Ponds Discharge	No	Backhoe broke waterline on raw coal bench.	191022	Water Treatment	Potable Water		Coal in Pit or Stockpile	5000	Litres -(l)	20	Sq. Metres	vac truck to suck up spill. no water ways affect no ditches affected.			Potable water	not evaluated further
FRO	4765	September 15, 2019	Cathedral	Cathedral	651406	5561507	357	Fording River	Yes	broken fire line near cathedral	DGIR 192038	Water Treatment	Potable Water		Soil	20000	Litres -(l)			berm was build to try and contain what was left of the water. Most of it ended up in the ditch leading to site drainage.			Potable water	not evaluated further
FRO	4658	July 21, 2019	Sunshine Laydown	Sumps located on the west side of the Fording River about 200m below the multi-plate culvert.	651186	5562332	57	Fording River	Yes	Fording River Operations (FRO) observed an unauthorized discharge to the Fording River as a result of receiving 49mm of rain over the last 24hrs. The origin of the unauthorized discharge was coming from our haul road drainage that goes into a series of designed sumps on the west side of the Fording River, approximately 200m downstream of the multi-plate culvert. These sumps were temporarily overwhelmed due to the intense rainfall and reported to the Fording River via sub-surface. Estimated flow of the source was determined by the amount of flow coming from the haul road and discharging through a culvert into the sumps which was about 11L/sec. The event was immediately reported to EMBC at 18:00 (DGIR# 191-322). The event stopped at 9:00 on July 21st and EMBC was updated.	191-322	Process Water/Solutions	Discharge Water			594000	Litres -(l)			Fording River Operations will continue to monitor this area and evaluate the overall effectiveness of these sumps which will drive a mitigation plan regarding the future actions on these sumps.			Process Water	high likelihood
FRO	4670	July 21, 2019	CP1	Swift Access Road that crosses the Fording River	652057	5558467	28	Swift Sediment Pond Discharge Channel	No	At 18:30 Fording River Operations identified an unauthorized discharge from a localized drainage west of the Swift Creek Sediment Pond discharge channel approximately 120 meters downstream of the Swift Creek Sediment Ponds permitted discharge location. Environmental monitors were onsite throughout the day monitoring drainage and maintaining sumps, which had seen 49 mm of rain prior to the event with no issues. Previous inspections of the area were completed at 18:15 and showed the area was clean. The event was preceded by snow followed by rain, which temporarily overwhelmed a local sump and silt fence. Upon identifying the issue, the flow from the unauthorized discharge was approximately 0.5 liters/second. The unauthorized discharge was mitigated by approximately 19:00, and rain stopped at approximately 20:00. The unauthorized discharge was reported to EMBC at 22:30 (DGIR #191323).	191323	Process Water/Solutions	Discharge Water		Water	900	Litres -(l)			Fording River Operations will continue to monitor this area, as well as other potential areas.			Process Water	high likelihood
GHO-UFR	3778	August 12, 2019	Door 26 on Overland Conveyor	Door 26 on Overland Conveyor	653812	5546555	113	Greenhills Creek	Yes	Environmental found signs of spill coming from overland clean coal conveyer. Washing/cleaning around conveyer resulted in water to flow across road and into nearby creek. It is belived the spill occured from Cleanup being done on the night shift of August 12th 2019 LPO notified and PEP was called. DGIR#191644 Water sampling conducted above and below the point of entry.	DGIR# 191644	Process Water/Solutions	Process Water		Rocky ground	1500	Litres -(l)			signs of spill was found by Environment Department the next day. it had dried up and no further actions have been taken at this time for cleanup.			Process Water	high likelihood
FRO	4719	August 22, 2019	Maxam Yard	Rail Loop	651066	5561154	171	Fording River	Yes	During an infrastructure upgrade of a nearby facility a contractor was walking a track hoe and was required to cross the authorized works that conveys effluent from a series of collection sumps at the Maxam Emulsion Explosives Plant to the South Tailing Pond. To make room for the track hoe, the contractor uncoupled the line approximately 42 m west of the South Tailings Pond authorized discharge location, however did not immediately reconnect the line, resulting in a spill of approximately 300 liters of sump effluent (i.e. wash water). The contents flowed into a low spot on the access road and nearby ditch that subsequently retained the spill. A vacuum truck was immediately dispatched to clean up the spilled contents and the line was reconnected to allow for normal operation of the system. FRO has reported the unauthorized discharge and spill to EMBC at 10:30, August 22nd (DGIR#191754).	191754	Process Water/Solutions	Gray Water		Rocky ground	300	Litres -(l)			cleaned up with vacume truck			Process Water	low likelihood
GHO-UFR	3787	August 23, 2019	Frozen coal building	Frozen coal building	653319	5547790	662	Gardine Creek	Yes	Due to a malfunction leading to shutdown of the plant feed conveyer, plant workers were reportedly hosing inside the frozen coal building all night and morning of Aug 23. Wash water was flowing out the buildings doors, down the road towards the wash plant. The building's sump discharges to the pipe (next to the STP outlet pipe) that under normal conditions flows into the ditch next to the plant road. That ditch leads to a culvert under the road that ultimately discharges into the TSF. The ditch appears to have been worked on very recently, and is filled with material where the pipes discharge. Due to the hosing in the building, the sump discharge pipe had increased water load, approximately 50% of which was flowing over the clogged ditch onto the road. From there, it was joining with water coming from the building's doors, all of which was flowing into the ditch system on the NE side of the wash plant, which discharges into the site-A sediment ponds. The ponds were not discharging to the site-A drainage pipe. DGIR191770	DGIR#191770	Process Water/Solutions	Process Water		Rocky ground	2000	Litres -(l)	300	Sq. Metres	Cleaned out ditch so water would report to the tailings pond			Process Water	high likelihood
FRO	4383	February 5, 2019	Maxam Sump	Maxam Bulk Explosive Plant Site - Sump	651054	5561113	180	Fording River	Yes	FRO's Maxam sump that pumps wash water to the South Tailings Pond as part of our effluent permit 5556, is believed to have a plugged line and is backing up into an adjacent sump within the Maxam Facility. That adjacent sump has an overflow pipe that is connected to a nearby collection ditch within the Maxam facility as well. That overflow pipe is allowing that backup wash water to flow to the collection ditch and ultimately going to ground. This has been reported to ENV as an unauthorized discharge and we are requesting a bypass as per section 2.1 of permit 5556 to allow us to send the sump water to our approved discharge location which is the South Tailings Pond, via a mobile diesel pump and a temporary overland pipe. We have also reported immediately to EMBC but no volumes have been provided as we are still determining what that amount would be.	DGIR #184-083	Process Water/Solutions	Process Water		Sump	5328000	Litres -(l)			Majority of wash water went to a collection ditch in the maxam facility and went to ground. Cleanup consisted of getting an bypass authorization to pump the wash water using a mobile diesel pump and overland pipe to the South Tailings Pond to stop the water from going to ground.			Process Water (Maxam Event)	high potential event (Teck designation)
FRO	3611	October 29, 2017	South Tailings	South Tailings	652128	5560399	535	Fording River	Yes	Tailings Solids in the South Tailing Pond backed up in area causing ponding and localized backflow through the overflow culvert at the north end of the pond.	DGIR172604	Slurry	Tailings		Waste Rock in Pit or Storage	136600	Litres -(l)	50	Sq. Feet	Diverted all site drainage to North Loop Pond, shutdown plant, shutdown Shandley waterline. Long arm excavator to dig channel tomorrow			Tailings	low likelihood

Table C-1: Screening of Spills

CorpCode	IncidentNum	IncidentDate	Location	Location Description	UTM E	UTM N																	
FRO	3624	October 31, 2017	South Tailings	North end of South Tailings Pond draining towards Maxam	652128	5560399	535	Fording River	Yes	At approximately 15:20 on Oct 31, approximately 750 – 1000 liters of tailings slurry was observed flowing from the North Abutment of the South Tailings Pond. This is a relatively flat, slightly depressed area at the north end of the South Tailings Pond of approximately 2 hectares size. The flow path proceeded downslope within the confines of a hard-pan concave road surface for approximately 100 meters away from the South Tailing main containment dyke. The flow path terminated at a flat spot on the road immediately outside the south gate entrance to Maxam Explosives Facility. From this point approximately 200 liters of tailings liquid entered the initial 10 m of a ditch depression that is occasionally connected to the Fording River via a series of small sumps. Elevated points of land between the sumps make it impossible for water to flow between them at present. It was confirmed that none of the flowing material or supernatant liquid entered any depression, sump, ditch or other structure having presence of water. Tailings had been placed on the edge of the Tailings Dyke to support improvements being carried out to eliminate the risk of further backflow through a drainage culvert associated with previous incident DGIR #172604. This material has a relatively high water content. While the material was sitting in place water began to seep out but remained at the work site contained in the small depression on the road surface. As more material was excavated, water seeping out of the excavated material exceeded the capacity of the depression. The ground immediately surrounding the location of the deposited pile had been frozen for the majority of the day and showed no indications that liquid would migrate beyond the immediate work area. This depressed area consistently has pooling water present. It is likely that a portion of the flow consisted of displaced water lying underneath the ice and forced from this depression as the tailings pile water was introduced. Samples of liquid fractions were obtained from depressed areas where accumulations occurred, as well as additional samples in the area.	172604	Slurry	Tailings		Other	1000	Litres -(l)	2	Hectares	Pooled material up above beginning to be pumped back into the South Tailings Pond.			Tailings	low likelihood
FRO	3703	December 25, 2017	South Tailings	South Tailings	652126	5560400	534	Fording River	Yes	Tailings solids in the South Tailings Pond backed up in area causing ponding and localized overflow through culvert into containment trench.	173260	Slurry	Tailings		Rocky ground	1000	Litres -(l)	50	Sq. Feet	Shut down plant Excavating loose material and placing barriers			Tailings	low likelihood
FRO	4347	January 17, 2019	North Yard	North Yard	651328	5562382	133	Fording River	Yes	While trying to pickup a drum of Tire life with the forklift, the forks were not aligned causing them to puncture the plastic casing and spill 1200L onto the ground.	183-823	Other	Other Liquid (describe)	Tire Life	Rocky ground	1200	Litres -(l)			Spill pads down, Vac truck to come suck up residue			Tire Life	low likelihood
FRO	3569	September 28, 2017	Eagle 6	Eagle North 1	654071	5563082	753	Clode Creek	No	16 RT backed over a large rock puncturing the transmission resulting in a hydraulic oil spill to ground.	172212	Oil/Petroleum	Transmission Oil		Rocky ground	300	Litres -(l)	1	Sq. Feet	Will be taken to landfarm.			Transmission Oil	low likelihood
FRO	3708	December 18, 2017	Swift	Permitted discharge from Liverpool Sediment Pond (E304835)	649727	5561586	1213	Fording River	Yes	During pit-dewatering test pumping to the Liverpool Sediment Ponds the flush of water to the previous empty primary pond may have resulted in re-suspension of loose sediment in the pond to re-suspend and discharge from the secondary pond permitted discharge. The result was an exceedance of PE-424 limits for total suspended solids at FR_LP1 (E304835).	DGIR173279	Other	Other Solid (describe)	sediment from bottom of sediment pond	Water	200	Litres -(l)			No clean up as this was a TSS release to water			TSS or Road Drainage (Ecofish)	not evaluated further
FRO	4455	March 16, 2019	Liverpool Ponds	100m above FR_LP1	651088	5562364	41	Fording River	Yes	With the recent warmer temperatures, Fording River Operations (FRO) observed an unauthorized discharge to the Fording River as a result of melting snow on our access roads. The origin of the unauthorized discharge was coming from a light vehicle road that accesses our FRO Liverpool Pond permitted discharge location. The road drainage was unable to drain to the existing sumps due to ice/snow berms along the north side of the access road and ended up flowing down the road and over the stream embankment to the Fording River.	184570	Water	Water	Inland water	water	127.6	Litres -(l)						TSS or Road Drainage (Ecofish)	not evaluated further
FRO	4456	March 18, 2019	FR_UFR1	Upper Fording River 1	651458	5566679	9.6	Fording River	Yes	With the recent warmer temperatures, Fording River Operations (FRO) observed an unauthorized discharge to the Fording River as a result of rapid snow melting occurring on the west side of our historic Henretta spoils. The majority of this runoff is directed to a culvert that allows the water to continue to existing sump structures adjacent to the Upper Fording River. The culvert; however, is still ice up and being overwhelmed with the amount of runoff occurring and coming onto the access road and flowing down the road to one of our northern monitoring locations referred to as UFR1 (E216777) in our 424 effluent permit.	DGIR 184952	Other	Fresh Water	Mine Contact Water - Unauthorized Discharge	Water	1	Litres -(l)						TSS or Road Drainage (Ecofish)	not evaluated further
FRO	4458	March 20, 2019	Post Ponds	Post Ponds	650982	5565212	6.1	Fording River	Yes	As a consequence of the recent warming trend combined with the recent commissioning of Fording River Operation's (FRO) new Post Sediment Ponds, the ponds are observing a Total Suspended Solids (TSS) exceedance within FRO's effluent permit 424. Construction of these ponds were completed at the end of November 2018 and flow commenced through the entire system as of March 18, 2019. The water entering the ponds is originating from the newly constructed diversion that diverts the north tributary of Lake Mountain Creek into the Post Ponds as opposed to the Lake Mountain Ponds last freshet. This new diversion has been covered by a designed rock drain within the diversion and over the winter this rock drain has been spoiled over as part of our approved mine plan. As a result of all this recent infrastructure now transporting this water, FRO is observing an anticipated flushing of this entire system. Internal results indicate a TSS result of 120.8 mg/L as of 1:00pm on March 20, 2019. (Permit 424 limit for TSS is 50mg/L). FRO has also reported the TSS exceedance to EMBC at 18:10 March 20th (DGIR#184616).	DGIR 184616	Concentrate	TSS	TSS (mg/L)	Water	120.8	Litres -(l)						TSS or Road Drainage (Ecofish)	not evaluated further
FRO	4459	March 21, 2019	Liverpool Outlet	Liverpool Ponds	651105	5562326	24	Fording River	Yes	As a consequence of the recent warming trend, Fording River Operation's (FRO) Liverpool Sediment Ponds are observing a Total Suspended Solids (TSS) exceedance within FRO's effluent permit 424. The actual pond discharge is clean; however, the discharge then flows down a 200 meter open channel to the Fording River. This 200 meter open channel contains sediment laden snow/ice accumulations which is being carried by the clean water from the ponds and discharging to the Fording River. This sediment laden snow/ice was not observed last year and was not anticipated in this year freshet as well. Internal results indicate a TSS result of 89.2 mg/L as of 14:45pm on March 21, 2019. (Permit 424 limit for TSS is 50mg/L). FRO has also reported the TSS exceedance to EMBC at 18:10 March 21st (DGIR#184634).	DGIR 184634	Concentrate	TSS	TSS (mg/L)	Water	89.2	Litres -(l)						TSS or Road Drainage (Ecofish)	not evaluated further
FRO	4628	June 21, 2019	Fording River	Fording River just upstream of the Swift Creek Bridge	652906	5557099	3.9	Fording River	Yes	Unauthorized discharge of mine effected drainage water directly to the Fording River just upstream of the Swift Creek Bridge. Fording River Operation (FRO) received 52.5mm of precipitation, combined with approximately 10cm of snow over the last 24 hrs. As a result, there was an excessive amount of road drainage flowing down the Swift Creek road onto the Bridge that spans over the Fording River and discharging into the Fording River. The road drainage typically flows into existing ditches and sumps to intercept the road drainage before getting onto the Bridge; however, the sumps and ditches were overwhelmed due to the significant amount of precipitation over the last 24 hrs.	190967	Other	Other Liquid (describe)	Water	Water	1	Litres -(l)			No clean up.			TSS or Road Drainage (Ecofish)	not evaluated further
FRO	4626	June 21, 2019	Sunshine Laydown	Fording River in proximity to the Liverpool Sedimentation Pond decant (approx 50 meters north)	651089	5562636	182	Fording River	Yes	Fording River Operation (FRO) received 52.5mm of precipitation, combined with approximately 10cm of snow over the last 24 hrs. As a result, there was an excessive amount of road drainage flowing down the Coal Haul road that crosses the Fording River. The road drainage in this location is directed to a series of sumps and was operating as designed. These sumps; however, were overwhelmed due to the significant amount of precipitation over the last 24 hrs and discharged dirty road drainage water into the Fording River.	190969	Other	Other Liquid (describe)	mine effected drainage water	Water	1000	Litres -(l)			no clean up required/possible			TSS or Road Drainage (Ecofish)	not evaluated further
FRO	4627	June 21, 2019	Liverpool Sediment Pond discharge sample location	Liverpool Sedimentation Pond	649724	5561594	1219	Fording River	Yes	Fording River Operation (FRO) received 52.5mm of precipitation, combined with approximately 10cm of snow over the last 24 hrs. As a result, there was an excessive amount of road drainage flowing down the Coal Haul road above the Liverpool Sediment Pond. The existing sumps and ditches along the Coal Haul road were overwhelmed due to the significant about precipitation received over the last 24 hrs causing more road drainage water than usual to report directly into the pond system. A dsicharge sample taken at the time of the occurance indicated 64 mg/l (limit 50 mg/l).	DGIR#190-969	Other	Other Liquid (describe)	Mine effected water discharging from a settling pond system	Water	10000	Litres -(l)	500	Sq. Metres	No clean up activtires were possible			TSS or Road Drainage (Ecofish)	not evaluated further
FRO	4635	July 4, 2019	CP1	Fording River at Swift Creek bridge	652151	5558592	14	Fording River	Yes	Unauthorized discharge of sediment laden water to the Fording River	dgir #191126	Other	Other Liquid (describe)	Mine Run-off Water	Water	32400	Litres -(l)			earth berms, strawbale check dams and additional sumps			TSS or Road Drainage (Ecofish)	not evaluated further
FRO	3785	February 10, 2018	Maxam Bulk Explosive Plant Site	Maxam Bulk Explosive Plant Site	651098	5561122	216	Fording River	Yes	A Maxam operator was mixing APX solution at the Maxam facility. They left the water valve turned on when they left the facility. The Maxam lead hand found the spill, shut the water valve off and called to report the spill to the LPO. APX mixture of Water, Glycol and 2- 22.7kg bags of sodium nitrate, an estimate of 200L total spilled from the APX room and out into the snow and on to the concrete pad. The entire Maxam yard is fenced and gated.	173888	Other	Other Liquid (describe)	APX Fluid	Concrete Floor/Pad	200	Litres -(l)	80	Sq. Feet	Applied spill pads. Mine Ops was called for assistance. A small loader was brought down to scrape up the spill. Contaminated materials contained in hazardous waste drums. Ministry of Environment also called for more information regarding the spill.			Water, glycol and sodium nitrate	low likelihood

APPENDIX D

Water Chemistry Screening

Table D1: Water Quality for Incident 4658

Conventional Parameters									
pH	-	6.5 - 9.0	6.5 - 9.0	-	-	8.4	8.4	8.4	8.4
Specific conductivity	µS/cm	-	-	-	-	444	471	470	425
Hardness, as $CaCO_3$	mg/L	-	-	-	-	231	252	248	240
Total alkalinity, as $CaCO_3$	mg/L	20[a]	-	-	-	141	145	137	141
Total dissolved solids	mg/L	-	-	1,000	5,000	277	290	286	268
Total suspended solids	mg/L	-	-	-	-	16	37	232	5.6
Total organic carbon	mg/L	-	-	-	-	2.4	8.5	88	-
Dissolved organic carbon	mg/L	-	-	-	-	1.3	1.3	1.3	-
Turbidity	NTU	-	-	-	-	7.0	27	308	1.5
Acidity, $CaCO_3$	mg/L	-	-	-	-	<1.0	<1.0	<1.0	<1.0
Bicarbonate alkalinity, as $CaCO_3$	mg/L	-	-	-	-	137	140	133	137
Carbonate alkalinity, as $CaCO_3$	mg/L	-	-	-	-	4.4	5.8	4.4	4.6
Hydroxide alkalinity, as $CaCO_3$	mg/L	-	-	-	-	<1.0	<1.0	<1.0	<1.0
Major Ions									
Bromide	mg/L	-	-	7.8	1,000	<0.05	<0.05	<0.05	<0.05
Chloride	mg/L	150	600	-	-	<0.5	<0.5	<0.5	<0.5
Fluoride	mg/L	0.12	1.7 - 1.7[b]	-	-	**0.21**[Mn]	**0.21**[Mn]	**0.21**[Mn]	**0.21**[Mn]
Potassium	mg/L	-	-	-	-	0.84	1.00	1.0	0.74
Sodium	mg/L	-	-	-	-	0.72	0.89	0.88	0.72
Sulphate	mg/L	429[b, c]	-	-	-	81	90	96	77
Nutrients									
Nitrate	mg-N/L	3.0	33	10 - 11[b]	-	**4.6**[Mn]	**4.4**[Mn]	**4.5**[Mn]	**3.1**[Mn]
Nitrite	mg-N/L	0.020[d]	0.060[d]	-	-	0.0051	0.0057	0.0074	0.0022
Total ammonia	mg-N/L	0.47[e]	2.4[e]	-	-	0.042	0.010	0.055	<0.005
Total Kjeldahl nitrogen	mg-N/L	-	-	-	-	0.35	0.51	2.2	-
Total phosphorus	mg-P/L	-	-	-	-	0.0083	0.028	0.25	<0.002
Total ortho-phosphate	mg-P/L	-	-	-	-	<0.001	<0.001	<0.001	<0.001
Total Metals									
Aluminum	µg/L	-	-	-	-	98	289	2,310	-
Antimony	µg/L	9.0	-	-	-	0.16	0.20	0.46	-
Arsenic	µg/L	-	5.0	-	-	0.16	0.27	1.3	-
Barium	µg/L	1,000	-	-	-	47	55	154	-
Beryllium	µg/L	0.13	-	5.3	380	<0.02	0.023	**0.23**[Mn]	-
Bismuth	µg/L	0.50	-	-	-	<0.05	<0.05	<0.05	-
Boron	µg/L	1,200	29,000	-	-	<10	<10	14	-
Cadmium	µg/L	-	-	-	-	0.045	0.089	0.47	-
Calcium	µg/L	-	-	-	-	55,600	58,700	60,600	-
Chromium	µg/L	1.0[f]	-	10	100	0.27	**1.3**[Mn]	**4.0**[Mn]	-
Cobalt	µg/L	4.0	110	-	-	0.15	0.35	2.4	-
Copper	µg/L	-	-	-	-	<0.5	0.93	7.0	-
Iron	µg/L	1,277 - 1,297[g]	1,000	2,256 - 2,291[g]	53,600	79	367	**2,420**[Mn, Mx, C]	-
Lead	µg/L	13 - 14[b]	237 - 265[b]	-	-	0.11	0.36	3.2	-
Lithium	µg/L	122	-	-	-	13	15	16	-
Magnesium	µg/L	-	-	-	-	20,700	23,100	24,400	-
Manganese	µg/L	1,621 - 1,714[b]	3,086 - 3,317[b]	-	-	4.7	14	44	-
Mercury	µg/L	0.010	-	-	-	<0.005	<0.005	<0.1[DL>Mn]	-
Molybdenum	µg/L	1,000	2,000	-	-	1.0	1.1	2.4	-
Nickel	µg/L	150[b]	-	119 - 127[h]	-	3.3	3.9	12	-
Potassium	µg/L	-	-	-	-	872	1,130	2,170	-
Selenium	µg/L	2.0	-	70	4,200	**17**[Mn]	**17**[Mn]	**19**[Mn]	-
Silicon	µg/L	-	-	-	-	1,700	1,890	4,590	-
Silver	µg/L	1.5[b]	3.0[b]	-	-	<0.01	0.010	0.11	-
Sodium	µg/L	-	-	-	-	753	933	922	-
Strontium	µg/L	-	-	-	-	93	97	109	-
Thallium	µg/L	0.80	-	-	-	<0.01	0.017	0.13	-
Tin	µg/L	300	-	-	-	<0.1	<0.1	<0.1	-
Titanium	µg/L	850	-	-	-	<10	<10	13	-
Uranium	µg/L	8.5	33	-	-	1.3	1.3	1.5	-
Vanadium	µg/L	120	-	-	-	0.68	1.7	11	-
Zinc	µg/L	113 - 129[b]	139 - 155[b]	-	-	3.0	5.3	32	-
Dissolved Metals									

Table D1: Water Quality for Incident 4658

Aluminum	µg/L	50[i]	100[i]	-	-	<3.0	<3.0	9.7	-
Antimony	µg/L	-	-	-	-	0.16	0.17	0.22	-
Arsenic	µg/L	-	-	-	-	<0.1	0.12	0.19	-
Cadmium	µg/L	0.39 - 0.42[b]	1.4 - 1.5[b]	-	-	0.029	0.028	0.043	-
Copper	µg/L	1.1[j]	6.5-6.6[j]	-	-	<0.5	<0.5	<0.5	-
Ungrouped Analytes									
Cation - anion balance	%	-	-	-	-	<1.9	<0.1	<0.6	1.9
Ion balance	%	-	-	-	-	96	100	99	104
Major anion sum	meq/L	-	-	-	-	4.9	5.1	5.1	4.7
Major cation sum	meq/L	-	-	-	-	4.7	5.1	5.0	4.9
Oxidation-reduction potential, lab	mV	-	-	-	-	429	437	449	307

Notes:

[a] = guideline is a minimum value, unless the background concentration or value is lower.

[b] = guideline is hardness dependent. The guideline range shown is based on the hardness range observed in the dataset (231 to 252 mg/L). The guideline is calculated based on the individual hardness value for each sample.

[c] tablished for sulphate; however, the observed data were screened against the guideline for very hard water (i.e., 429 mg/L) for

[d] = guideline is chloride dependent. The guideline range shown is based on the chloride concentration observed in the dataset (0.2500 mg/L). The guideline is calculated based on the individual chloride concentration in each sample.

[e] = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (0.47 or 2.4 mg-N/L) is based on the combination of field pH (8.4) and water temperature (8.0°C); water temperature of 8.0°C corresponds to the median temperature in July 2019 at the Fording River upstream of Kilmarnock Creek (FR_FR2; 0200201). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect effects at the low and high pH and temperature extremes. The guideline is calculated based on the individual field pH and temperature measurements for each sample.

[f] = guideline is for chromium VI.

[g]

[h]

[i] = guideline is pH dependent. The guideline range shown is based on the pH range observed in the dataset (8.4). The guideline is calculated based on the individual pH for each sample.

[j] = guideline calculated using the Biotic Ligand Model. The guideline range shown is based on the toxicity-modifying factors for each sample with copper concentrations above the detection limit. Temperature was assumed to be 8 C, per rationale provided in footnote (e).

[Mx] = concentration is higher than the maximum BC ENV guideline or outside the recommended pH, DO or total alkalinity range.

[C] = concentration is higher than the chronic sv I1 guideline or outside the recommended DO or total alkalinity range.

[DL>Mn] = analytical detection limit is higher than the 30-day mean BC ENV guideline.

Bolded concentrations are higher than water quality guidelines.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision *after* comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.

- = no guideline or no data.

Guidelines described in Appendix A of Costa and de Bruyn (2021)

Table D2: Water Quality for Incident 4670

						FR_DSSWFTCRBRDG	FR_DSSWFTCRBRDG	FR_FR3	FR_LP1UD03162019	GH_SC3
Conventional Parameters										
pH	-	6.5 - 9.0	6.5 - 9.0	-	-	8.4	8.4	8.4	8.4	8.2
Specific conductivity	µS/cm	-	-	-	-	483	475	479	1,340	1,630
Hardness, as $CaCO_3$	mg/L	-	-	-	-	256	262	253	827	1,060
Total alkalinity, as $CaCO_3$	mg/L	20[(a)]	-	-	-	148	151	149	253	248
Total dissolved solids	mg/L	-	-	1,000	5,000	292	288	304	**1,100[(C)]**	**1,400[(C)]**
Total suspended solids	mg/L	-	-	-	-	26	28	25	265	303
Total organic carbon	mg/L	-	-	-	-	6.1	-	4.9	6.3	22
Dissolved organic carbon	mg/L	-	-	-	-	1.4	-	1.1	3.3	2.5
Turbidity	NTU	-	-	-	-	15	17	14	300	385
Acidity, $CaCO_3$	mg/L	-	-	-	-	<1.0	<1.0	<1.0	<1.0	2.1
Bicarbonate alkalinity, as $CaCO_3$	mg/L	-	-	-	-	142	144	143	245	248
Carbonate alkalinity, as $CaCO_3$	mg/L	-	-	-	-	6.0	6.4	5.6	8.6	<1.0
Hydroxide alkalinity, as $CaCO_3$	mg/L	-	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0
Major Ions										
Bromide	mg/L	-	-	7.8	1,000	<0.05	<0.05	<0.05	<0.25	<0.25
Calcium	mg/L	-	-	-	-	61	67	61	141	192
Chloride	mg/L	150	600	-	-	<0.5	<0.5	<0.5	2.5	<2.5
Fluoride	mg/L	0.12	1.7 - 2.3[(b)]	-	-	**0.20[(Mn)]**	**0.21[(Mn)]**	**0.20[(Mn)]**	**0.23[(Mn)]**	**0.18[(Mn)]**
Magnesium	mg/L	-	-	-	-	25	23	25	115	140
Potassium	mg/L	-	-	-	-	1.0	1.0	1.0	2.5	2.9
Sodium	mg/L	-	-	-	-	0.98	0.89	0.91	5.7	1.3
Sulphate	mg/L	429[(b, c)]	-	499	9,900	93	92	94	**584[(Mn, C)]**	**766[(Mn, C)]**
Nutrients										
Nitrate	mg-N/L	3.0	33	11 - 22[(b)]	-	**4.6[(Mn)]**	**4.5[(Mn)]**	**4.7[(Mn)]**	**3.2[(Mn)]**	**15[(Mn)]**
Nitrite	mg-N/L	0.020 - 0.040[(d)]	0.060 - 0.12[(d)]	0.054 - 0.096[(d)]	-	0.0071	0.0064	0.0049	<0.005	**0.022[(Mn)]**
Total ammonia	mg-N/L	0.47 - 0.73[(e)]	2.4 - 3.8[(f)]	-	-	0.028	0.014	0.041	0.027	0.029
Total Kjeldahl nitrogen	mg-N/L	-	-	-	-	0.45	-	0.32	0.77	1.2
Total phosphorus	mg-P/L	-	-	-	-	0.030	0.0047	0.012	0.27	0.73
Total Metals										
Aluminum	µg/L	-	-	-	-	194	-	235	3,470	3,840
Antimony	µg/L	9.0	-	-	-	0.20	-	0.19	0.42	0.77
Arsenic	µg/L	-	5.0	-	-	0.21	-	0.17	2.9	4.0
Barium	µg/L	1,000	-	-	-	53	-	53	109	112
Beryllium	µg/L	0.13	-	5.3	380	<0.02	-	<0.02	**0.27[(Mn)]**	**0.36[(Mn)]**
Bismuth	µg/L	0.50	-	-	-	<0.05	-	<0.05	0.055	0.071
Boron	µg/L	1,200	29,000	-	-	<10	-	<10	13	15
Cadmium	µg/L	-	-	-	-	0.090	-	0.064	0.51	0.61
Chromium	µg/L	1.0[(g)]	-	10	100	0.41	-	0.39	**5.3[(Mn)]**	**5.6[(Mn)]**
Cobalt	µg/L	4.0	110	-	-	0.28	-	0.22	2.3	3.5
Copper	µg/L	10[(b)]	26 - 40[(b)]	-	-	0.75	-	0.61	8.1	10
Iron	µg/L	1,122 - 2,354[(h)]	1,000	1,982-4,160[(h)]	53,600	219	-	148	**7,090[(Mn, Mx, C)]**	**9,270[(Mn, Mx, C)]**
Lead	µg/L	14 - 20[(b)]	266 - 417[(b)]	-	-	0.27	-	0.21	3.0	4.4
Lithium	µg/L	122	-	-	-	16	-	16	25	36
Manganese	µg/L	1,718 - 2,585[(b)]	3,328 - 3,394[(b)]							
Mercury	µg/L	0.010	-	-	150	<0.005	-	<0.005	<0.05[(DL>Mn)]	<0.025[(DL>Mn)]
Molybdenum	µg/L	1,000	2,000	-	-	1.2	-	1.1	2.7	5.4
Nickel	µg/L	150[(b)]	-	133 - 159[(i, b)]						
Potassium	µg/L	-	-	-	-	1,120	-	1,130	3,850	4,650
						17[(Mn)]	-	**18[(Mn)]**	**97[(Mn, C)]**	**290[(Mn, C)]**
Silicon	µg/L	-	-	-	-	1,710	-	1,940	7,130	7,240
Silver	µg/L	1.5[(b)]	3.0[(b)]							
Sodium	µg/L	-	-	-	-	1,070	-	973	6,020	1,460
Strontium	µg/L	-	-	-	-	97	-	97	119	148
Thallium	µg/L	0.80	-	-	-	0.013	-	0.011	0.19	0.25
Tin	µg/L	300	-	-	-	<0.1	-	<0.1	<0.1	0.12
Titanium	µg/L	850	-	-	-	<10	-	<10	19	26
Uranium	µg/L	8.5	33	-	-	1.4	-	1.4	2.9	6.9
Vanadium	µg/L	120	-	-	-	1.2	-	1.2	13	13

GOLDER
MEMBER OF WSP

Table D2: Water Quality for Incident 4670

Zinc	µg/L	130 - 188(b)	155 - 341(b)	-	-	5.0	-	3.6	44	53
Dissolved Metals										
Aluminum	µg/L	50(j)	100(j)							
Antimony	µg/L	-	-	-	-	0.17	-	0.18	0.19	0.62
Arsenic	µg/L	-	-	-	-	0.12	-	0.10	0.20	0.21
Barium	µg/L	-	-	-	-	47	-	48	54	46
Boron	µg/L	-	-	-	-	<10	-	<10	<10	<10
Cadmium	µg/L	0.42 - 0.46(b)	1.5 - 2.8(b)	-	-	0.050	-	0.034	0.034	0.027
Cobalt	µg/L	-	-	-	-	<0.1	-	<0.1	0.14	<0.1
Copper	µg/L	0.9-2.9(k)	5.5-17.8(k)	-	-	<0.5	-	<0.5	0.55	<0.5
Iron	µg/L	-	350	-	-	<10	-	<10	<10	<10
Lithium	µg/L	-	-	-	-	16	-	16	23	33
Manganese	µg/L	-	-	-	-	0.28	-	1.5	2.4	3.6
Mercury	µg/L	-	-	-	-	<0.005	-	<0.005	<0.005	<0.005
Molybdenum	µg/L	-	-	-	-	1.2	-	1.2	2.3	4.9
Nickel	µg/L	-	-	-	-	2.5	-	2.7	0.97	11
Selenium	µg/L	-	-	-	-	20	-	20	112	344
Strontium	µg/L	2,500	-	-	-	100	-	99	104	130
Tin	µg/L	-	-	-	-	<0.1	-	<0.1	<0.1	<0.1
Titanium	µg/L	-	-	-	-	<10	-	<10	<10	<10
Uranium	µg/L	-	-	-	-	1.4	-	1.4	2.7	6.7
Vanadium	µg/L	-	-	-	-	<0.5	-	<0.5	<0.5	<0.5
Zinc	µg/L	-	-	-	-	1.4	-	<1.0	<1.0	<1.0
Ungrouped Analytes										
Cation - anion balance	%	-	-	-	-	<0.5	0.30	<1.3	<2.0	<1.7
Ion balance	%	-	-	-	-	99	101	97	96	97
Major anion sum	meq/L	-	-	-	-	5.2	5.3	5.3	18	22
Major cation sum	meq/L	-	-	-	-	5.2	5.3	5.1	17	21
Oxidation-reduction potential, lab	mV	-	-	-	-	258	420	262	319	299

Notes:

(a)

(b) = guideline is hardness dependent. The guideline range shown is based on the hardness range observed in the dataset (253 to 1,

(c) = for some samples, water hardness was greater than 250 mg/L. At this hardness, no BC ENV water quality guideline has been established for sulphate; however, the observed data were screened against the guideline for very hard water (i.e., 429 mg/L) for comparative purposes.

(d) = guideline is chloride dependent. The guideline range shown is based on the chloride concentration range observed in the dataset (1.2500 to 2.5000 mg/L). The guideline is calculated based on the individual chloride concentration in each sample.

(e) N/L) is based on the combination of field pH (8.4) and water temperature (8.0°C); water temperature of 8.0°C corresponds to the median temperature in July 2019 at the Fording River upstream of Kilmarnock Creek (FR_FR2; 0200201). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect toxic effects at the low and high pH and temperature extremes. The guideline is calculated based on the individual field pH and temperature measurements for each sample.

(f) N/L) is based on the combination of field pH (8.4) and water temperature (8.0°C);water temperature of 8.0°C corresponds to the median temperature in July 2019 at the Fording River upstream of Kilmarnock Creek (FR_FR2; 0200201). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect toxic effects at the low and high pH and temperature extremes. The guideline is calculated based on the individual field pH and temperature measurements for each sample.

(g) = guideline is for chromium VI.

(h) = screening value is pH- and DOC-dependent.

(i)

(j) = guideline is pH dependent. The guideline range shown is based on the pH range observed in the dataset (8.2-8.4). The guideline is calculated based on the individual pH for each sample.

(k) = guideline calculated using the Biotic Ligand Model. The guideline range shown is based on the toxicity-modifying factors for each sample with copper concentrations above the detection limit. Temperature was assumed to be 8 C, per rationale provided in footnote (e).

(Mx) = concentration is higher than the maximum BC ENV guideline or outside the recommended pH, DO or total alkalinity range.

(C) = concentration is higher than the chronic sv I1 guideline or outside the recommended DO or total alkalinity range.

(DL>Mn)

Bolded concentrations are higher than water quality guidelines.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision *after* comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.

\- = no guideline or no data.

Guidelines described in Appendix A of Costa and de Bruyn (2021)

Table D3: Water Quality for Incident 3778

						08-15-2019	08-14-2019	08-14-2019
Field Measured								
pH	-	6.5 - 9.0	6.5 - 9.0	-	-	8.4	-	-
Specific conductivity	µS/cm	-	-	-	-	1,110	-	-
Temperature	°C	-	-	-	-	15	-	-
Dissolved oxygen	mg/L	8.0 - 11 [(a)]	5.0 - 9.0 [(a)]	6.0 - 9.0 [(a)]	-	**8.6**[(Mn, C)]	-	-
Dissolved oxygen	%	-	-	-	-	86	-	-
Conventional Parameters								
Specific conductivity	µS/cm	-	-	-	-	1,200	1,380	1,370
Hardness, as $CaCO_3$	mg/L	-	-	-	-	682	902	913
Total alkalinity, as $CaCO_3$	mg/L	20[(a)]	-	-	-	226	277	260
Total dissolved solids	mg/L	-	-	1,000	5,000	997	**1,230**[(C)]	**1,210**[(C)]
Total suspended solids	mg/L	-	-	-	-	2.0	<1.0	16
Total organic carbon	mg/L	-	-	-	-	3.3	-	-
Turbidity	NTU	-	-	-	-	0.47	0.27	2.1
Acidity, $CaCO_3$	mg/L	-	-	-	-	<1.0	<1.0	<1.0
Bicarbonate alkalinity, as $CaCO_3$	mg/L	-	-	-	-	218	270	260
Carbonate alkalinity, as $CaCO_3$	mg/L	-	-	-	-	8.0	6.8	<1.0
Hydroxide alkalinity, as $CaCO_3$	mg/L	-	-	-	-	<1.0	<1.0	<1.0
Major Ions								
Bromide	mg/L	-	-	7.8	1,000	<0.25	<0.05	<0.05
Fluoride	mg/L	0.12	2.1 - 2.2[(b)]	-	-	**0.17**[(Mn)]	**0.17**[(Mn)]	**0.18**[(Mn)]
Sulphate	mg/L	429[(b, c)]	-	499	9,900	**510**[(Mn, C)]	**599**[(Mn, C)]	**599**[(Mn, C)]
Nutrients								
Nitrate	mg-N/L	3.0	33	22[(b)]	-	**4.9**[(Mn)]	**5.4**[(Mn)]	**5.2**[(Mn)]
Nitrite	mg-N/L	0.020[(d)]	0.060[(d)]	-	-	0.0088	<0.001	<0.001
Total ammonia	mg-N/L	0.45 - 0.56[(e)]	2.4 - 2.9[(f)]	-	-	0.15	0.013	0.011
Total Kjeldahl nitrogen	mg-N/L	-	-	-	-	0.77	0.51	0.72
Total phosphorus	mg-P/L	-	-	-	-	<0.002	<0.002	0.0070
Total ortho-phosphate	mg-P/L	-	-	-	-	<0.001	<0.001	<0.001
Total Metals								
Aluminum	µg/L	-	-	-	-	5.5	3.6	20
Antimony	µg/L	9.0	-	-	-	0.50	0.53	0.67
Arsenic	µg/L	-	5.0	-	-	0.21	0.17	0.21
Barium	µg/L	1,000	-	-	-	42	51	52
Beryllium	µg/L	0.13	-	-	-	<0.02	<0.02	<0.02
Bismuth	µg/L	0.50	-	-	-	<0.05	<0.05	<0.05
Boron	µg/L	1,200	29,000	-	-	12	13	13
Cadmium	µg/L	-	-	-	-	0.011	0.0058	0.010
Calcium	µg/L	-	-	-	-	122,000	151,000	149,000
Chromium	µg/L	1.0[(g)]	-	-	-	0.12	<0.1	0.11
Copper	µg/L	-	-	-	-	<0.5	<0.5	<0.5
Iron	µg/L	1,621[(i)]	1,000	-	-	<10	<10	45
Lead	µg/L	20[(b)]	417[(b)]	-	-	<0.05	<0.05	0.057
Lithium	µg/L	122	-	-	-	12	13	13
Magnesium	µg/L	-	-	-	-	96,200	120,000	118,000
Manganese	µg/L	2,585[(b)]	3,394[(b)]	-	-	1.6	0.48	1.6
Mercury	µg/L	0.010	-	-	-	0.00058	0.00059	0.00083
Molybdenum	µg/L	1,000	2,000	-	-	1.9	1.8	1.8

Table D3: Water Quality for Incident 3778

						08-15-2019	08-14-2019	08-14-2019
Nickel	µg/L	150 (b)	-	156 (h, b)	-	8.3	11	11
Potassium	µg/L	-	-	-	-	1,820	2,080	2,080
Selenium	µg/L	2.0	-	70	4,200	**88** (Mn, C)	**118** (Mn, C)	**118** (Mn, C)
Silicon	µg/L	-	-	-	-	2,870	3,180	3,200
Silver	µg/L	1.5 (b)	3.0 (b)	-	-	<0.01	<0.01	<0.01
Sodium	µg/L	-	-	-	-	2,640	2,610	2,610
Strontium	µg/L	-	-	-	-	160	185	182
Thallium	µg/L	0.80	-	-	-	<0.01	<0.01	<0.01
Tin	µg/L	300	-	-	-	<0.1	<0.1	<0.1
Titanium	µg/L	850	-	-	-	<10	<10	<10
Uranium	µg/L	8.5	33	-	-	5.8	6.7	6.8
Vanadium	µg/L	120	-	-	-	<0.5	<0.5	<0.5
Zinc	µg/L	188	341	-	-	<3.0	<3.0	<3.0
Dissolved Metals								
Aluminum	µg/L	50 (i)	100 (i)					
Antimony	µg/L	-	-	-	-	0.50	0.54	0.56
Arsenic	µg/L	-	-	-	-	0.22	0.20	0.17
Barium	µg/L	-	-	-	-	40	49	48
Beryllium	µg/L	-	-	-	-	<0.02	<0.02	<0.02
Bismuth	µg/L	-	-	-	-	<0.05	<0.05	<0.05
Boron	µg/L	-	-	-	-	10	12	12
Cadmium	µg/L	0.46 (b)	2.8 (b)	-	-	0.0063	<0.005	<0.005
Chromium	µg/L	-	-	-	-	0.12	<0.1	<0.1
Cobalt	µg/L	-	-	-	-	<0.1	<0.1	<0.1
Copper	µg/L	1.7 - 2 (j)	9.6-11.8 (j)					
Iron	µg/L	-	350	-	-	<10	<10	<10
Lead	µg/L	-	-	-	-	<0.05	<0.05	<0.05
Lithium	µg/L	-	-	-	-	12	14	15
Manganese	µg/L	-	-	-	-	0.55	0.22	0.19
Mercury	µg/L	-	-	-	-	<0.005	<0.005	<0.005
Molybdenum	µg/L	-	-	-	-	1.9	1.8	1.8
Nickel	µg/L	-	-	-	-	8.1	11	11
Selenium	µg/L	-	-	-	-	91	127	123
Silicon	µg/L	-	-	-	-	2,680	3,220	3,250
Silver	µg/L	-	-	-	-	<0.01	<0.01	<0.01
Strontium	µg/L	2,500	-	-	-	166	181	178
Thallium	µg/L	-	-	-	-	<0.01	<0.01	<0.01
Tin	µg/L	-	-	-	-	<0.1	<0.1	<0.1
Titanium	µg/L	-	-	-	-	<10	<10	<10
Uranium	µg/L	-	-	-	-	5.5	6.8	6.9
Vanadium	µg/L	-	-	-	-	<0.5	<0.5	<0.5
Zinc	µg/L	-	-	-	-	<1.0	<1.0	<1.0
Parent PAHs								
Naphthalene	µg/L	-	1.0	-	-	-	<0.02	0.078
Acenaphthylene	µg/L	-	-	-	-	-	<0.01	<0.01
Acenaphthene	µg/L	6.0	-	-	-	-	<0.01	<0.01
Fluorene	µg/L	12	-	-	-	-	<0.01	0.023
Phenanthrene	µg/L	0.30	-	-	-	-	<0.02	0.077
Anthracene	µg/L	0.10	-	-	-	-	<0.01	<0.01
Pyrene	µg/L	0.020	-	-	-	-	<0.01	**0.023** (Mn)
Fluoranthene	µg/L	0.20	-	-	-	-	<0.01	<0.01
Benzo(a)anthracene	µg/L	0.10	-	-	-	-	<0.01	<0.01
Chrysene	µg/L	-	-	-	-	-	<0.01	0.013
Benzo(a)pyrene	µg/L	0.010	-	-	-	-	<0.005	<0.005
Benzo(g,h,i)perylene	µg/L	-	-	-	-	-	<0.01	<0.01
Indeno(c,d-123)pyrene	µg/L	-	-	-	-	-	<0.01	<0.01
Dibenzo(a,h)anthracene	µg/L	-	-	-	-	-	<0.005	<0.005

Table D3: Water Quality for Incident 3778

						08-15-2019	**08-14-2019**	**08-14-2019**
Ungrouped Analytes								
2-bromobenzotrifluoride	%	-	-	-	-	-	81	90
2-methylnaphthalene	µg/L	-	-	-	-	-	<0.02	0.24
Acenaphthene-d10	%	-	-	-	-	-	102	105
Acridine	µg/L	-	-	-	-	-	<0.01	<0.01
Benzo(b&j)fluoranthene	µg/L	-	-	-	-	-	<0.01	<0.01
Benzo(k)fluoranthene	µg/L	-	-	-	-	-	<0.01	<0.01
Cation - anion balance	%	-	-	-	-	<5.8	<0.7	0.90
Chrysene-d12	%	-	-	-	-	-	80	82
Extractable petroleum hydrocarbons c10-c19	mg/L	-	-	-	-	-	<0.25	<0.25
Extractable petroleum hydrocarbons c19-c32	mg/L	-	-	-	-	-	<0.25	<0.25
Ion balance	%	-	-	-	-	89	99	102
Major anion sum	meq/L	-	-	-	-	16	18	18
Major cation sum	meq/L	-	-	-	-	14	18	18
Naphthalene, 1-methyl- (1-methylnaphthalene)	µg/L	-	-	-	-	-	<0.05	0.17
Oxidation-reduction potential, field	mV	-	-	-	-	204	-	-
Oxidation-reduction potential, lab	mV	-	-	-	-	337	325	495
Phenanthrene-d10	%	-	-	-	-	-	101	102
Quinoline	µg/L	-	-	-	-	-	<0.05	<0.05
	mg/L	-	-	-	-	-	<0.5	<0.5
Total extractable hydrocarbons (teh 10-30)	mg/L	-	-	-	-	-	<0.25	<0.25

Notes:

(a) = guideline is a minimum value. For alkalinity, this applies unless the background concentration or value is lower. For dissolved oxygen, guideline and L1 exceedance was calculated assuming that the embryo/alevin guideline applies from May 15 to August 31.

(b) = guideline is hardness dependent. The guideline range shown is based on the hardness range observed in the dataset (682 to 913 mg/L). The guideline is calculated based on the individual hardness value for each sample.

(c) = for some samples, water hardness was greater than 250 mg/L. At this hardness, no BC ENV water quality guideline has been established for sulphate; however, the observed data were screened against the guideline for very hard water (i.e., 429 mg/L) for comparative purposes.

(d) = guideline is chloride dependent. The guideline range shown is based on the chloride concentration range observed in the dataset (1.25 to 1.56 mg/L). The guideline is calculated based on the individual chloride concentration in each sample.

(e) = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (0.45 mg-N/L) is based on the combination of field pH (8.4) and water temperature (15.0°C). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be u
temperature extremes. The guideline is calculated based on the individual field pH and temperature measurements for each sample.

(f) = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (2.35 mg-N/L) is based on the combination of field pH (8.4) and water temperature (15.0°C). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be u
temperature extremes. The guideline is calculated based on the individual field pH and temperature measurements for each sample.

(g) = guideline is for chromium VI.

(h) = screening value is hardness-, pH-, and DOC-dependent.

(i) = guideline is pH dependent. The guideline range shown is based on the pH range observed in the dataset (8.3 to 8.4). The guideline is calculated based on the individual pH for each sample.

(j) each sample with copper concentrations above the detection limit.

(Mn) = concentration is higher than the 30-day mean BC ENV guideline or outside the recommended pH, DO or total alkalinity range.

(C) = concentration is higher than the chronic sv l1 guideline or outside the recommended DO or total alkalinity range.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision *after* comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.
- = no guideline or no data.
Guidelines described in Appendix A of Costa and de Bruyn (2021)

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