PERMIT 107517

ENVIRONMENTAL MONITORING COMMITTEE

2018 Public Report

Contents

Message from the Environmental Monitoring Committee

Dear readers,

This report is our fourth annual summary of the technical reports we have reviewed. This was another busy, but productive year for our committee. We met five times in person and had 19 conference calls. We reviewed 30 reports, study designs, and data packages, and provided 1,230 pieces of technical advice to Teck and the Director. We are proud to be members of this committee and we are committed to providing scientific recommendations to improve, broaden, and support environmental monitoring in the Elk Valley.

Teck's environmental monitoring programs in the Elk Valley produce a lot of complex information. This year, we've tried to highlight and summarize for you what we feel are the important findings in Teck's results and analyses from 2017. The technical reports that form the basis of this report are now available to the public, so you can access the details if you wish. We've provided a list of these reports, and directions on where to find them, at the end of this report.

In conjunction with the release of this report, we hold an annual public meeting. This meeting is intended to give you an opportunity to ask us questions about the information we have reviewed.

We hope that the new format of this year's report helps you to find and understand the information that is important to you. We want to keep improving how we share this information, so please let us know what we can do better. You can chat with us directly at the public meeting, fill out our feedback form, or email us anytime through our facilitator, Lynne Betts at emcpermit107517@gmail.com

Sincerely,

Patrick Williston
on behalf of the British Columbia Ministry of Environment and Climate Change Strategy

Jesse Sinclair
on behalf of the Ktunaxa Nation Council

Alison Neufeld
on behalf of the British Columbia Ministry of Environment and Climate Change Strategy

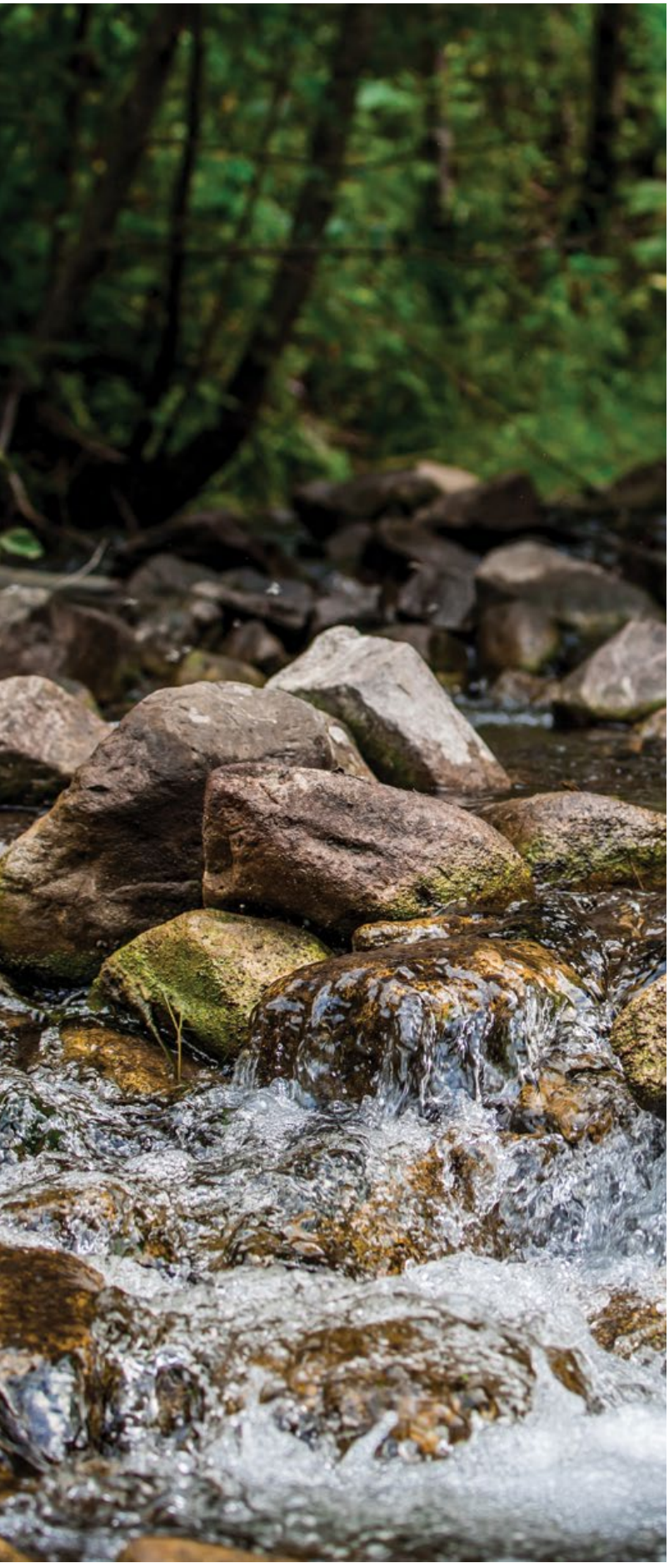
Carla Fraser
on behalf of Teck

Bruce Kilgour
Independent Scientist

Mark Digel
on behalf of Teck

Heather McMahon
on behalf of the Ktunaxa Nation Council

1 Managing Water Quality in the Elk Valley



The Elk Valley Water Quality Plan

In April 2013, the British Columbia Minister of Environment issued Ministerial Order No. M113, which required Teck to prepare an area-based management plan for the Elk River watershed and the Canadian portion of the Koocanusa Reservoir. In this plan, Teck was required to identify the actions it will take to manage water quality downstream of its five mines. This plan guides water quality management in the Elk Valley.

From 2013 to 2014, Teck developed an area-based management plan, called the Elk Valley Water Quality Plan. Teck had input from the public, First Nations, provincial and federal governments, technical experts, and other stakeholders. Teck submitted the Elk Valley Water Quality Plan to the Minister in July 2014 and it was approved in November that same year.

The Elk Valley Water Quality Plan, or EVWQP, sets targets for the concentration of selenium, sulphate, nitrate, and cadmium in surface water at specific locations throughout the Elk Valley and in the Koocanusa Reservoir. These targets—both short term and long term—are meant to stabilize and reverse increasing concentrations.

Lower targets come into effect as water treatment facilities come online. This supports water quality improvements over time. By achieving long-term targets in the Fording River, Elk River, and Koocanusa Reservoir, it is expected that most sensitive aquatic organisms will be protected from mining-related effects on water quality.

2013

April 2013
The British Columbia Minister of Environment issues Ministerial Order No. M113 under Section 89 of the Environmental Management Act.

2014

July 2014
Teck submits the Elk Valley Water Quality Plan.

November 2014
The British Columbia Ministry of Environment approves the Elk Valley Water Quality Plan and issues Permit 107517.

2015

March 2015
The Environmental Monitoring Committee meets for the first time.

Projecting Future Water Quality

The Regional Water Quality Model was developed by Teck to examine how activities at its five coal mines could affect water quality in the Elk River watershed. The model is a tool used to simulate how historical, current, and future mining activities will affect the concentrations of selenium, sulphate, nitrate, and cadmium in the Fording River, Elk River, tributaries to these rivers located in and around mine sites, and the Koocanusa Reservoir. The model is calibrated and refined using historical information and is used to project future concentrations of water quality substances.

The Regional Water Quality Model was used in 2014 to develop projections of water quality into the future and to support how water quality would be addressed in the EVWQP. Permit 107517 requires Teck to update the model every three years. The first update was submitted to the Director in October 2017.

Who is the Director?

The Director is the governmental office within the British Columbia Ministry of Environment and Climate Change Strategy that is responsible for issuing permits under the Environmental Management Act and for determining compliance with permit requirements. All the study designs, plans, and reports required under Permit 107517 are submitted to the Director, many of which require formal acceptance or approval.

The Elk Valley Permit

In November 2014, the Ministry of Environment issued Permit 107517 to Teck under the Environmental Management Act. Many of the actions and commitments that Teck made in the Elk Valley Water Quality Plan were made legal requirements by this permit. To maintain compliance, Teck must meet the requirements in the permit, including the water quality targets. There are two types of targets: **compliance limits** and **site performance objectives**.

Compliance limits are set for compliance points. Compliance points are water monitoring stations that are immediately downstream from each of Teck's mine operations in the Elk Valley. These points are intended to reflect conditions at the point where mine-influenced water first enters a creek or river. There are eight compliance points which have limits for selenium, sulphate, nitrate, and cadmium.[1]

Site performance objectives (SPOs) are set for order stations. These stations are also water monitoring stations, but these are further downstream from Teck's mining operations. They are intended to reflect fully mixed conditions, taking into account water from all upstream sources. There are seven order stations which have SPOs for selenium, sulphate, nitrate, and cadmium.

Site performance objectives are the same as the targets described in the EVWQP, whereas compliance limits were based on projected water quality conditions with the implementation of the EVWQP.

Permit 107517 does not replace any of the permits previously issued to each of the mine operations. It is regionally focused and adds another layer of legal requirements that are in addition to those in Teck's existing permits.

[1]The target for cadmium at compliance points is actually referred to as a site performance objective in the permit.

The Environmental Monitoring Committee

One of the requirements in Permit 107517 is the formation of the Environmental Monitoring Committee. The purpose of this committee is to strengthen Teck's aquatic monitoring programs. It does this by reviewing Teck's monitoring submissions that are required by the permit and providing technical advice and **Traditional Knowledge** advice.

In addition to an independent scientist (an aquatic specialist), the Environmental Monitoring Committee has representatives from each of these organizations:

- British Columbia Ministry of Environment and Climate Change Strategy (ENV)
- British Columbia Ministry of Energy, Mines, and Petroleum Resources (EMPR)
- Ktunaxa Nation Council (KNC)
- Interior Health Authority (IHA)
- Teck

The federal government has been invited to participate in the Environmental Monitoring Committee and has agreed to provide its perspectives when requested by the committee.

An independent facilitator helps to coordinate meetings and the flow of information between Teck and the Environmental Monitoring Committee (EMC).

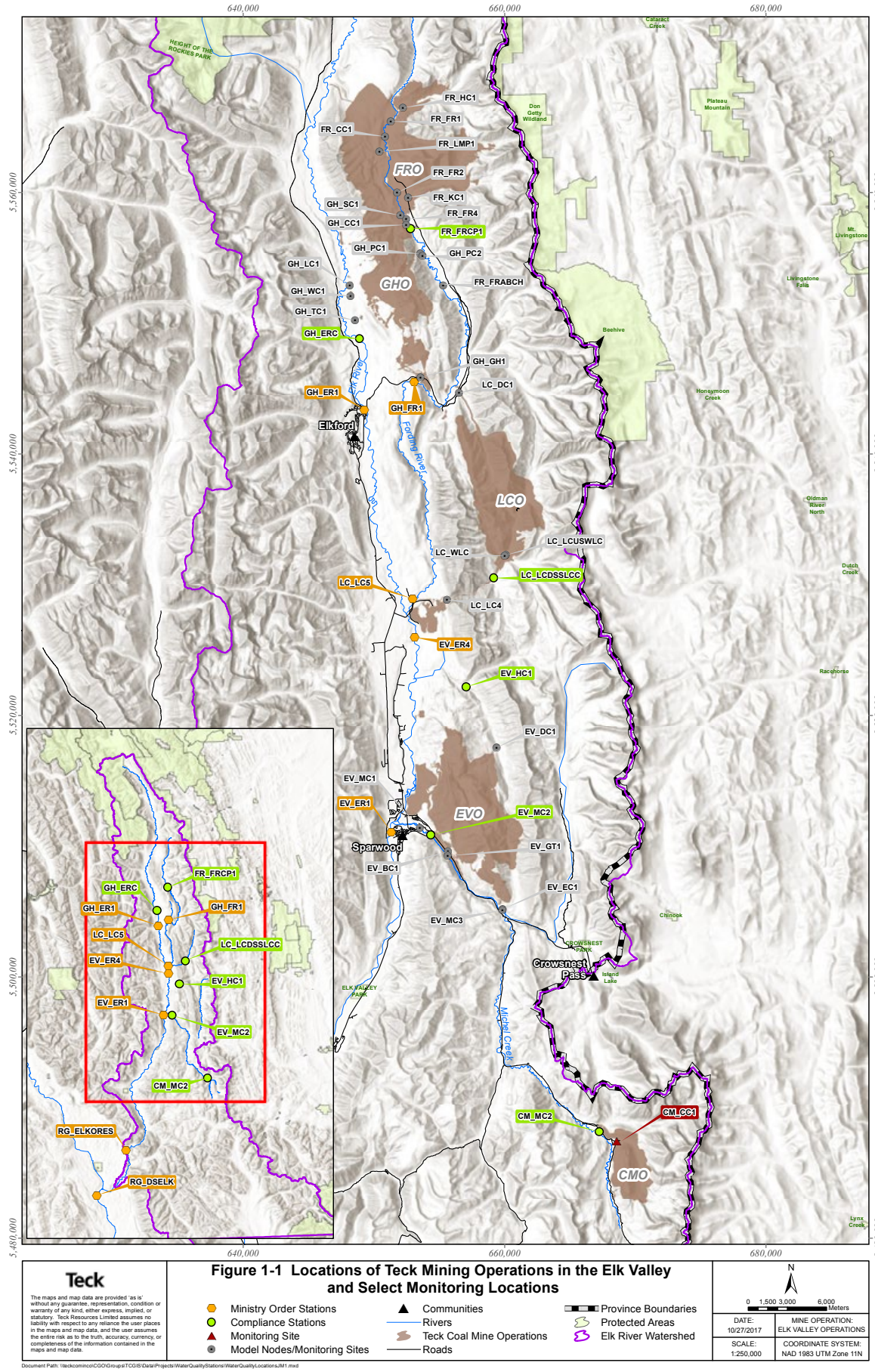
Traditional Knowledge

Archaeological evidence indicates that for more than 10,000 years the Ktunaxa (pronounced 'k-too-nah-ha') people have occupied the lands along the Kootenay and Columbia Rivers, and the Arrow Lakes of British Columbia. The Ktunaxa Territory is divided into Land Districts, and the Elk Valley falls within one of these districts, called Qukin ?amak?is, or Raven's Land. The Ktunaxa people have continuously used and occupied the Elk Valley area within Qukin ?amak?is, and the formation of the geography of the Elk Valley is described in the final events of the Ktunaxa Creation story.

Because of their deep connection to the Elk Valley, the Ktunaxa Nation Council (KNC) has been invited to provide Traditional Knowledge-based advice and science-based advice.

Information on the Ktunaxa Nation, the Ktunaxa Creation story, and Ktunaxa law has been provided by KNC and can be found in in Appendix A.

[2]Sometimes referred to simply as the Ministry of Environment in this document for conciseness.



Teck

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Figure 1-1 Locations of Teck Mining Operations in the Elk Valley and Select Monitoring Locations

- Ministry Order Stations
- Compliance Stations
- Monitoring Site
- Model Nodes/Monitoring Sites
- Communities
- Rivers
- Teck Coal Mine Operations
- Roads
- Province Boundaries
- Protected Areas
- Elk River Watershed

N

0 1,500 3,000 6,000 Meters

DATE: 10/27/2017	MINE OPERATION: ELK VALLEY OPERATIONS
SCALE: 1:250,000	COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

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Figure 1. Compliance points, order stations, and permit boundaries in the Elk Valley

2 Important Findings from 2017

Surface Water Quality

In addition to the eight compliance points and the seven order stations, Teck routinely monitors water quality at 87 other locations in the Elk Valley. The results from all these monitoring stations are used to evaluate Teck's compliance with its permit requirements and its progress towards achieving the objectives set in the Elk Valley Water Quality Plan. The water quality results from all these monitoring locations are included in an annual report that Teck submits to the Director in March every year.[3]

The water quality projections mentioned in this report are from the 2017 update to the regional water quality model, which factored in the initial implementation plan from the EVWQP. Teck submitted the updated model to ENV (the Director), EMPR, and the KNC in October 2017. These updated projections and schedules for active water treatment required that the initial implementation plan (from the EVWQP) also be updated. Teck has updated the plan (Implementation Plan Adjustment) and it is currently being reviewed by ENV, EMPR, and the KNC.

Selenium

Selenium is a common element found naturally in rock, and it is an essential nutrient for all living things. In water, selenium is taken up by algae and other microorganisms and transferred through the food web and accumulates in the body tissues of aquatic invertebrates, fish, birds, and other vertebrates (bioaccumulation). When selenium accumulates in the tissues of animals, it can interfere with reproduction, especially in animals that lay eggs such as fish, birds, amphibians, and reptiles.

In aquatic environments, the uptake, accumulation, and toxicity of selenium has proven to be very complex. The propensity of selenium to accumulate varies for different aquatic settings and aquatic species. Selenium is more likely to accumulate in still water than in moving water, and certain forms of selenium accumulate more easily than others. Guidelines for selenium reflect the current scientific understanding, but scientific experts continue to study these factors and expand our knowledge.

The current British Columbia (BC) water quality guideline for selenium is 2 micrograms per litre (µg/L) of water. This guideline is intended to be protective for the most sensitive aquatic life forms and the most sensitive life stages. But in moving water (streams and rivers), scientific research conducted for the EVWQP showed that sensitive fish species are expected to be protected when the concentration of selenium in flowing water in the Elk Valley is as high as 19 µg/L (Level 1 benchmark for sensitive fish). For less sensitive fish species—Westslope Cutthroat Trout, for example—the scientific research showed that they are expected to be protected when the concentration of selenium in flowing water in the Elk Valley is as high as 70 µg/L (Level 1 benchmark for Westslope Cutthroat Trout).[4]

The concentration of total selenium in the waters of the Elk Valley has increased since the 1990s and has exceeded the BC water quality guideline of 2 µg/L in the Elk River mainstem since 1993. In 2017, the monthly average concentrations of total selenium in the Fording River, downstream of Greenhills Creek were less than 70 µg/L[5]. The monthly average concentrations of total selenium in the Fording River, downstream of Line Creek; in the Elk River, downstream of Grave Creek ;and in the Koocanusa Reservoir were all below the current SPO for these locations and the lower SPO that takes effect in December 2019 (Figure 2).

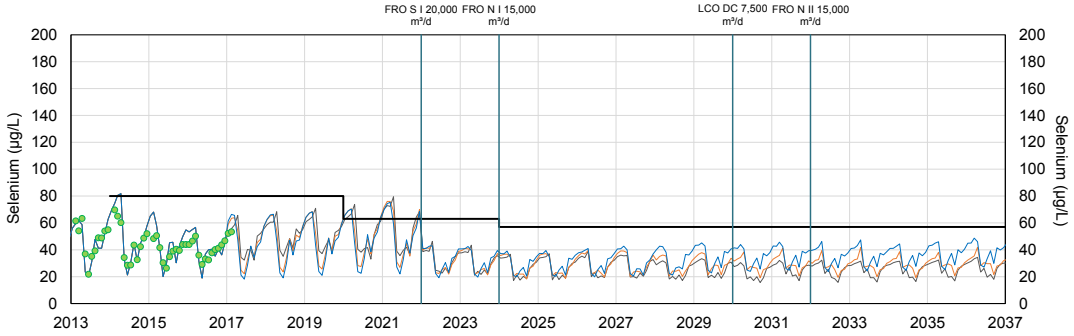
The revised implementation plan of active water treatment is anticipated to result in selenium SPOs being met in all parts of the Elk River system by 2023. There is potential for the monthly average concentrations of selenium in the Elk River, downstream of Grave Creek to approach the SPO from about 2025 through to 2037, but the concentrations at all other order stations are projected to be below the SPOs. These projected concentrations for the Elk River downstream of Grave Creek should be considered with caution because the modelled monthly maximums tend to overestimate measured values.

[3] Permit 107517 Annual Water Quality Monitoring Report, 2017 (March 2018)

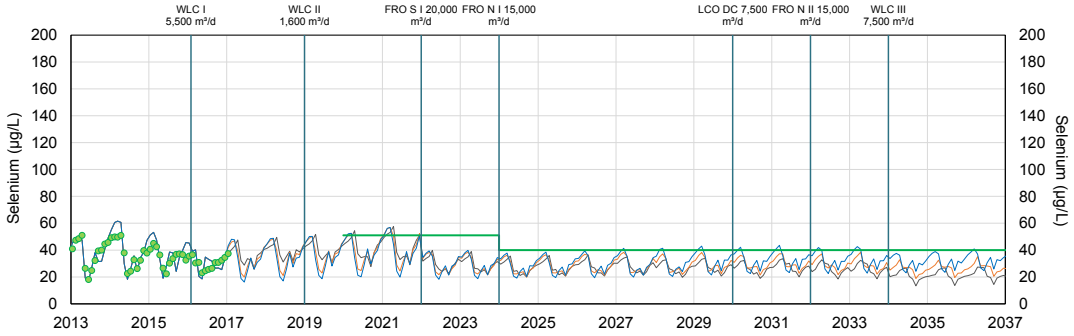
[4] Elk Valley Water Quality Plan (July 2014)

[5] The benchmark for sensitive aquatic life in the Fording River (EVWQP).

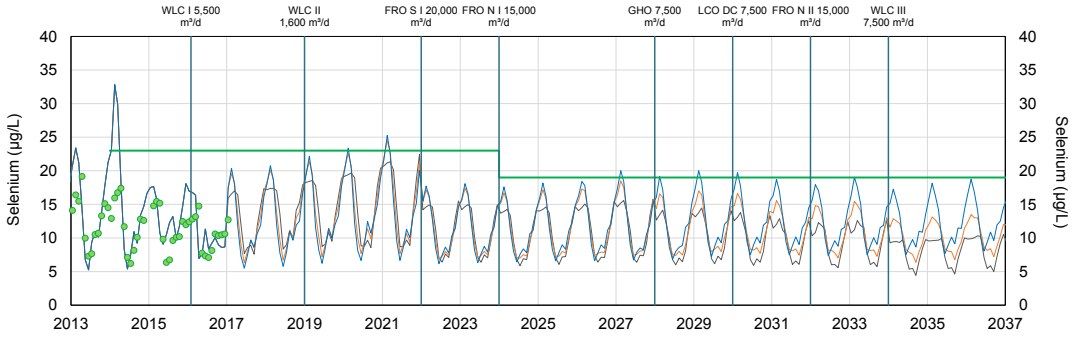
[6] These and other projections in this report are based on current operating permits issued for the Elk Valley by the Ministry of Environment.



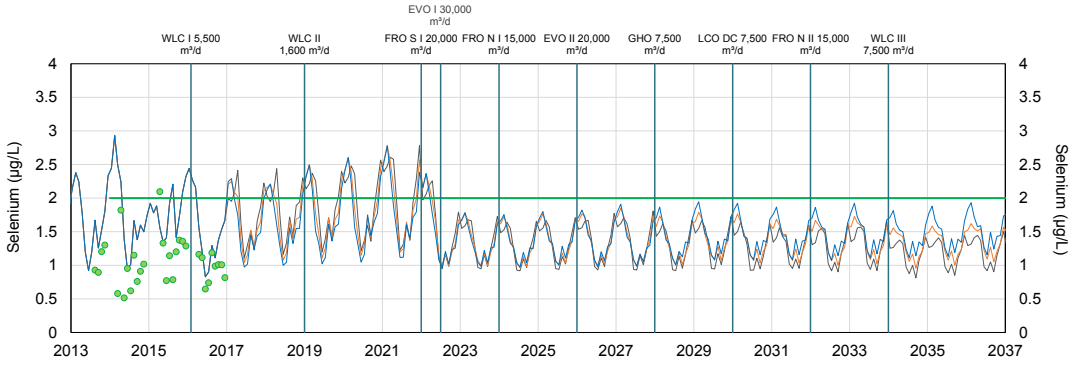
a) Fording River downstream of Greenhills Creek (GH_FR1)



b) Fording River downstream of Line Creek (LC_LC5)



c) Elk River upstream of Grave Creek (EV_ER4)



d) Koocanusa Reservoir (RG_DSELK)

Projected Monthly Average Concentrations under Low Flows
Projected Monthly Average Concentrations under Average Flows
Projected Monthly Average Concentrations under High Flows
Observed Data
Site Performance Objective
Limit

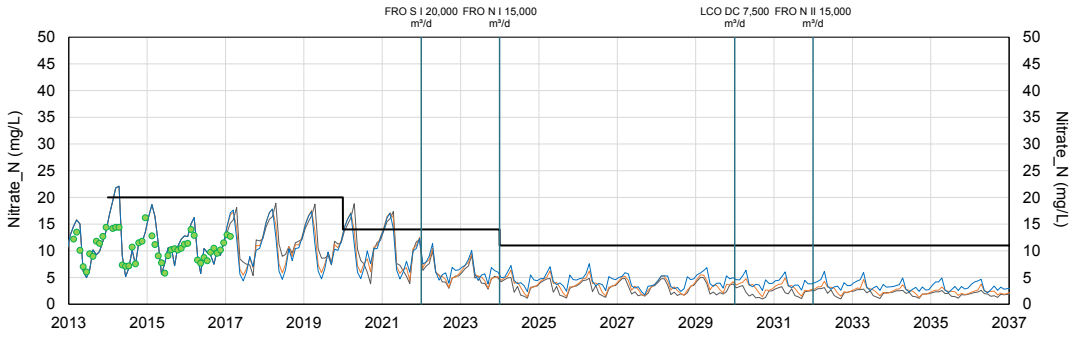
Figure 2. Projected concentrations of selenium at four order stations to the year 2037 (applying the initial implementation plan).

Nitrate

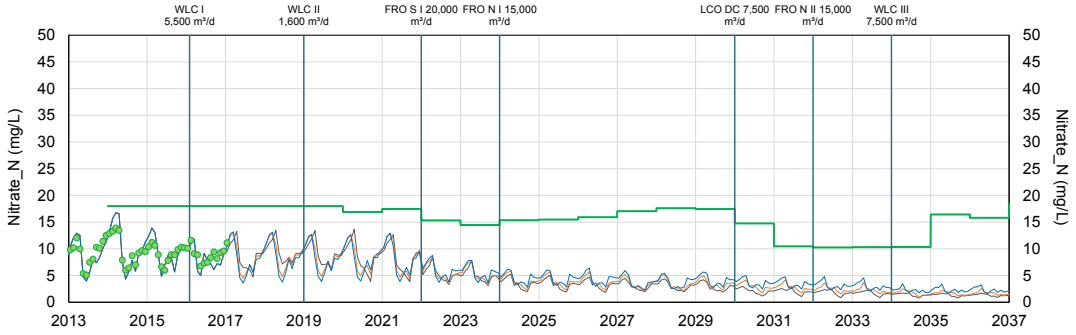
Nitrate is an inorganic substance that contains nitrogen and oxygen. It can be carried by water from waste rock piles, which contain residual material from the explosives used in mining. High concentrations of nitrate in the water may be harmful to fish and other aquatic organisms; it can disrupt their ability to use oxygen, which harms growth and development, particularly in the early life stages (the larval stage, for example). High concentrations of nitrate in the water can also contribute to **eutrophication** (excessive plant growth).

To ensure the protection of sensitive aquatic organisms, the BC water quality guideline for total nitrate is 3 milligrams of nitrogen per litre of water (mg N/L). The long-term SPO for nitrate in the Elk River mainstem and in the Koocanusa Reservoir is the same as the BC water quality guideline. The long-term SPO for nitrate in the Fording River is 11 mg N/L downstream of the Greenhills Operations and 10 mg N/L downstream of the Line Creek Operations. These targets are expected to protect sensitive aquatic organisms in the Elk Valley.

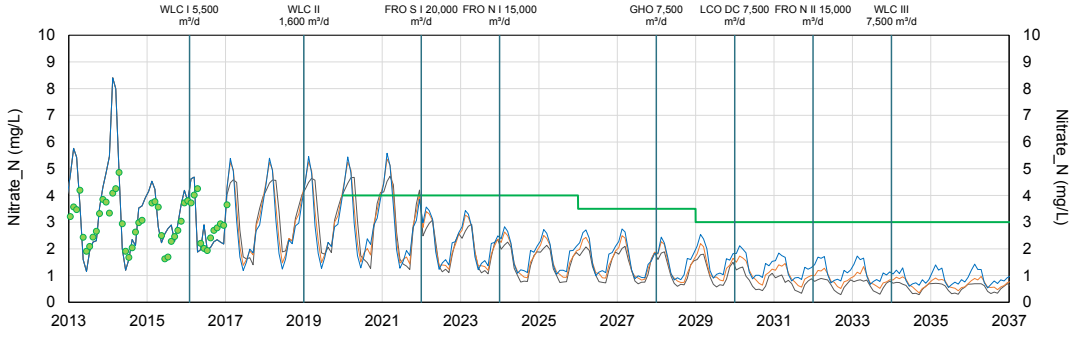
The concentration of nitrate in the waters of the Elk Valley have increased over time. The graphs in Figure 3 show the anticipated future concentrations of nitrate as projected in the 2017 update to the regional water quality model and the initial implementation plan from the EVWQP. Nitrate concentrations were projected to be below SPOs in all areas of the Elk River by 2021, and they were anticipated to remain below the BC water quality guideline in the Koocanusa Reservoir.



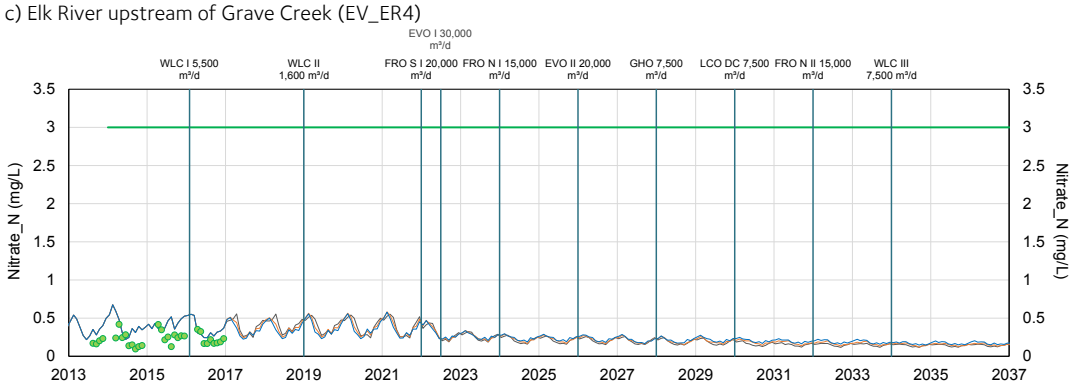
a) Fording River downstream of Greenhills Creek (GH_FR1)



b) Fording River downstream of Line Creek (LC_LC5)



c) Elk River upstream of Grave Creek (EV_ER4)



d) Koocanusa Reservoir (RG_DSELK)

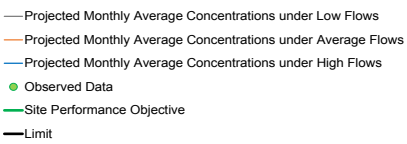
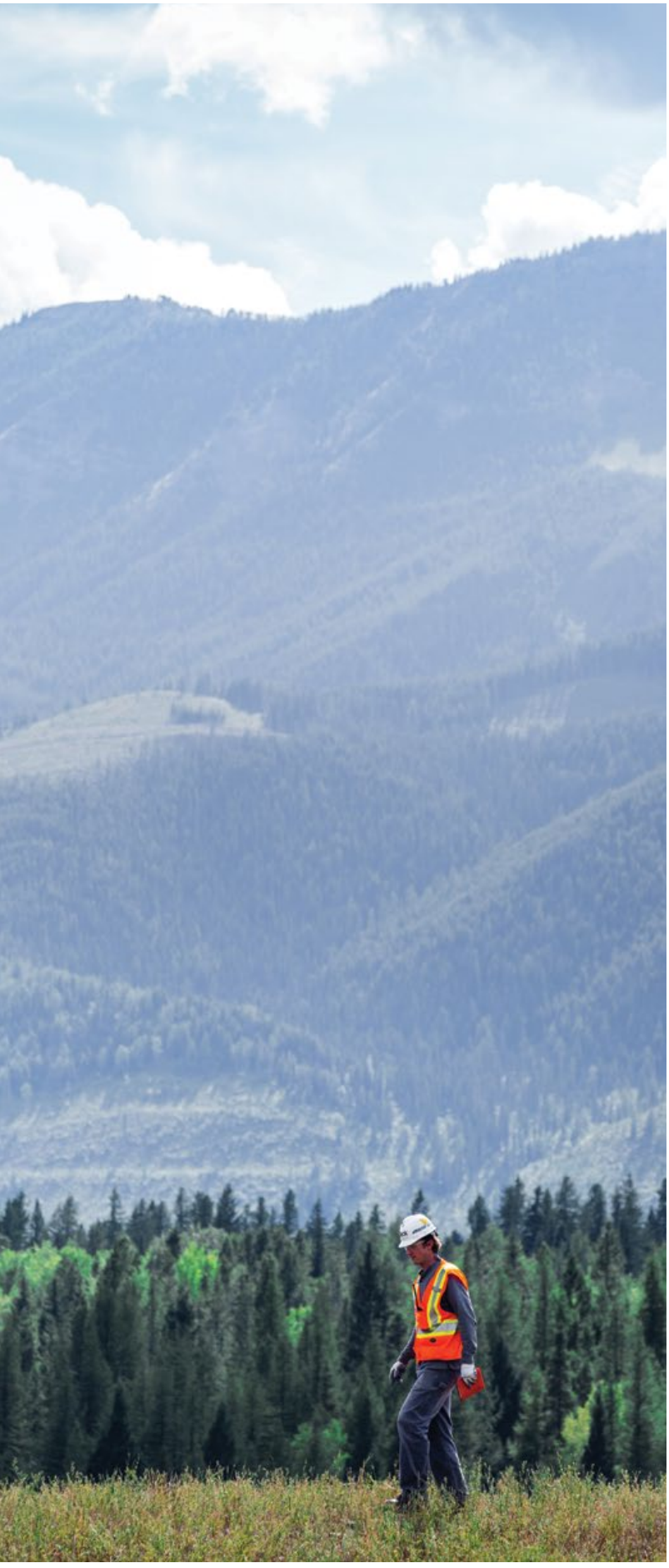


Figure 3. Projected concentrations of nitrate at four order stations to the year 2037 (applying the initial implementation plan).

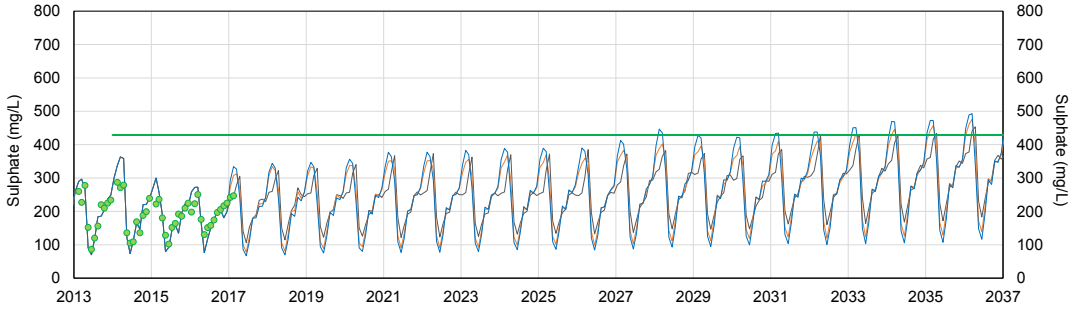


Sulphate

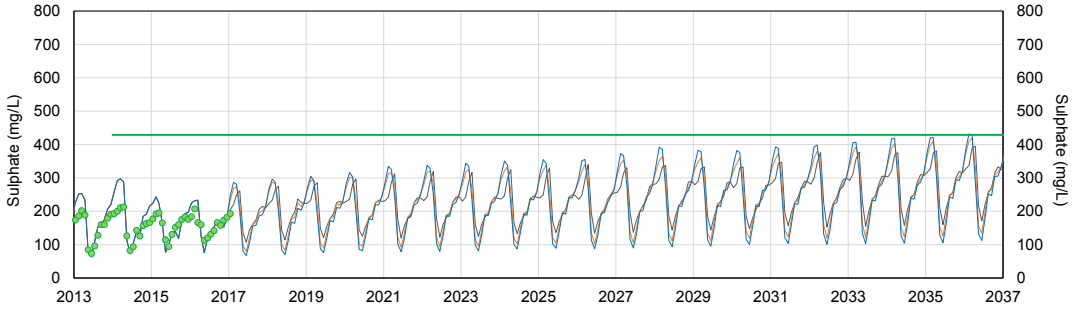
Sulphate is a naturally occurring substance that contains sulphur and oxygen. It is released from waste rock through the oxidation of minerals containing sulphide. When exposed to high sulphate in the water, many aquatic invertebrates may experience impaired regulation of bodily fluids, and high sulphate levels can be harmful to fish and other aquatic organisms.

To ensure the protection of sensitive aquatic organisms, the BC water quality guideline for sulphate is 429 mg/L. The concentrations of sulphate in the Elk River are projected to increase over time, but remain below the BC guideline (Figure 4). The concentrations of sulphate in the Fording River are projected to increase over time and eventually exceed the BC guideline by the year 2027 in the upper Fording River. In the EVWQP, Teck committed to monitoring sulphate trends, to undertake further studies on sulphate toxicity and, if required, to implement treatment to maintain sulphate at levels that would protect aquatic life.

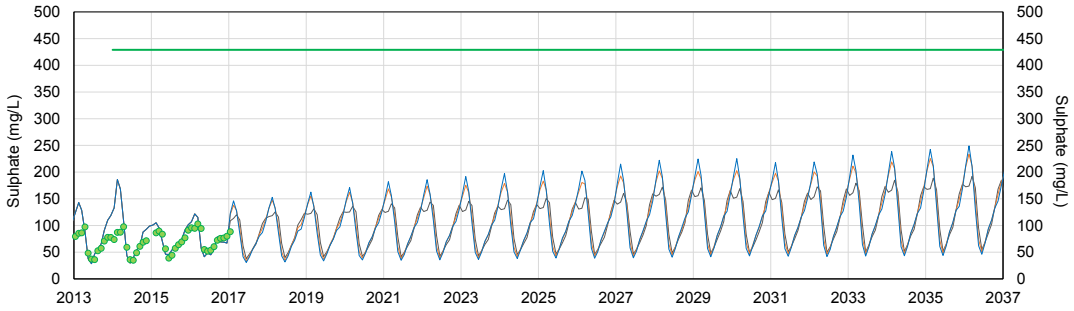
There is uncertainty about the risks that a guideline exceedance poses to sensitive aquatic life. We know, for example, that the toxicity of sulphate is lower in highly mineralized water (also called hard water). Because the waters of the Fording River have very high hardness (around 400 to 500 mg/L), Teck is undertaking laboratory studies to determine if these high-hardness waters protect sensitive organisms from the effects of high sulphate. The results of those studies will be summarized in the next public report (October 2019).



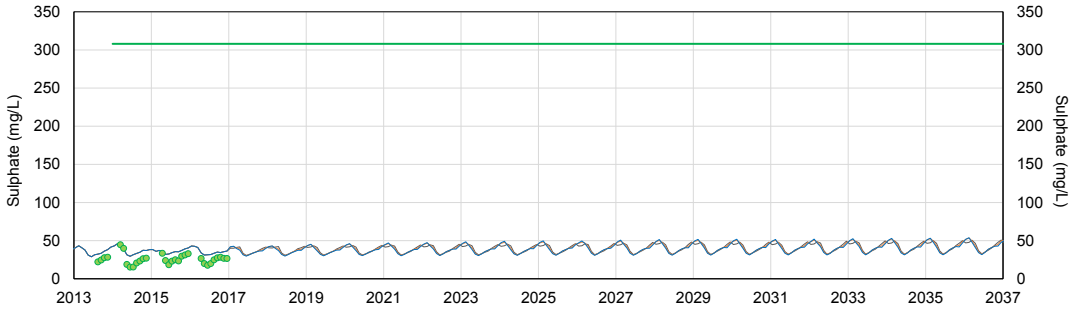
a) Fording River downstream of Greenhills Creek (GH_FR1)



b) Fording River downstream of Line Creek (LC_LC5)



c) Elk River upstream of Grave Creek (EV_ER4)



d) Koocanusa Reservoir (RG_DSELK)

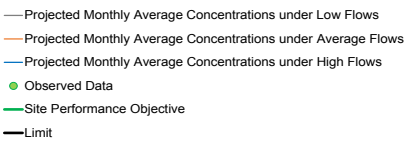


Figure 4. Projected concentrations of sulphate at four order stations to the year 2037 (applying the initial implementation plan).

Cadmium

Cadmium is a metal that is released from the mineral sphalerite. Rock that is naturally high in sphalerite, may release high levels of cadmium to the water when it is exposed to air and water through mining. Cadmium can be harmful at elevated concentrations in aquatic environments, and increasing cadmium concentrations have been observed in tributaries associated with coal mines in the Elk Valley.

The BC water quality guideline for cadmium varies with water hardness. It is approximately 0.35 µg/L when water hardness is 200 mg/L (lower Elk River) and approximately 0.6 µg/L when water hardness is 400 mg/L (upper Fording River). The concentration of cadmium in the waters of the Elk Valley has been below the BC water quality guideline throughout the watershed.

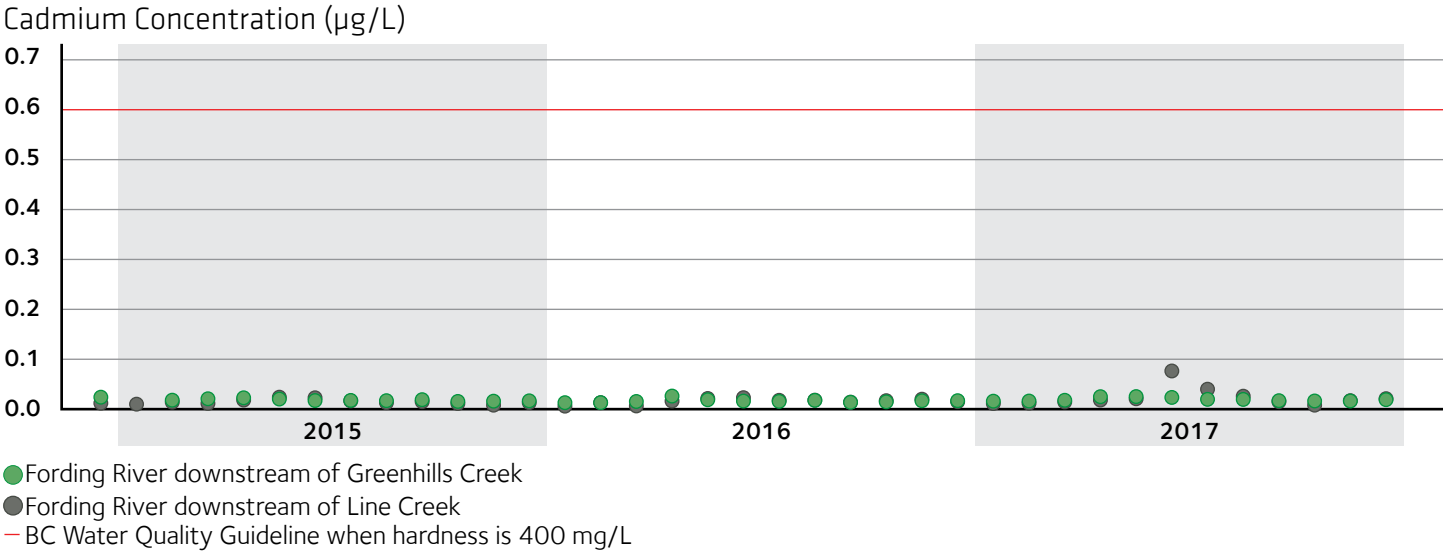


Figure 5. Monthly average concentrations of cadmium at two order stations in the Fording River from 2014 to 2017.

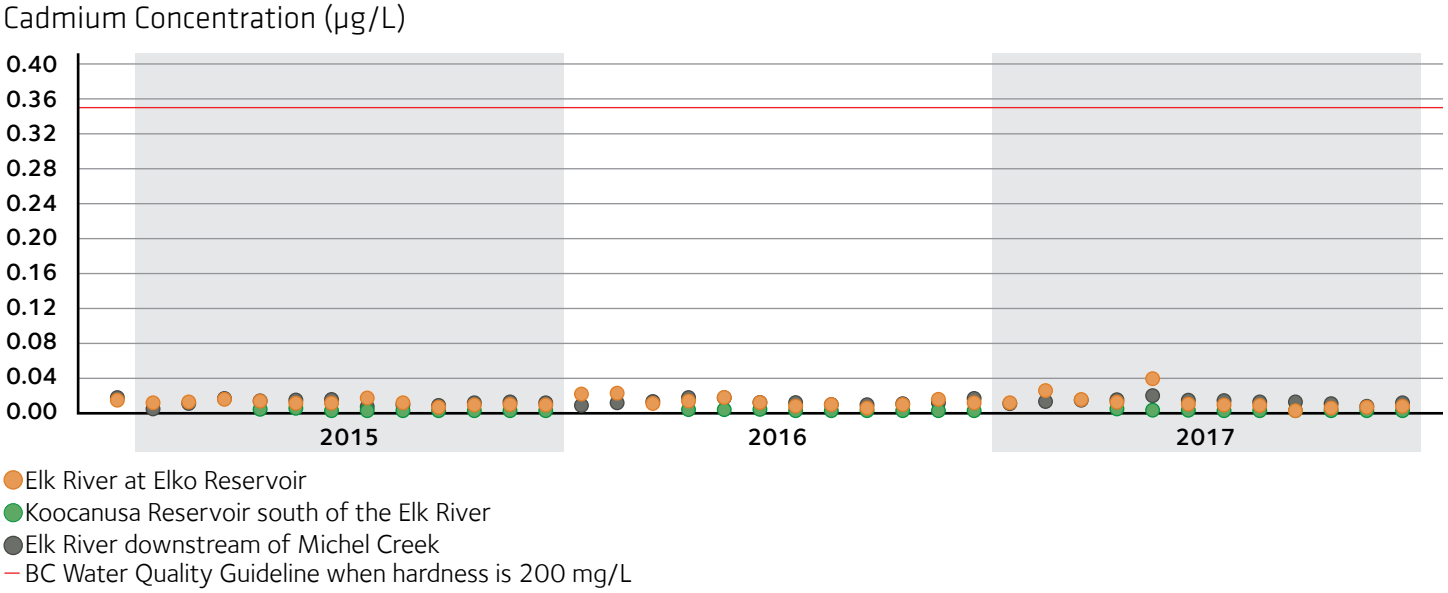


Figure 6. Monthly average concentrations of cadmium at order stations in the Elk River and the Koocanusa Reservoir from 2014 to 2017.

Calcite

Calcite is a white or colourless mineral consisting of calcium carbonate. As water travels through the ground, or through mined waste rock, calcium carbonate is dissolved and carried downstream where it may precipitate (separate from the water) and form a calcite crust on the streambed. This is similar to what happens when calcium builds up on the bottom of a kettle. When calcite builds up on the streambed, it can cement gravel and rocks together, degrading fish and aquatic invertebrate habitat.

In 2017, the calcite distribution in Elk Valley streams and rivers was similar to previous years. The majority of mine-affected areas that were sampled had calcite index values ranging between 0 and 0.5 (very little calcite). Higher values occurred in creek watersheds where mining has occurred.

In addition to the annual calcite monitoring program, Teck conducts studies on the biological effects of calcite. Results from 2015 showed that the percent of mayfly larvae in the benthic community tended to decrease when calcite index values were above 1.

Teck as been conducting additional studies since 2017 to determine the potential effect of calcite formation on the quality of water within the substrate and how it might affect incubating fish eggs. The results of those studies are still being analyzed.

Permit 107517 required Teck to begin treatment to reduce calcite in a priority stream in October 2017. After completing a pilot project and considering the calcite monitoring results, Teck selected Greenhills Creek and started calcite treatment in October 2017. Teck is monitoring this new calcite treatment system to understand its effectiveness and to determine what the results might mean for treatment in other creeks.

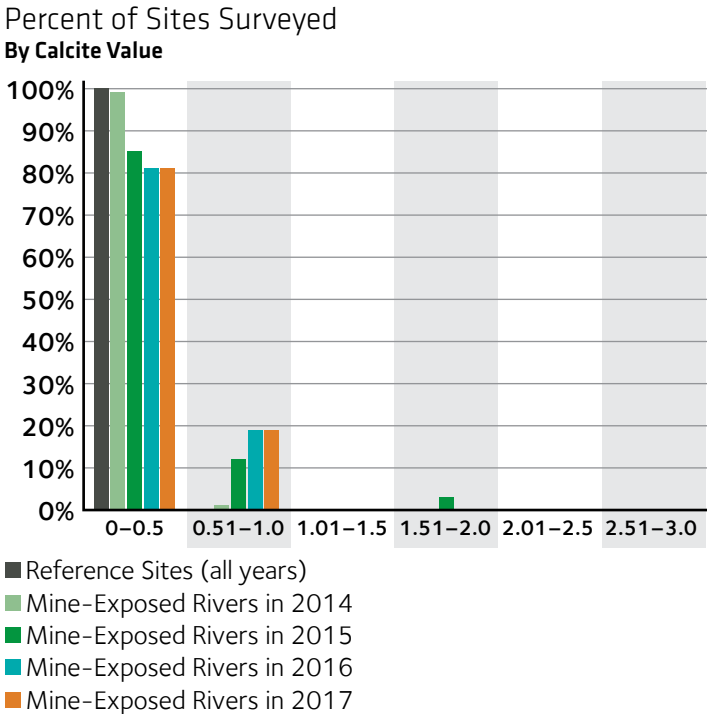


Figure 7. Calcite distribution in mine-exposed areas of the Elk and Fording Rivers from 2014 to 2017.

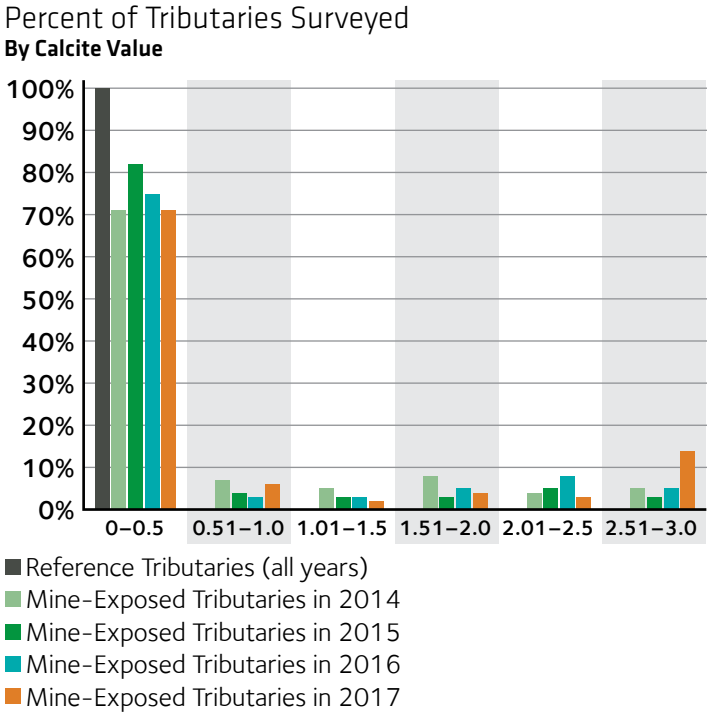


Figure 8. Calcite distribution in mine-exposed tributaries from 2014 to 2017.

Permit Compliance for Selenium, Sulphate, Nitrate, and Cadmium in 2017

The SPOs for selenium, sulphate, nitrate, and cadmium were met at all order stations in all months in 2017. At the compliance points, 90.2% of the monthly average concentrations were below compliance limits in 2017 (97.5% in 2016).

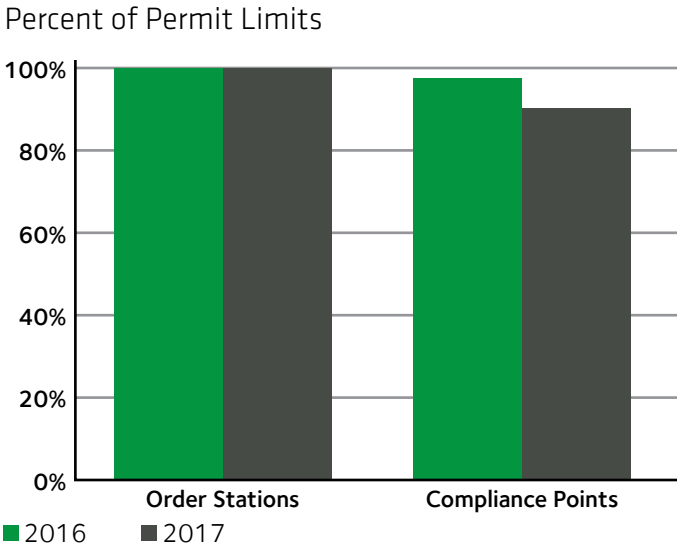


Figure 9. Summary of compliance at order stations and compliance points in 2016 and 2017.

The monthly average concentrations that exceeded compliance limits occurred at the Fording River Operations compliance point, the Line Creek Operations compliance point, and the Coal Mountain Operations compliance point.

Fording River Operations Compliance Point: The monthly average concentration of both selenium and sulphate exceeded compliance limits during the winter months (see Figure 10 and 11) when flows at the compliance point are the lowest. During these times, the majority of flow in the Fording River comes from Cataract Creek, which is a mine-impacted tributary. In August 2018, Teck submitted an application to the Director that proposes an alternate location for this compliance point that is further downstream and would better reflect fully mixed flows. That application is currently under review.

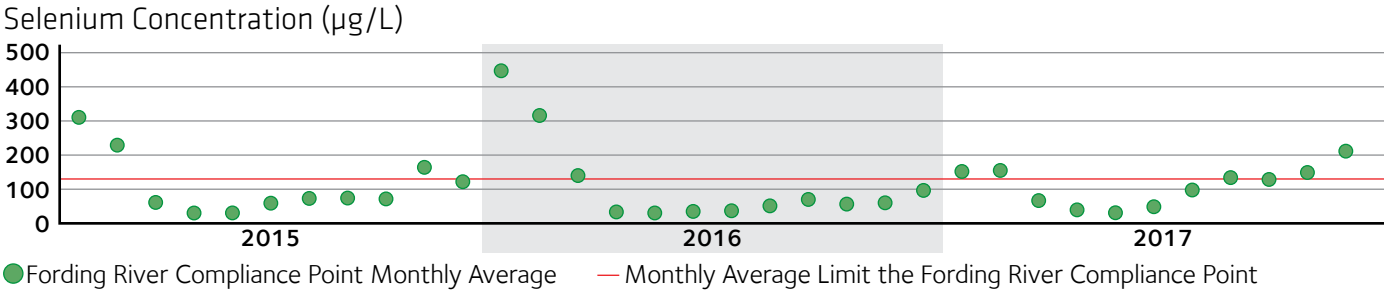


Figure 10. Monthly average concentrations of selenium at the Fording River Operations compliance point (Fording River downstream of Cataract Creek) from 2014 to 2017.

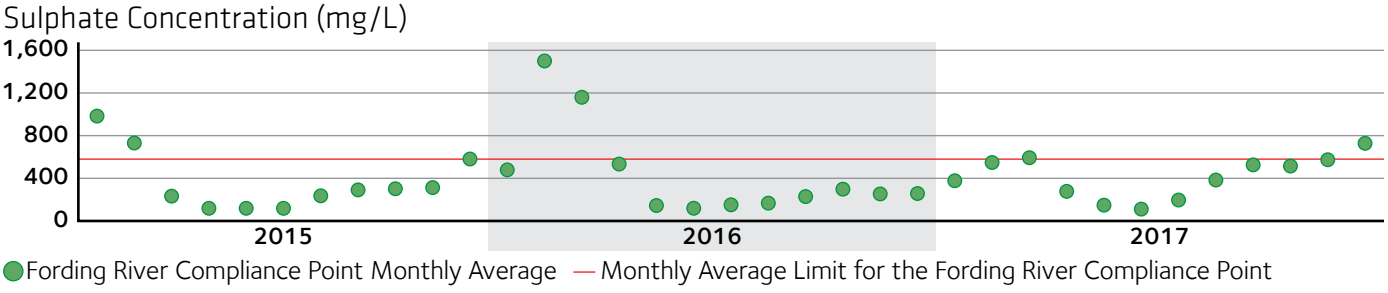


Figure 11. Monthly average concentrations of sulphate at the Fording River Operations compliance point (Fording River downstream of Cataract Creek) from 2014 to 2017.

Line Creek Operations Compliance Point: The monthly average concentration of both selenium and nitrate exceeded the compliance limits after Teck reduced the flow rate of the West Line Creek Active Water Treatment Facility from 5,500 m3/day to 2,500 m3/day in October 2017 (see Figure 12 and 13). This treatment facility is designed to remove selenium and nitrate from West Line Creek. By reducing the volume of water treated, the concentration of selenium and nitrate increased downstream at the Line Creek compliance point. See page 27 for more information about the West Line Creek Active Water Treatment Facility.

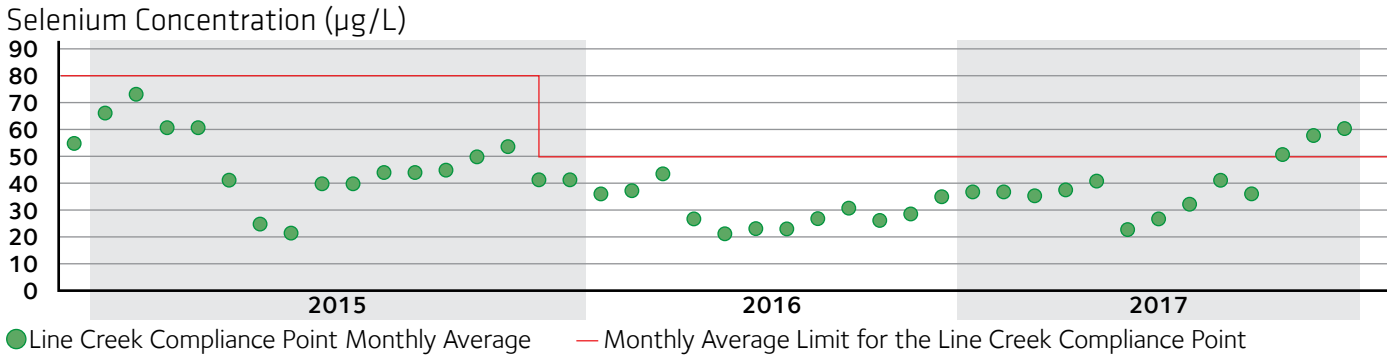


Figure 12. Monthly average concentrations of selenium at the Line Creek Operations compliance point (Line Creek below the water treatment facility) from 2014 to 2017.

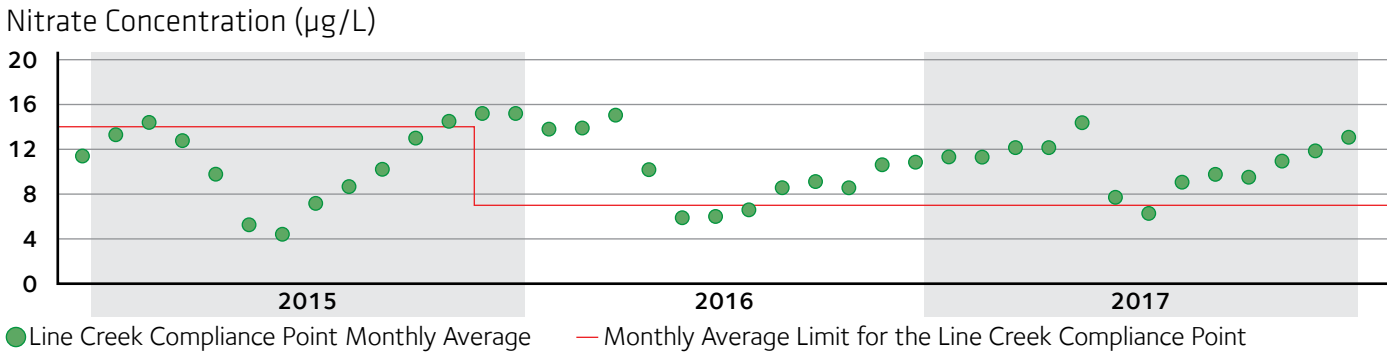


Figure 13. Monthly average concentrations of nitrate at the Line Creek Operations compliance point (Line Creek below the water treatment facility) from 2014 to 2017.

Coal Mountain Operations Compliance Point: Only one monthly average concentration of nitrate exceeded the compliance limit (see Figure 14). This occurred in January when pit dewatering introduced more mine-affected water than usual into Corbin Creek during low flow conditions. The compliance limit is 5 mg/L and the January 2017 monthly average reached 6 mg/L.

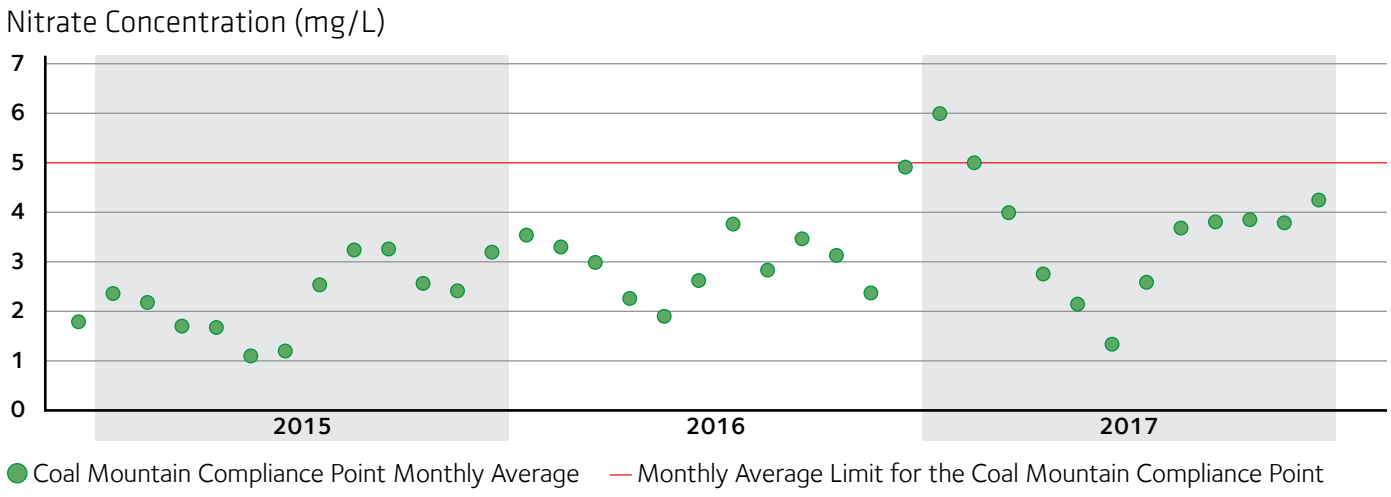


Figure 14. Monthly average concentrations of nitrate at the Coal Mountain Operations compliance Point (Michel Creek upstream of Andy Goode Creek) from 2014 to 2017.

Groundwater

The Regional Groundwater Monitoring Program is focused on monitoring groundwater conditions in the upper part of the Elk Valley watershed, with the southern boundary of this program located just south of the Town of Sparwood. The program focuses on the areas in the valley considered to be the most vulnerable to potential impacts from mining activities, and regular monitoring provides an early warning system for detecting mining-related substances.

The purpose of this program is to understand potential impacts of Teck's mining operations on groundwater and the interactions between groundwater, surface water, and aquatic environments. The program is designed to gain a better understanding of groundwater flow pathways and how mining-related substances may be transported along these pathways in the Elk Valley. Mining-related substances may be transported to groundwater through three main pathways: from settling ponds, from process plants, and from surface water in creeks and rivers.

The groundwater monitoring program evaluates water quality based on sensitive receptors or users including: domestic or household users, aquatic life, livestock, and irrigation. Groundwater samples are collected each quarter and the results are analyzed and reported on each year. Results from 2017 are similar to results from 2015 and 2016.[7]

Important points about groundwater:

- In groundwater studies, collecting baseline and background data is important because sometimes trace metals or other minerals that are related to mining can exist in groundwater naturally. An understanding of the natural conditions is important in order to compare them to potential mine-impacted conditions.
- Groundwater generally flows below the surface in shallow sand and gravel aquifers, parallel to the surface water in main rivers and tributaries in the Elk Valley. Flow rates in aquifers are much slower than in rivers and tributaries.
- During times of high flow (early spring), rivers and tributaries may recharge the groundwater (surface water moves to groundwater). During times of low flow (late summer through winter), groundwater may discharge to the rivers and tributaries (groundwater moves into surface waters). These are possible ways that mine-related substances in groundwater or surface water can be transferred between environments.
- In general, groundwater has lower concentrations of mine-related substances compared to surface water.

[7] Regional Groundwater Monitoring Program 2017 Annual Report (May 2018)

Toxicity Testing

Teck undertakes a large number tests to monitor the toxicity of effluent from mine operations to aquatic organisms. Teck conducts routine short-term (acute) and long-term (chronic) exposure tests as well as supporting studies to further explore specific questions related to chronic toxicity (Figure 15). All toxicity tests are conducted in a laboratory and use sensitive aquatic species that are most representative of the area.

Short-Term Exposure Tests

Short-term exposure tests are conducted on water samples collected from a number of monitoring stations. These tests use Rainbow Trout and water fleas (a small 1 to 5 mm crustacean called *Daphnia magna*). The water sample passes the test if 50% or more of the organisms survive exposure (tests are 96 hours for the trout and 48 hours for *Daphnia*). Failing the test triggers follow-up investigations that may include re-testing the water sample or an additional study to determine the cause of the failure.

In 2017, 210 trout tests were conducted, and all passed (50% or more of the organisms survived short-term exposure). Of the 235 *Daphnia* tests, 4.3% failed. These test failures were associated with water collected from West Line Creek and Cataract Creek. These *Daphnia* test failures are thought to relate to the formation of calcite on the shells of individual water fleas when the temperature of the test water (less than 10°C at collection) is raised to the standard testing temperature of 20°C (laboratory standard temperature). At Teck's request, the laboratories have been conducting *Daphnia* tests at both 10°C and 20°C on water samples collected from West Line Creek and Cataract Creek since 2016. The tests conducted at 10°C pass, but Teck is required to report the 20°C results. Teck is planning calcite mitigation for both these locations in early 2019, which is expected to resolve this issue.

Long-Term Exposure Tests

Long-term exposure tests are conducted on water samples collected from the eight compliance points. The tests use algae, amphipods, water fleas, Fathead Minnows, and Rainbow Trout, and range in duration from 72 hours (for algae) to 30 days (for Fathead Minnow and Rainbow Trout).

Of the 96 tests conducted in 2017, 69 (or 72%) showed no adverse responses (Figure 16) and 21 showed a likely adverse response. There were no adverse responses in the algae tests. Some adverse responses were considered potentially associated with mine-related substances such as sulphate, nitrate, and nickel.

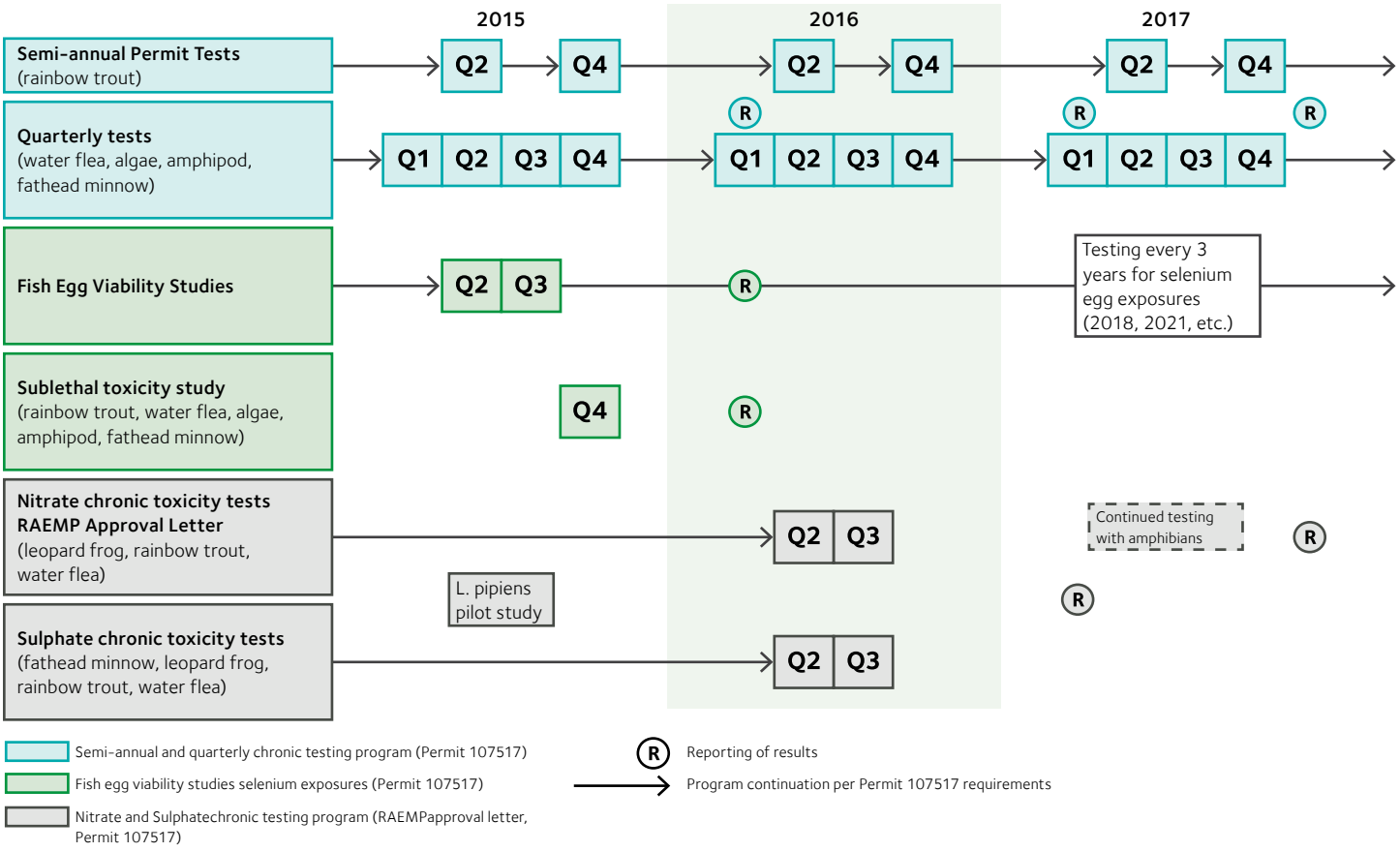


Figure 15. Overview of the long-term toxicity testing program.

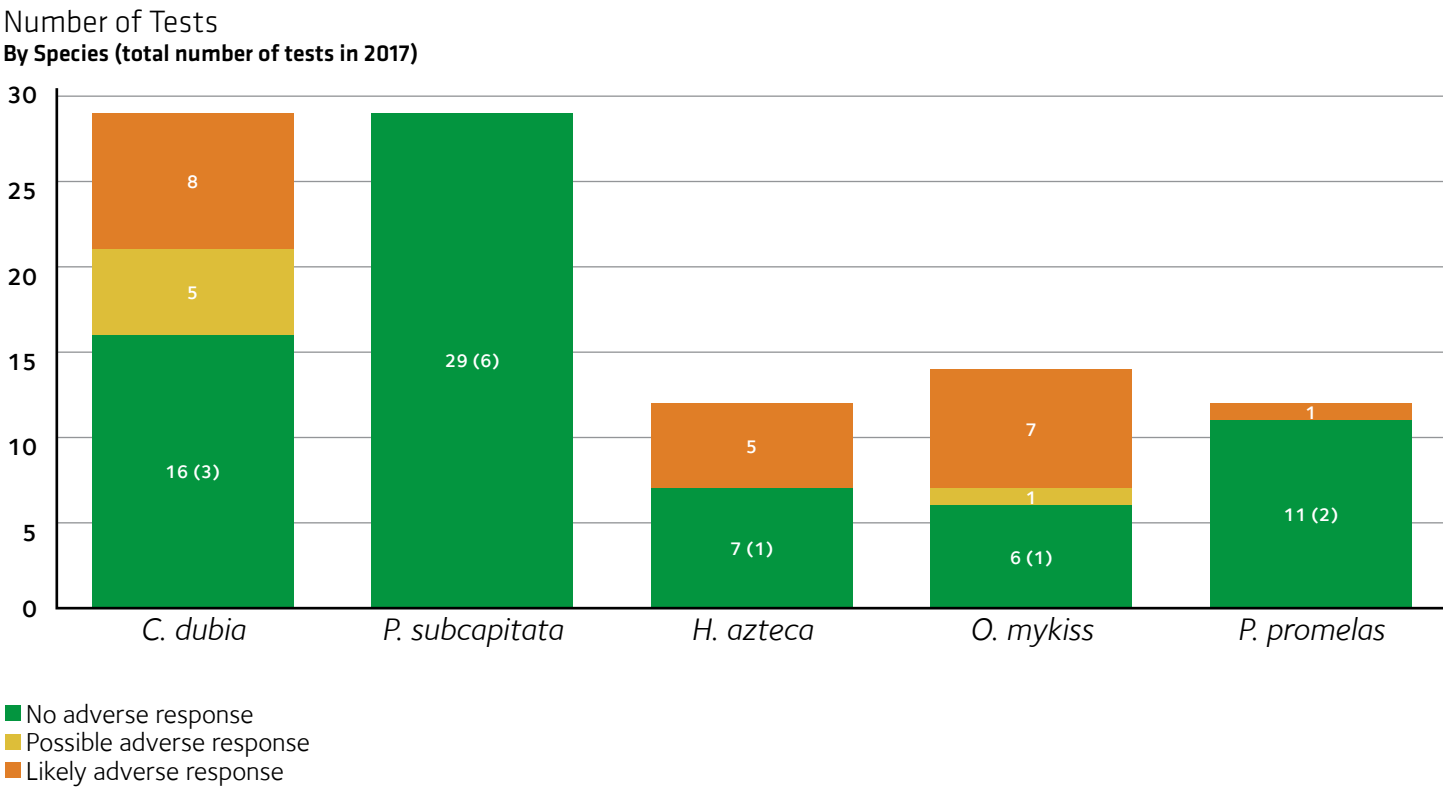


Figure 16. Long-term toxicity test results from 2017.

Nitrate and Sulphate Toxicity Studies

In 2016, Teck began conducting studies to investigate the effects of exposure to nitrate and sulphate (at the same time) on aquatic invertebrates, fish, and amphibians.

Results from the work on aquatic invertebrates and fish confirmed that the benchmarks that were used to develop the SPOs are protective of aquatic life. In addition, the results provided evidence that the margin of safety of the SPOs may be greater than described in the EVWQP.

For amphibians, standardized government-approved tests do not currently exist. To address this gap, Teck is working with commercial laboratories to develop and implement a testing program with the Northern Leopard Frog (*Lithobates pipiens*). Amphibian testing in 2016 and 2017 produced unreliable results because of unexplainable mortality in the control samples (lab water). Testing continues in 2018 with improvements to the test procedures that are expected to reduce mortality in the control samples.

Fish Egg Viability Studies

In 2015, an egg-viability study was completed using eggs collected from Westslope Cutthroat Trout. This study measured the concentration of selenium in the eggs and evaluated their survival and development. That study resolved remaining uncertainties about Westslope Cutthroat Trout, and in 2017, the EMC recommended the next egg-viability study focus on Redside Shiners because little is known about the accumulation and toxicity of selenium in that species. Redside Shiners are abundant in the Elk River watershed and sample results from 2015 and 2016 show that it has greater accumulation of selenium in its tissues than that of most other fish species. Teck designed and implemented an egg-viability study on Redside Shiners in 2018, and the results will be summarized in the next public report.

Regional Aquatic Effects

The Regional Aquatic Effects Monitoring Program (RAEMP) is a valley-wide program that looks at the biological effects of water quality on aquatic organisms, specifically benthic invertebrates and fish. Field sampling occurs every year, but the results are analyzed and reported on every three years. The purpose of this program is to:

- assess the effects of mine operations, individually and together, on aquatic ecosystems within the Elk River watershed
- monitor changes over time
- help understand whether Teck's management and mitigation actions are working as intended by the Elk Valley Water Quality Plan

Teck completed the first comprehensive cycle of field sampling in 2015 and completed additional sampling in 2016 at a subset of areas. The findings that follow are from the report Teck submitted to the Director in September 2017.[8]

[8] Elk River Watershed Regional Aquatic Effects Monitoring Program (RAEMP) Report, 2015-2016

Benthic Invertebrates

Benthic invertebrate communities in the flowing portions of the Elk River and its tributaries are dominated numerically by mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*), and caddisflies (*Trichoptera*). These three aquatic invertebrates are collectively referred to as EPT. EPT are considered highly sensitive to changes in water quality and to habitat disturbances. When EPT are abundant, it indicates good quality habitat for all aquatic organisms.

Of the 59 mine-exposed areas sampled, almost half (27 of 59) had EPT abundances less than the normal range observed in reference (not mine-exposed) tributaries. These results were expected in some of the mine-impacted tributaries that were monitored; however, a measured reduction in the proportion of three types of mayflies in the upper Fording River was not expected. The extent and cause of this reduction could not be explained by water quality or calcite, and Teck is continuing to investigate the finding under its local aquatic effects monitoring program for the Fording River Operations (see page 28).

The selenium concentrations in the body tissues of benthic invertebrates collected in fast-moving waters in 2015 and 2016 have typically been less than the Level 1 benchmark for effects to invertebrates (13 µg/g dw), as well as benchmarks for dietary effects to juvenile fish (11 µg/g dw) and birds (15 µg/g dw). The concentrations of selenium in benthic invertebrates from slow-moving water have frequently been greater than Level 1 benchmarks.

These results were compared to normal reference ranges and to expected values derived from water quality models and bioaccumulation models developed for the EVWQP. Tissue selenium concentrations measured in organisms from mine-exposed areas were generally at the upper end of, or greater than, the normal range for reference areas (51 of 58 areas monitored, or 88%). This reflects bioaccumulation of selenium in mine-exposed areas.

The tissue selenium concentrations in benthic invertebrates were within the range of model projections in all study areas except for Bodie Creek. We don't know whether the samples taken from Bodie Creek reflect drift of invertebrates from the sediment ponds, exposure to mine-influenced water downstream of the sediment ponds, or some other factor related to the proximity to the point of discharge. Locations close to sediment ponds have greater potential to be influenced by mine-water (pit dewatering, for example). Bodie Creek is one of three tributaries at Elkview Operations scheduled for active water treatment.

Fish

In the first cycle of this program, Teck studied three species of fish that are common in the Elk Valley: Westslope Cutthroat Trout, Mountain Whitefish, and Longnose Sucker.

Westslope Cutthroat Trout

Westslope Cutthroat Trout are widely distributed throughout the Elk River watershed and are the only fish present in the Fording River upstream of Josephine Falls. In 2015, muscle samples were collected, non-lethally, from Westslope Cutthroat Trout collected in the Fording and Elk Rivers. Ninety fish were sampled and all had selenium concentrations near or above the upper limit of the normal range of variation observed in reference area fish. However, tissue concentrations were within ranges projected by bioaccumulation models developed to inform the EVWQP. All fish collected from fast-moving water had selenium concentrations less than the Level 1 benchmark for reproductive effects. One fish (which was one of ten sampled from Henretta Lake, slow-moving water) had selenium in muscle exceeding the Level 1 benchmark for potential reproductive effects.

Teck commissioned a study on the Westslope Cutthroat Trout population in the upper Fording River from 2014 to 2016 beyond the requirements of Permit 107517. That study indicated that the Westslope Cutthroat Trout population in the upper Fording River is stable and potentially increasing in numbers.[9]

[9]Upper Fording River Westslope Cutthroat Trout Population Monitoring Project 2017 (December 2017)

Mountain Whitefish

Mountain Whitefish are found mainly in the Elk River and in the lower reaches of the Fording River, Line Creek, Alexander Creek, and Michel Creek. Tissue samples were collected in 2015 and analyzed for selenium concentrations.

To address a knowledge gap on the effects of selenium on Mountain Whitefish, Teck commissioned a study in 2010 to measure selenium reproductive effects in this species.[10] The study, completed in 2013, was unable to collect fish with high enough selenium concentrations to elicit a clear effect; however, the authors suggested that the lower bound of a potential selenium effect threshold for Mountain Whitefish (29.3 µg/g dw). Of the 20 Mountain Whitefish individuals captured from mine-exposed areas in 2015, six (or 30%) had ovary selenium concentrations higher than this lower bound estimate. The EMC will discuss the recommended next steps for this species.

Dwarf Longnose Sucker

In six of the eight mine-exposed areas sampled in 2015 (or 75%), Dwarf Longnose Sucker had tissue selenium concentrations greater than those from reference areas. Ovary and muscle selenium concentrations were above the Level 1 benchmark of 18 µg/g dw (for reproductive effects) for all individuals from Goddard Marsh, some individuals from the Elk River wetland downstream from Grave Creek, and some individuals from the Stanford Pond near Fernie.

The Level 1 benchmark was derived from tests with Brown Trout (a very sensitive trout species); therefore, these selenium concentrations do not necessarily indicate reproductive effects in Dwarf Longnose Sucker. More research is needed to determine the potential for adverse effects related to accumulation of selenium in this species.

What is µg/g dw?

The abbreviation **µg** stands for micrograms (or millionths of a gram), **g** stand for grams, and **dw** stands for dry weight. So a selenium concentration of 11 µg/g dw means 11 micrograms of selenium per one gram of dry fish tissue.

Local Aquatic Effects

Teck carries out four local aquatic effects monitoring programs (LAEMPs). These programs are designed to answer specific questions about aquatic effects that arise because of the unique circumstances of a particular mine operation.

Line Creek Operations

The local aquatic effects monitoring program at Line Creek Operations began in 2014. The purpose of this program is to understand the potential effects of the West Line Creek Active Water Treatment Facility on water quality and aquatic organisms. Teck built this facility to reduce the concentration of selenium and nitrate in Line Creek. It is the first facility of this type and scale to operate anywhere in the world to treat selenium and nitrate. This facility is required by Permit 107517.

The facility operated from July to October in 2014, but was shut down because of performance issues. It was recommissioned in late 2015 and began discharging treated water in October that same year. Water quality monitoring results from 2016 and 2017 showed that the facility was removing 95% of the total selenium and 90% of the nitrate from the water. However, biological monitoring results showed elevated concentrations of selenium in the body tissues of aquatic organisms collected immediately downstream of the facility in Line Creek (these results were restricted to Line Creek and did not extend to the Fording River).

Teck brought in scientific experts to support its investigation of these confounding results. The investigation determined that the treatment process was converting the remaining selenium in the treated water (the 5%) to other forms of selenium that are more easily accumulated by aquatic organisms. Subsequent water quality results confirmed that there was an increase in the concentration of these other forms of selenium downstream of the facility. In response to this new information, Teck reduced the flow rate of the facility by 55% in October 2017 to protect the aquatic organisms in Line Creek. Teck also applied to the Director to shut down the facility until a solution could be implemented.

Teck began work to implement a solution, and the facility was shut down in March 2018. Teck evaluated a variety of approaches and during the summer of 2018, Teck successfully piloted an advanced oxidation process. This new process was installed and recommissioning of the treatment facility began in August 2018. The local aquatic effects monitoring program continues to monitor water quality and aquatic organisms downstream of the facility to ensure the effectiveness of the

[10]Evaluation of the Effects of Selenium on Early Life Stage Development of Mountain Whitefish from the Elk Valley, BC (July 2017)

treatment system. Moving forward, monitoring for these different forms of selenium is now routine at locations where there is a potential for them to occur.

To coincide with the scheduled commissioning of the treatment facility in 2015, the daily maximum compliance limit for nitrate in Line Creek reduced from 20 mg N/L to 9 mg N/L. It has since become apparent that the nitrate loadings in Line Creek were previously underestimated by the 2014 water quality projections. Although the facility is functioning as designed, the reduced compliance limits are consistently exceeded, with values up to 15 mg N/L in Line Creek. Despite exceeding the compliance limit at this location, the concentrations of nitrate at the downstream order station in the Fording River have remained below the site performance objective of 18 mg N/L.

To address the nitrate challenges at Line Creek, Teck developed and implemented a **Nitrate Compliance Action Plan**, which focuses on managing nitrate at the source[11]. This plan was approved by the Director in January 2018 and Teck submitted an update in September 2018, which is under review. This is a long-term plan that outlines a path forward to achieve compliance for nitrate concentrations in Line Creek. Some of the actions outlined in this plan include:

- reviewing blasting products and practices
- minimizing the accumulation of water in pits and blasting areas
- improving nitrate load estimates and updating the regional water quality model
- accelerating the development of treatment alternatives

Although originally developed for Line Creek Operations, the best management practices identified in this plan are being adopted by the other Teck coal operations to help manage nitrate through source control at their locations.

Fording River Operations

The local aquatic effects monitoring program at Fording River Operations began in 2016. The purpose of this program is to document current conditions and evaluate the aquatic effects of mine development and future active water treatment. An active water treatment facility is under construction and will treat water from Cataract Creek, Swift Creek, and Kilmarnock Creek.

Results from 2016 showed a decrease from 2012 and 2015 in the relative abundances of three types of mayflies in the Upper Fording River, from downstream of Kilmarnock Creek to upstream of Ewin Creek.[12] Results from 2017 showed the same pattern. Analyses of the results from both years did not point to a single direct cause, but suggest that the decrease may be due to a combination of both mine-related and natural factors (mine-related water quality, water temperature variability, annual flow, and predation by other organisms).

The potential causes of the mayfly decrease are still being investigated, and the 2018 program has been adjusted in order to determine the contributing factors. Additional samples and measurements were collected in 2018 to better understand the seasonal variability of benthic invertebrate communities, including how they may be affected by increases in temperature.

Greenhills Operations

The local aquatic effects monitoring program at Greenhills Operations started in 2017. Greenhills Operations straddles a ridge between the Elk River and the Fording River. The purpose of this program in the first year was to develop a better understanding of a side channel that lies between Greenhills Operations and the Elk River. This side channel receives water from four creeks that flow from Greenhills Operations: Thompson Creek, Wolfram Creek, Leask Creek, and likely Mickelson Creek.

The side channel undergoes substantial seasonal flooding and braiding and has highly variable flow throughout the year. In parts of the side channel, water goes subsurface during low flow periods, which results in isolated surface pools with different water quality and biological characteristics than in the flowing portions. The program was designed to understand the hydrology, biology, and environmental quality of this side channel, and the potential effects of west spoil development on water quality and aquatic organisms in both the side channel and the Elk River.

Results from 2017 showed that the four tributaries have had no effect on aquatic organisms in the Elk River mainstem, and minimal effects on aquatic organisms within the side channel, the side channel wetland, and isolated pools. The results from the 2017 program were used to refine the program for 2018 to 2020 to evaluate and track short-term mine-related effects in the side channel over time.

[11] The Nitrate Compliance Action Plan is not under EMC review.

[12] Samples in 2012 and 2015 were collected under the regional sampling program before the Local Aquatic Effects Monitoring Program at Fording River Operations was established.

Coal Mountain Operations

The local aquatic effects monitoring program at Coal Mountain Operations is currently being developed. The purpose of this program is to study the influence of Coal Mountain Operations on water quality, calcite levels, and benthic invertebrate communities in Michel Creek, downstream of the mine. There are three drivers for this program:

- Biological monitoring results from 2015 and 2017 showed that the benthic invertebrate community in Corbin Creek and Michel Creek had lower percent EPT and a lower percent of mayflies relative to local reference areas.
- Chronic toxicity tests with water from Michel Creek (downstream of operations) showed adverse effects to *Hyalella azteca* (a **crustacean** 3-8 mm long) and *Ceriodaphnia dubia* (a crustacean less than 1 mm long). An investigation into these toxicity results suggest that nickel concentrations may be the cause.
- Teck observed an increase in nickel concentrations through its routine water quality monitoring at Coal Mountain monitoring stations.

Although the nickel concentrations are below the current British Columbia water quality guideline, new information from this program may lead to a site-specific objective for nickel at this location.

Koocanusa Reservoir

The Koocanusa Reservoir straddles the border between Canada and the United States, and lies within the traditional territory of the Ktunaxa people. Three Canadian rivers supply most of the inflow to the reservoir: the Kootenay River (62%), the Elk River (26%), and the Bull River (11%).

Teck conducted a three-year study, from 2014 to 2016, to understand the physical, chemical, and biological conditions in the Canadian portion of Koocanusa Reservoir. Samples were collected upstream and downstream of the Elk River confluence, and the results from these samples were compared to each other to identify potential mining-related effects. The results of this study are summarized in a report Teck submitted to the Director in June 2017.[13]

Routine water quality monitoring in the reservoir continued in 2017, with additional aquatic effects monitoring planned for 2018 to 2020. The water quality results from 2017 are summarized in a report that Teck submitted to the Director in June 2018.[14]

Teck has developed a comprehensive monitoring program for the Canadian portion of the Koocanusa Reservoir for 2018-2020. The 2018-2020 program will collect information on water (physical and chemical), sediment (physical and chemical), phytoplankton, zooplankton, benthic invertebrates, and fish. This program is designed to determine if conditions in the reservoir are changing, and if those changes can be attributed to influences from the Elk River and upstream mining activities.

[13] Koocanusa Reservoir Monitoring Report, 2014 to 2016 (January 2018)

[14] Permit 107517 2017 Summary Report of Monitoring Results in the Koocanusa Reservoir (June 2018)

Water and Sediment Quality

Based on the results from 2014 to 2017, water quality in the reservoir is generally good with minor exceptions. Concentrations of nitrate and selenium tended to be higher in areas downstream from the Elk River confluence compared to areas upstream of the confluence (when considering the annual average surface water quality). However, site performance objectives and BC water quality guidelines for nitrate, selenium, sulphate, and cadmium were met consistently at the order station in the Koocanusa Reservoir.

Sediment results from 2014 to 2016 showed that concentrations of most metals and polycyclic aromatic hydrocarbons[15] were higher in sediments collected downstream of the Elk River confluence, but these concentrations were all still below the BC sediment guideline. Only selenium showed a slight increase from 2014 to 2016, but concentrations were less than those measured in 2013.

Aquatic Algae and Invertebrates

Samples of phytoplankton (tiny suspended algae) and zooplankton (tiny suspended invertebrates) were collected upstream and downstream of the Elk River confluence in 2015 and 2016. The numbers and kinds of organisms present (community structure) were evaluated, as well as the concentration of selenium in zooplankton; the results showed no significant differences between the upstream and downstream locations.

Clams, insect larvae, worms, seed shrimp, and mites were among the organisms found in reservoir sediments. These types of organisms are typical of reservoir habitat (deep and slow moving). There were minor differences in the kinds of organisms found in sediments downstream of the Elk River confluence compared to upstream, with natural variations in sediment texture likely to be the cause of those biological variations.

Fish

Teck collected samples of several different fish species in the Koocanusa Reservoir from 2014 to 2016, including Peamouth Chub, Northern Pikeminnow, Largescale Sucker, Redside Shiner, and Yellow Perch. These samples provided important information on fish age, condition (weight in relation to length), liver size, gonad size, and growth. In addition to these fish health and population measurements, the concentration of selenium was measured in the muscle tissue, whole body tissues, and ovaries.

Fish health surveys, which focused on fish survival (mean age), growth (body size-at-age), reproduction (relative gonad weight) and energy storage (relative liver weight and overall condition), showed no consistent patterns among fish species, sexes, or sampling years that would indicate an influence from the Elk River.

The selenium concentrations measured in fish tissues were compared to guidelines published by the USEPA[16] and the British Columbia Ministry of Environment. They were also compared to the benchmarks established in the EVWQP. Selenium guidelines for fish tissues are estimates above which there is a potential risk of reproductive impairment. Guidelines vary between agencies because the critical burden of selenium in fish tissue (causing reproductive effects) is an evolving field of study. The concentration of selenium in ovaries is the most relevant because it is selenium in eggs that poses risk of reproductive effects.

The average concentrations of selenium in the ovaries of fish collected from the reservoir were frequently above the BC guideline of 11 µg/g dw, particularly in Peamouth Chub, Northern Pikeminnow, and Redside Shiner. For all species except Redside Shiner and Northern Pikeminnow, the average selenium concentrations in the ovaries were below both the EVWQP Level 1 benchmark (18 mg/kg dw) and the USEPA guideline (15.1 µg/g dw). Redside Shiner samples were above the Level 1 benchmark at both downstream and upstream locations in the two years it was sampled (2015 and 2016).

[15]Polycyclic aromatic hydrocarbons are organic compounds containing only carbon and hydrogen. They occur naturally and are released from burning fossil fuels, trash, tobacco, and wood.

[16]The acronym USEPA stands for the United States Environmental Protection Agency. The guidelines were published in 2016.

Redside Shiners appear to have a greater body burden (greater accumulation) of selenium than most other species. The implications of these higher concentrations are unknown because no studies have been done to determine the toxicity of selenium on this species. Redside Shiners are highly abundant in the Elk Valley watershed, so the EMC has recommended a study to evaluate the effects of selenium on the early life stages of Redside Shiners (see page 25).

Northern Pikeminnow collected downstream of the Elk River confluence in 2014 were the only individuals with average selenium concentrations in their ovaries above the Level 1 benchmark. The ovaries collected that year were relatively undeveloped.

When a selenium guideline or benchmark is exceeded, it does not necessarily mean that there will be an effect to the organism. Fish species have a range of sensitivities to selenium in their tissues, and critical levels have not been established for all the species that have been reported in the Koocanusa Reservoir.

Selenium Concentration in Fish Ovaries (µg/g dw)

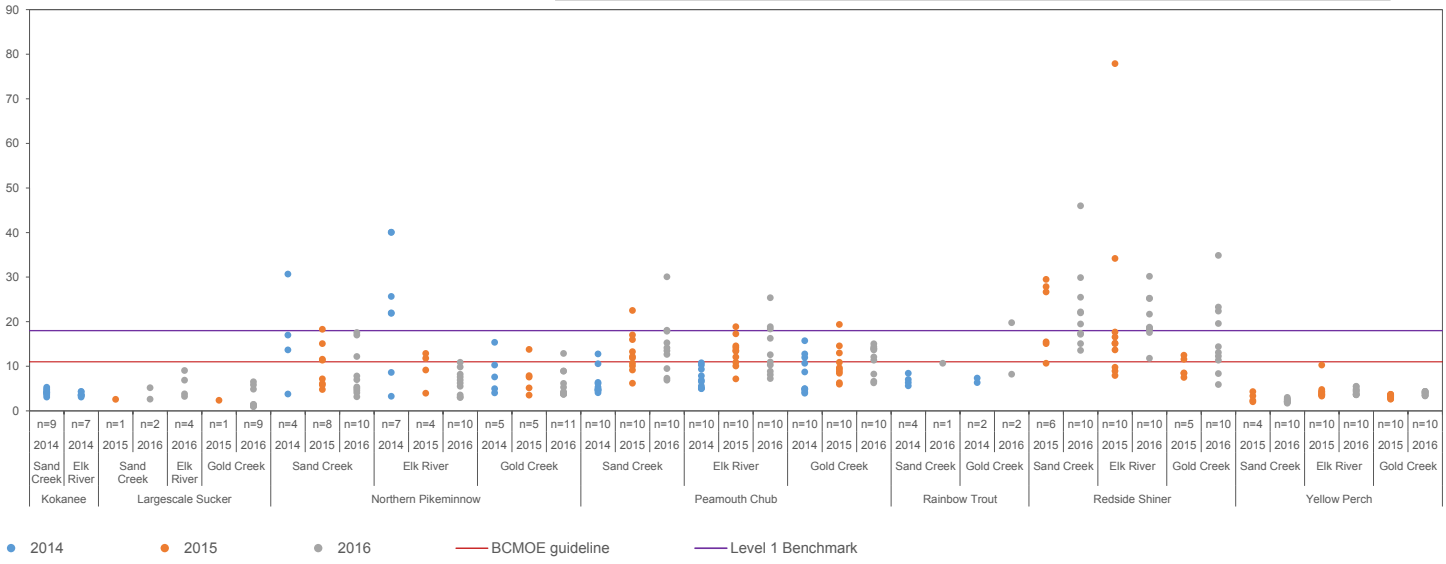


Figure 17. Selenium concentrations in fish ovaries (µg/g dw) in the Koocanusa Reservoir from 2014 to 2016. The Sand Creek study area is upstream of the Elk River confluence, and the Elk River and Gold Creek study areas are downstream.

Tributary Management

In 2017, Teck developed a Tributary Management Plan with input from the EMC, and submitted it to the Director in December 2017. This plan details protection and rehabilitation goals for tributaries (creeks and streams) within the Elk Valley. The plan provides guidance for the environmental management of tributaries and it must be taken into consideration during future mine planning. The Tributary Management Plan complements the Elk Valley Water Quality Plan and supports its objectives.

The overall goal of the Tributary Management Plan aligns with the requirement in the permit and is stated as follows:

Protect and rehabilitate tributaries of the Elk River watershed on a priority and feasibility basis to benefit fish, aquatic-dependent wildlife, and vegetation, recognizing biological, social, and economic values, and Ktunaxa world view.

In consideration of the above goal, and taking Teck's future mine development plans into consideration, the permit requires that:

- The tributaries that are **not impacted** by mining activities, that provide relatively high habitat value, and/or support ongoing habitat use by fish and sensitive aquatic dependent wildlife (i.e. directly or indirectly through food production), shall be identified as the highest priority tributaries for permanent **protection**.
- The tributaries that **have been impacted** by mining, provide or have the potential to provide relatively high habitat value, and/or support (or could support) habitat use by fish and sensitive aquatic dependent wildlife, shall be identified as the highest priority tributaries for **restoration/rehabilitation**.

The Tributary Management Plan considers all the tributaries upstream of Sparwood that flow into the Fording River, Michel Creek, or the Elk River and that are currently mine-influenced or could potentially be influenced by future development plans.[17] The Tributary Management Plan does not include the mainstem of the Fording River, Michel Creek, or the Elk River, because these are managed under other regional programs of the EVWQP and under the Regional Fish Habitat Management Plan.

All tributaries considered in recent environmental assessments (Line Creek Operations Phase 2, Fording-Swift, Baldy Ridge Extension, Cougar Pit Extension, and Coal Mountain Operations Phase 2) are also included in the Tributary Management Plan. The Tributary Management Plan does not include tributaries that have been permanently removed or severely altered by mining activities within Teck's current mine permit boundaries.[18] Loss of habitat for these tributaries are governed by the BC Environmental Mitigation Policy and applicable federal and provincial legislation.

In early 2017, the EMC participated in an exercise to prioritize tributaries for protection, rehabilitation, or both.

- Using a prioritization tool developed specifically for this exercise, tributaries were ranked based on biological values.
- EMC members made adjustments and clarifications to these ranks and provided their rationale.
- Results were collated and discussed with the EMC to further adjust rankings.
- Final rankings were decided by Teck.

In deciding on the final rankings, Teck considered the output of the prioritization tool and the written and verbal input from each EMC member. Teck has provided the EMC with a written rationale for their final rankings and described how it considered EMC input throughout the process.

Consensus among the EMC members was not achieved on all priorities, and this was expected. This was the reason for adopting the iterative, transparent approach described above. Although there were some differences among EMC members, many of their rankings were similar. These are all outlined in the 2017 Tributary Management Plan.

The permit requires that the Tributary Management Plan be updated each year to incorporate changes to current and future development plans.

[17] Mine-influenced means that the mine footprint extends into a portion of the tributary's catchment, so the tributary receives water that has been influenced (i.e. changed) as a result of contact with mine works or supporting infrastructure.

[18] Permanently removed or severely altered is defined as: destroyed by pits or covered by waste spoils or altered by mine infrastructure (e.g., sediment ponds) or dewatered.

Adaptive Management

Teck developed and submitted an Adaptive Management Plan to the Director in February 2016. After receiving considerable technical advice from the EMC, Teck revised and resubmitted the plan in July 2016. The KNC informed Teck and the Director of eight key concerns that remained in the revised Adaptive Management Plan. Since then, Teck and the KNC have been working together to address KNC's concerns. In June 2017, after discussions with the KNC, the Director instructed Teck to submit a proposal to revise and re-submit the Adaptive Management Plan. Teck and the KNC co-developed the proposal and Teck submitted the proposal to the Director for approval in December 2017. The Director formally accepted the proposal in January 2018. In that proposal, Teck committed to submitting a revised Adaptive Management Plan in December 2018.

Teck is also required to prepare and submit an annual report that describes the activities it took in each stage of the adaptive management cycle. Because of the work underway to resolve KNC's concerns and develop a proposal for a revised plan, the Director requested a status report instead of an annual report for 2017. Teck submitted this status report in July 2017.

Teck continues to work with the EMC on a revised Adaptive Management Plan, focusing on these areas:

- Continuous improvement
- Key measurement endpoints and triggers
- Refining management questions, key uncertainties, and hypotheses, and aligning with existing monitoring programs
- Groundwater
- Reporting and other refinements
- EMC advice on the July 2016 Adaptive Management Plan

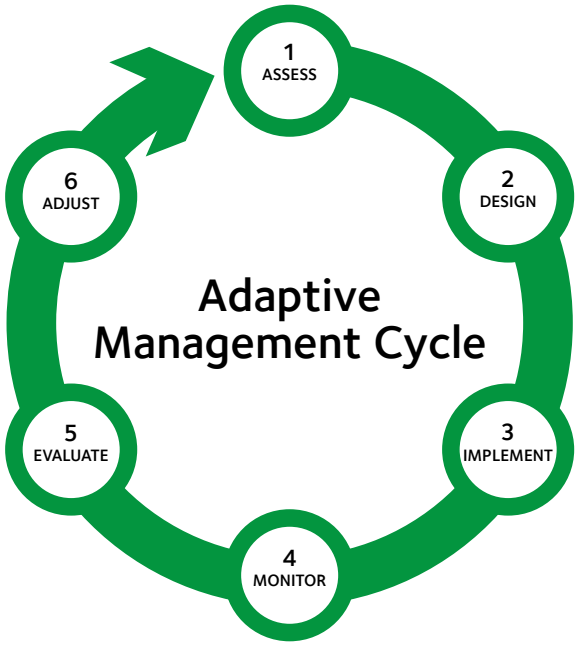
At the same time, Teck and the EMC continue to evaluate results from the various monitoring programs and supporting studies under the permit to determine if the results are producing the information needed to support the Adaptive Management Plan. Teck will continue to use monitoring results to inform and adapt its management actions.

What is Adaptive Management?

It is a systematic, rigorous approach to environmental management structured around a six stage management cycle (a form of the plan-do-check-act management loop).

It focuses on learning about important uncertainties, while at the same time implementing management actions based on the current understanding.

It provides a framework in which management actions are adapted based on what is learned.



Third-Party Audit

Permit 107517 requires Teck to contract a qualified third-party professional to audit the monitoring data and data analyses for reports submitted under the permit. Teck contracted Matrix Solutions Inc. to conduct the audit, and the EMC developed the audit objectives, scope, and criteria. The 2017 audit was the first under Permit 107517.

The scope of the audit covered two topics:

- data quality and completeness
- Teck's standard operating procedures

And four subject areas:

- surface water quality
- acute toxicity
- chronic toxicity
- benthic community structure

The auditors conducted interviews with Teck staff and consultants, and conducted an extensive review of records, including study plans, Teck's standard operating procedures (SOPs), field forms and sampling results, laboratory data (raw and within the database), and reports. No field visits were conducted during this audit.

The auditors noted several positive observations throughout the audit:

- Teck personnel and contractors were supportive of the audit process, helpful, and forthcoming with information.
- Teck had ten relevant SOPs in place and was in the process of developing more data quality-related procedures during the audit.
- During the audit, personnel in Teck's Sparwood office were implementing several new features and improvements within their database, which will support sampling and data quality processes in the future.
- Contractors working on the sampling programs demonstrated engagement with their programs and with the EMC.

The audit resulted in 30 findings, and the auditors provided several recommendations. The audit team found that the monitoring programs evaluated under this audit could be improved by implementing robust and timely evaluations of the data quality and by updating SOPs. Overall, the audit found that the complex surface water quality, acute toxicity, chronic toxicity, and aquatic effects program requirements are generally well-managed by Teck and its consultants.

Since receiving the audit report, Teck has been finalizing new and updated procedures and implementing updated data quality review processes.

Human Health Risk Assessment

Teck submitted the Human Health Risk Assessment Report (HHRA) to the EMC and the Director in March 2016. After reviewing that report, the IHA and the KNC felt the potential health risks to Ktunaxa citizens based on their preferred consumption rates of wild foods were not addressed. In response, Teck submitted a technical memo to the EMC and the Director in September 2016. This memo evaluated and discussed the risks associated with consuming wild foods at the preferred rates that were defined in the Ktunaxa First Nation Diet Study (Firelight 2015). The IHA and the KNC were concerned that two separate documents would be a source of confusion and misunderstanding among community members, decision-makers, and other readers.

The Director has formally acknowledged that he has received Teck's submission of the HHRA and the technical memo and that Teck met the permit deadline, but he has not approved or rejected the report. Instead, he is expecting the KNC, IHA, and Teck to work together to resolve the information gaps and submit an updated HHRA that includes a complete analysis of both current and preferred consumption rates in one report.

The IHA and the KNC, with support from the First Nation Health Authority, have continued to reach out to the Director and the Ministry of Health to express their concerns and seek help to resolve the stalemate over the 2016 HHRA. In a letter to the EMC in May 2018, the IHA indicated that because its concerns have not been addressed it would not participate in the preparation of the 2018 public report or attend the 2018 public meeting.

The EMC has acknowledged that there are information gaps associated with the current preferred consumption rates, and the KNC is now working on an updated preferred consumption rates study. At the same time, Teck will work with the KNC and the IHA to develop the objectives and scope for updating the HHRA, which at this time is targeted for 2020. Teck and the KNC will continue with the wild foods sampling program that measures the concentration of mine-related substances in wild game, fish, and plants. The results from that program will be included in the updated HHRA.

What is a Human Health Risk Assessment?

A human health risk assessment determines the potential risks to human health posed by the presence of contaminants within a defined area. It considers both the exposure to and the toxicity of the contaminants.

Glossary

active water treatment
a method of removing substance from water that requires regular human intervention and management.

acute toxicity
the adverse effects of a substance on an organism that result from either a single exposure or from multiple exposures in a short period of time.

adaptive management
a systematic, rigorous approach to environmental management that focuses on learning about important uncertainties, while at the same time implementing management actions based on the current understanding.

aquatic organisms
animals and plants that live in an aquatic environment.

area-based management plan
an environmental management plan for a designated area under the Environmental Management Act.

baseline
current or existing conditions that serve as a reference point for comparing future conditions.

benchmark
a standard or point of reference against which things may be compared or evaluated. See also effect benchmark and level 1 benchmark.

benthic invertebrates
small organisms that lack backbones and live in or on the bottom of sediments of rivers, streams, and lakes; these include the larvae of aquatic insects, as well as clams, snails, mussels, crayfish, and various other kinds of aquatic worms.

bioaccumulation
the buildup of substances, both toxic and benign, within the body tissues of an organism.

calcite
a mineral made up of calcium, carbon, and oxygen.

calcite index
a numeric expression of the extent and degree of calcite formation; typically given as a range from 0 to 3.

chronic toxicity
the adverse effects of a substance on an organism that result from long-term exposure.

compliance point
a water monitoring station that is immediately downstream from one Teck's mine operations in the Elk Valley.

constituent
an element, substance, or ionic compound

control sample
a sample containing water that has not been modified or impacted by mining, that is subjected to the same analyses as the mine-water being tested; this helps to confirm the quality and reliability of the results. See also lab water.

crustacean
a large, diverse group of invertebrates with an external skeleton.

daily maximum limit
the maximum allowable concentration of a substance in a 24-hour period.

Director
the governmental office within the British Columbia Ministry of Environment and Climate Change that is responsible for issuing permits under the Environmental Management Act and for determining compliance with permit requirements.

discharge, v
flowing from one source into another.

effect benchmark
the concentration of a substance shown to produce a specific level of effect on an organism.

effluent
outflow or waste from human activities that is introduced into water or onto land.

Elk River watershed
the area that includes the Elk River and all of its tributaries.

Environmental Management Act
a British Columbia legislation that regulates release of effluent to water, land, and air.

exposed site/area/stream
sites, areas, or streams that are downstream of mining activities.

groundwater
water that flows beneath the water table, in soils and geologic formations.

hardness, hard water
water with a high content of calcium and magnesium or other dissolved metals.

human health risk assessment
an assessment to determine the potential risks to human health posed by the presence of contaminants within a defined area.

lab water
distilled or city water sometimes used in control samples in laboratory tests.

level 1 benchmark
the concentration above which there is a potential for a 10% effect on the growth or reproduction of an organism.

local aquatic effects monitoring program
programs designed to answer specific questions about aquatic effects that arise because of the unique circumstances of a particular mine operation.

larval stage, larvae
the newly hatched, juvenile form of an animal before metamorphosis into an adult.

monthly average
the average of all samples collected in a calendar month at a sample location.

order station
a location specified by Ministerial Order No. 113 to monitor water quality.

periphyton
freshwater organisms such as algae and bacteria that attach to rocks, plants, suspended particles, and other objects in the water.

phytoplankton
microscopic algae that live in the water column and are food for zooplankton and fish.

pit dewatering
the movement of water from pits to support mine operations

reach
a section of a stream that is typically 100 metres long or more.

reference (stream, area, tributary)
a watercourse that has not been affected by mining activity; typically located upstream of mine operations.

regional aquatic effects monitoring program
a long-term monitoring program to assess potential regional-scale effects in the aquatic environment downstream of mining operations within the Elk River watershed.

site performance objective
an authorized limit or standard set by the Director for specific location.

tributary
a river, stream, or creek flowing into a larger river or lake.

water quality guideline
the recommended limit for the concentration of a substance in the water to protect ecological or human health; may be federal or provincial.

water quality limit
an authorized limit for the concentration of a substance in the water set by the Director for specific location.

wild foods
food that is harvested through hunting, gathering, and fishing.

zooplankton
tiny invertebrates that live in the water column and are food for many fish species.

Appendix A:
The Ktunaxa Nation and the Elk Valley

The Ktunaxa Nation is made up of all Ktunaxa citizens residing both within and outside of **Ktunaxa ʔamakʔis**, including the member communities and their citizens. The northern portion of **Ktunaxa ʔamakʔis** has historically been claimed by Canada, while the southern half is claimed by the United States. In Canada, the member communities of the Ktunaxa Nation include, **ʔakink'umɬasnuqɬiʔit** (Tobacco Plains Band), **ʔaq̓am** (formerly known as St. Mary's Band), **yaqan nuʔkiy** (Lower Kootenay Band), and **ʔakisq'nuk** (Columbia Lake Band). The Ktunaxa Nation maintains unceded Aboriginal title in much of what is now considered the East and West Kootenays. Ktunaxa communities south of the Canada-USA border are located in what is now Idaho and Montana. The Elk Valley, which is wholly within the unceded and unsurrendered territory of the Ktunaxa has been occupied continuously by the Ktunaxa Nation since time immemorial, and is maintained as Aboriginal title by the Ktunaxa Nation. The British Columbia (BC) portion of the traditional territory is subject to ongoing treaty negotiations with the Province of BC and the Government of Canada.

The Elk Valley was traditionally used and occupied by the Ktunaxa Nation. Important Ktunaxa settlements were maintained in the Elk Valley well into the 20th century, and Ktunaxa citizens continue to reside throughout the lower Elk Valley, including in Sparwood, Fernie, and elsewhere. Ktunaxa oral histories, supported by historic archival and ethnographic data, suggest that Ktunaxa presence in the Elk Valley has long been centred on an important habitation area named **ḵ aqawakanmituk**, a Ktunaxa settlement at the confluence of Michel Creek and the Elk River near present-day Sparwood. This is a very important cultural area in the Elk Valley. It was occupied annually, and likely for a long period of time up to the late 1800's, by the Michel Prairie people, also referred to as the Fernie Band, or **ḵ aqawakanmitukniḵ**. This was a historic Ktunaxa community with close ties to the current Ktunaxa community of Tobacco Plains whose annual round included hunting bison on the eastern slopes of the Rocky Mountains. As described further below, many Michel Prairie people died as a result of early smallpox epidemics, likely in the late 1700s.The settlement of **ḵ aqawakanmituk** at Michel Prairie included important tobacco cultivation areas, as well as habitation areas, processing areas, and other features including trails that connected the valley to mountain passes to the east. While there are no reserve lands in the Elk Valley, the Ktunaxa understand that reserve areas were promised in the area of Michel Flats and present day Sparwood, but were never formally allotted.

The Elk Valley itself falls within the Ktunaxa traditional land district of **qukinʔamakʔis**. **Qukin ʔamakʔis** is translated as Raven's Territory, Raven's Land or the Land of Raven. It is also sometimes used as a synonym for the Elk Valley because the valley and its surrounding mountains make up the majority of the lands associated with Raven. Today, the Elk Valley is known to Ktunaxa peoples not only for the richness of its fish and game but also for the presence of coal and extensive coal mining, and the associated restrictions on access to mining lands, many of which are private. For the Ktunaxa Nation, the history of coal mining in the Elk Valley, including recent history, has been a story of exclusion with more than a century of efforts by non-Ktunaxa individuals and companies to extract **qukin nuʔkiy** (Raven's Rock, or Coal) from **qukinʔamakʔis** (Raven's Land). Available information (archival and ethnographic), as well as oral histories and archaeology, supports an understanding that the Elk Valley in general, and specifically the upper Elk River, including areas around Michel Creek, Line Creek, Grave Creek, Round Prairie, and the Fording River, has been continuously used and occupied by Ktunaxa peoples, and specifically Upper Ktunaxa peoples, for hundreds of years prior to 1846.

Water is fundamental to the Ktunaxa creation story, and is understood by Ktunaxa knowledge holders to be the basis for all living things within **Ktunaxa ʔamakʔis**. Rivers, streams, lakes, and riparian areas provide essential habitat for the fish, and many of the animals and plants that Ktunaxa harvesters rely on, and responsible stewardship of water is a critical component of Ktunaxa responsibility. The Ktunaxa principle **ofʔa'kxam̓ is q̓** apiqapsin is translated to mean a responsibility for stewardship of all living things. Within the borders claimed by Canada and British Columbia, the **ʔamakʔis** of the Ktunaxa Nation covers approximately 70,000 km2 (27,000 square miles) of mountains, valleys, rivers and lakes in the Kootenay region. The region's landscape is alive with Ktunaxa culture and history. The Ktunaxa creation story relates the origins of the Ktunaxa people and describes the events and relationships that helped shape—and continue to shape—**Ktunaxa ʔamakʔis**. The geography of the Elk Valley is formed in the final events of the story, when the animal chief and creation hero, **Naɬmuqƛin**, collapses, forming the Rocky Mountains with his body.

Ktunaxa Law

Ktunaxa law (**ʔaknumuɬtiťiť**) and oral history (**ʔaqaťq'anuxwatiť**) are both sacred and legal in nature. Ktunaxa land use rights are based on a sacred covenant with the Creator, whereby, in exchange for the land providing the Ktunaxa with the necessities of life, the Ktunaxa are responsible as stewards of the lands and resources in **Ktunaxa ʔamakʔis**. The Ktunaxa have terms that address the natural world and how people are a part of it. **ʔakuk'pukam** speaks to anything that gets life from the earth through roots. **ʔakuk'pukamnam** adds the human dimension, whereby the earth's life is translated into human life. That is, the Ktunaxa have roots that tie them to **Ktunaxa ʔamakʔis**, and they are of the earth. In other words, they believe that what they do to the earth, they do to themselves and to future generations. The Ktunaxa phrase that captures interconnectedness and the stewardship concepts applicable to land management is **YaqaťHankatiťiťkinaʔamak**. This phrase translates to "our people care for the land, the land cares for our people."

More information on the Ktunaxa laws and principles can be found in Section C for the Baldy Ridge Expansion project found on the Environmental Assessment Office website (**https://projects.eao.gov.bc.ca/p/baldy-ridge-extension/docs**).

Ktunaxa Creation Story

In ancestral times referred to by the Ktunaxa as the animal world, there were references made many times by the Creator to when there will be ʔaqɬmakniƛ̓ (people).

At that time, there was some disturbance caused by a huge sea monster known as Yawuʔniƛ̓, who killed many of the animals. A council was called by the Chief animal, Naɬmuqɕin. Naɬmuqɕin was huge. He was so tall that he had to crawl on his hands and knees, for if he stood up his head would hit the ceiling of the sky.

It was decided that Yawuʔniƛ̓ had to be destroyed. A war party was formed. Yawuʔniƛ̓ plied the Kootenay and Columbia River System including Columbia Lake and Arrow Lakes.

Yawuʔniƛ̓ was sighted in the Columbia Lake near Yaqaʕn Nuʔkiy and the chase was on. At that time, the Kootenay River and the Columbia Lake were joined. As the chase proceeded, Naɬmuqɕin gave names to many locations along the Kootenay River, Kootenay Lake, Arrow Lakes and the Columbia River.

Yawuʔniƛ̓ was pursued down the Kootenay River past the Wasa sloughs, now called Wasa, BC. Skinkuɕ got into trouble here when he fell into the river and had to be rescued by Wasa, (horse-tail).

The chase went by where the St. Maryʓs River empties into the Kootenay River. ʔaq̓am, where the St. Maryʓs Reserve is now located, then on down river to Kanƛ̓ak (spring) where Mayuk (weasel) joined the war party. There were animals on both sides of the river as the chase continued, and among the party was a parasite, ʔaʕkukɬakuwum, who had to be carried on the backs of other animals. His name was Ƈumtus and he was mean and bossy. The other animals grew tired of his nagging and dumped him into the river at a place now known as Yaqakiɬ wat̓mitquɬiɬki Ƈumtus.

Leaving the land of the Eagle, ʔaʕknuqɬuɬam̓ʔamaƛ̓is and into the land of the woodtick, Ƈam̓na ʔAmakis, past Wasaʔki (Waldo) then on past the now 49th Parrallel and then past Kaxax (Turtle), now underwater, near Rexford, Montana. The chase went on by ʔaʕkiʔyi (jennings) and on by ʔaqswaq (libby) then into Skinkuɕ ʔAmakis (the land of Coyote), past ʔaq̓anqmi (Bonners Ferry, Idaho) then northerly past the now international boundary into ʔaɕpu ʔamakis, the land of the Wolverine, past Yaqaʕn Nuʔkiy (Creston, BC) then up the Kootenay Lake past ʔaq̓asqnuk, (Kuskannok, BC). The chase went on by ʔAkuqɬi (Akokli Creek), past Ksanka Creek. The Yawuʔniƛ̓ chose to follow the Kootenay River past ʔaqyamɬup (Nelson, BC). The chase was now in Miɕqaqas ʔamakis (the land of Chickadee).

At Kiƛ̓siɬuk, (Castlegar, BC) Yawuʔniƛ̓ went north into the Arrow Lakes, past ʔakinƛ̓aʔnuk (Arrow Rock) where arrows were shot into a crevice in the rock. If the arrow was true, the journey continued, if the mark was missed, beware, danger ahead. The arrow was true and the journey continued past Ƈaɬnuʔniƛ̓ (Nakusp) then up past Ktunwakanmituk Miɕqaqas (Revelstoke, BC) where the Columbia River flows into the Arrow Lakes, then up and around The Big Bend then down past ʔaknuqɬuk (Golden, BC) past Yaknusuʔki (Briscoe, BC) then on past Yakyuɕki. The chase carries on through Kwataq̓nuk (Athalmere) then past Kananuk (Windermere, BC) past ʔakiskq̓nuk (Windermere Lakes), then back into the Columbia Lake, Yaqaʕn Nukiy, (Canal Flats, BC). This completed the cycle of the chase.

Yawuʔniƛ̓ would once again escape into the Kootenay River and the chase would go on. The chase would go on and on. Every time the war party thought they had Yawuʔniƛ̓ cornered, Yawuʔniƛ̓ would escape again.

One day sitting on the river bank observing the chase was a wise old one named Kiƛ̓um. Kiƛ̓um told Naɬmuqɕin, You are wasting your time and energy chasing the monster. Why not use your size and strength and with one sweep of your arm, block the river from flowing into the lake and the next time the monster enters the lake you will have him trapped. Naɬmuqɕin took the advice of Kiƛ̓um and did as he was told. The next time Yawuniƛ̓ entered the lake, he was trapped.

Having successfully corralled Yawuʔniƛ̓, a decision had to be made as to whom the honor of killing Yawuʔniƛ̓ would be bestowed upon. The honor was awarded to Yamakpaɬ (Red-headed Woodpecker).

When Yawuʔnik̓ was killed, he was taken ashore and butchered and distributed among the animals. There remained only the innards and bones. The ribs were scattered throughout the region and now form the Hoo Doos seen throughout the area.

Na+lmuqƛin then took the white balloon-like organ, known as the swim bladder, and crumbled it into small pieces and scattered it in all directions saying, 'These will be the white race of people'. He then took the black ingredient from the inner side of the backbone, the kidney, and broke it into small pieces and scattered them in all directions declaring,'These will be the black race'. He then took the orange roe and threw the pieces in all directions saying,'These will be the yellow race of people'.

Na+muqƛin looked at his bloody hands and reached down for some grass to wipe his hands. He then let the blood fall to the ground saying, 'This will be the red people, they will remain here forever'.

Na+muqƛin, in all the excitement, rose to his feet and stood upright hitting his head on the ceiling of the sky. He knocked himself dead. His feet went northward and is today know as Ya·+iki, in the Yellowhead Pass vicinity. His head is near Yellowstone Park in the State of Montana. His body forms the Rocky Mountains.

The people were now keepers of the land. The spirit animals ascended above and are the guiding spirits of the people.

Ktunaxa Nation website: Ktunaxa.org

Appendix B:
List of 2017 Technical Reports Available Online

A number of Teck's technical reports are now available online. Most of these reports are those that have been reviewed by the Environmental Monitoring Committee and submitted to the Director under Permit 107517. Some reports are provided as additional information, but are not formally reviewed by the EMC.

You can find the technical reports at: https://www.teck.com/responsibility/sustainability-topics/water/water-quality-in-the-elk-valley/research-and-monitoring-reports/

- Third-Party Audit 2017 Report (October 2017)
- Water Quality Model 2017 Update Overview Report (October 2017)
- Upper Fording River Westslope Cutthroat Trout Population Monitoring Project, 2012-2017 (December 2017)
- Elk River Watershed Regional Aquatic Effects Monitoring Program (RAEMP) Report, 2015-2016 (January 2018)
- Selenium Bioaccumulation Model 2017 Update Report (January 2018)
- Annual Water Quality Monitoring 2017 Report (March 2018)
- Final Interpretive Report: Chronic Toxicity Testing of Nitrate and Sulphate to Support Permit Requirements (March 2018)
- Chronic Toxicity Testing Program 2017 Report (April 2018)
- Fording River Operations Local Aquatic Effects Monitoring Program 2017 Report (May 2018)
- Greenhills Operations Local Aquatic Effects Monitoring Program 2017 Report (May 2018)
- Line Creek Operations Local Aquatic Effects Monitoring Program 2017 Report (May 2018)
- Calcite Monitoring Program 2017 Report (May 2018)
- Regional Groundwater Monitoring Program 2017 Report (May 2018)
- Monitoring the Relationship of Calcite with Fish Spawning and Incubation 2017 Report (June 2018)
- Koocanusa Water Quality 2017 Report (June 2018)

Feedback Form

Please contact the independent facilitator for the Environmental Monitoring Committee if you have questions about this report, the Committee, or the science-based advice it provides.

Contact Information:
Environmental Monitoring Committee
Lynne Betts, Independent Facilitator
emcpermit107517@gmail.com

☐ Notify me about the EMC's annual public meetings and reports.

I would like to request the EMC's advice or input, plus feedback from Teck on the following:

☐ Surface Water Quality

☐ Toxicity Testing

☐ Groundwater

☐ Regional Aquatic Effects

☐ Local Aquatic Effects

☐ Koocanusa

☐ Tributary Management

☐ Adaptive Management

☐ Third Party Audit

☐ Human Health Risk Assessment

Name: _____

Affiliation (if any): _____

Email: _____ Phone: _____

Notes

Notes