Elk Valley Water Quality Plan

2022 Implementation Plan Adjustment

Annex C - Projected Concentrations of Nitrate, Selenium and Sulphate

Rev0

July 2022

Teck

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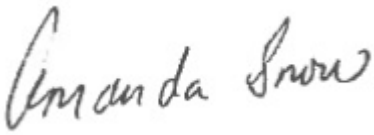

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1 Introduction

The projected concentrations of nitrate, selenium, and sulphate at Order Stations, compliance points and in LCO Dry Creek are presented in this document with mitigation based on the 2022 Implementation Plan Adjustment (IPA). The 2022 IPA is an update to the *Elk Valley Water Quality Plan 2019 Implementation Plan Adjustment* (2019 IPA; Teck 2019). The 2022 IPA outlines Teck's updated mitigation plan to meet the long-term water quality-based compliance limits and Site Performance Objectives (SPOs) for nitrate, selenium, and sulphate defined in *Environmental Management Act* Permit 107517.

The 2022 IPA was developed using the 2020 Regional Water Quality Model (RWQM) described in Teck (2021a), and updated as outlined in Annex A. The 2022 IPA was developed considering existing waste rock through 2019 and all permitted development. It does not consider any future planned development that has not been approved. The model period encompasses the full duration of permitted development, plus additional time to account for the full effects of loading from the permitted waste rock and from pit decanting. The purpose is to demonstrate how the 2022 IPA will manage the full effects of permitted development and to form the base case for future mining permit applications.

The 2022 IPA was developed based on refinements and additions to both the decisions (i.e., the sources to target for treatment and how quickly treatment could be constructed) and assumptions (i.e., the effluent quality from treatment, release rates, and water availability for treatment) used to set the 2019 IPA. Refinements and additions resulted from Teck's learning since the 2019 IPA and constitute the basis on which the 2019 IPA was adjusted. The updated understanding was reflected in the water quality modelling completed to support the development of the 2022 IPA and is expected to be adjusted over time. The water related inputs used to inform the 2022 IPA are summarized in the main report.

The 2022 IPA is based on the application of Saturated Rock Fills (SRFs), active water treatment facilities (AWTFs), and clean water diversions where practical to support efficient treatment, to address increasing nitrate, selenium, and sulphate water concentrations in the Elk Valley. The expected performance of SRFs and AWTFs, in terms of effluent concentrations, as well as the clean water diversions incorporated into the 2022 IPA are outlined in the main report. A summary of the mitigation included in the 2020 RWQM for the 2022 IPA is provided in Tables 1-1 and 1-2.

Projected monthly average concentrations of nitrate, selenium, and sulphate at Order Stations, compliance points and in LCO Dry Creek are presented in Section 2. A summary of the projected monthly average influent concentrations of nitrate, selenium, and sulphate for each SRF and AWTF are provided in Section 3. Section 3 also includes a summary of the projected monthly average loads of nitrate, selenium, and sulphate removed by each SRF or AWTF and a reference to Appendix A, which contains plots of projected monthly average influent concentrations and loads removed by each SRF or AWTF and Appendix B, which contains monthly hydrographs of treated flows. Results of the sensitivity analyses are presented in Section 4, with reference to Appendices C through I, which contain projected monthly average concentrations of nitrate, selenium, and sulphate at Order Stations, compliance points, and in LCO Dry Creek as appropriate, for each sensitivity analysis. Projected monthly average concentrations of nitrate, selenium, and sulphate at Order Stations, compliance points, and in LCO Dry Creek with and without mitigation are provided in Appendix J.

Table 1-1: Mitigation Included in the 2020 Regional Water Quality Model for the 2022 Implementation Plan Adjustment for Nitrate and Selenium

Site	Sources Targeted for Treatment / Diversion	Treatment Vessel / Associated Diversions	Maximum Hydraulic Capacity (m^3/d)	Associated Diversions and Conveyance of Mine-Influenced Water	Operational Date in the 2020 RWQM[a]
FRO	Swift Creek Cataract Creek Kilmarnock Creek[b]	FRO AWTF-S	20,000	• Convey combined Swift/Cataract and Kilmarnock to the AWTF • Discharge equivalent proportion of treated effluent from Swift and Cataract to the Fording River • Discharge equivalent proportion of treated effluent from Kilmarnock Creek to Kilmarnock Creek	September 1, 2022
	Upper Kilmarnock Creek	Kilmarnock Creek Diversion	86,000	• Convey upper Kilmarnock Creek downstream of Kilmarnock intake	December 31, 2021
	Eagle 4 Pit	FRO-N 1 SRF Phase I	9,500	• Convey water from Eagle 4 Pit to SRF • Discharge treated effluent to Clode Creek	December 31, 2022
	Clode Creek Liverpool Ponds/Swift Pit Post Ponds	FRO-N 1 SRF Phase II	20,500	• Convey water from Clode, Liverpool Ponds/Swift Pit, and Post Ponds to SRF • Discharge treated effluent to Clode Creek	December 31, 2023
	Clode Creek Liverpool Ponds/Swift Pit Post Ponds Eagle Pond	FRO-N 1 SRF Phase III	10,000	• Convey water from Clode, Liverpool Ponds/Swift Pit, Post Ponds and Eagle Pond to SRF • Discharge treated effluent to Clode Creek	December 31, 2025
	Clode Creek Liverpool Ponds/Swift Pit Post Ponds Eagle Pond Kilmarnock Creek	FRO-N 2 SRF Phase I	20,000	• Convey water from Clode, Liverpool Ponds/Swift Pit, Post Ponds and Eagle Pond to SRF • Convey water from Kilmarnock Creek (not treated at the FRO AWTF-S) to SRF • Discharge equivalent proportion of treated effluent from Clode, Liverpool Ponds/Swift Pit, Post Ponds and Eagle Pond to Clode Creek • Discharge equivalent proportion of treated effluent from Kilmarnock Creek to Kilmarnock Creek	December 31, 2026
		FRO-N 2 SRF Phase II	15,000		Post 2100
	Eagle 6 Pit North and South	Eagle 6 SRF Phase I	6,500	• Convey Eagle 6 Pit North and South to SRF • Discharge treated effluent to Kilmarnock Creek	June 30, 2033
		Eagle 6 SRF Phase II	2,500		Post 2090
LCO	West Line Creek surface water Mine Services Area West[c] Line Creek	WLC AWTF	7,500	• Convey water from West Line Creek, Mine Services Area West, and Line Creek to AWTF • Discharge treated effluent to Line Creek	January 1, 2020
	North Line Creek North Line Extension Pit Mine Services Area West West Line Creek surface water Line Creek LCO Dry Creek	NLC SRF Phase I	12,500	• Convey water from North Line Creek, North Line Extension Pit, and Mine Services Area West, West Line Creek and Line Creek (water not treated at the WLC AWTF) to SRF • Convey water from LCO Dry Creek to SRF • Discharge equivalent proportion of treated effluent from Line Creek sources to Line Creek • Discharge equivalent proportion of treated effluent from LCO Dry Creek to LCO Dry Creek upstream of the conveyance intake	December 31, 2025
	North Line Creek North Line Extension Pit Mine Services Area West West Line Creek surface water West Line Creek groundwater[d] Line Creek	NLC SRF Phase II	10,000	• Convey water from North Line Creek, North Line Extension Pit, and Mine Services Area West, West Line Creek surface water, West Line Creek groundwater, and Line Creek (water not treated at the WLC AWTF) to SRF • Discharge equivalent proportion of treated effluent from Line Creek sources to Line Creek	December 31, 2030
	North Line Creek North Line Extension Pit Mine Services Area West West Line Creek surface water West Line Creek groundwater[d] Line Creek LCO Dry Creek	NLC SRF Phase III	17,500	• Convey water from North Line Creek, North Line Extension Pit, and Mine Services Area West, West Line Creek surface water, West Line Creek groundwater, and Line Creek (water not treated at the WLC AWTF) to SRF • Convey mine-influenced water from LCO Dry Creek to SRF • Discharge equivalent proportion of treated effluent from Line Creek sources to Line Creek • Discharge equivalent proportion of treated effluent from LCO Dry Creek to LCO Dry Creek upstream of the conveyance intake	December 31, 2033
	Upper Line Creek Horseshoe Creek No Name Creek	Upper Line Creek Diversion Horseshoe Creek Diversion No Name Creek Diversion	42,000	• Convey water from unaffected areas in Upper Line Creek, Horseshoe Creek and No Name Creek downstream of the Line Creek intake	December 31, 2025
	LCO Dry Creek	Conveyance / Supplementation	30,000	• Convey water from LCO Dry Creek to the Fording River • Supplement flow in LCO Dry Creek with water from the Fording River	March 29, 2023

Table 1-1: Mitigation Included in the 2020 Regional Water Quality Model for the 2022 Implementation Plan Adjustment for Nitrate and Selenium

Site	Sources Targeted for Treatment / Diversion	Treatment Vessel / Associated Diversions	Maximum Hydraulic Capacity (m^3/d)	Associated Diversions and Conveyance of Mine-Influenced Water	Operational Date in the 2020 RWQM[(a)]
EVO	F2 Pit Erickson Creek Natal Pit	EVO SRF Phase I	20,000	• Convey mine-influenced water from Erickson Creek and Natal Pit to SRF • Discharge equivalent proportion of treated effluent from Erickson Creek to Erickson Creek • Discharge equivalent proportion of treated effluent from Natal Pit to Bodie Creek	September 1, 2021
	EVO Dry Creek	EVO SRF Phase II	4,000	• Convey mine-influenced water from EVO Dry Creek to SRF • Discharge equivalent proportion of treated effluent to EVO Dry Creek, with the returned water possibly being subject to sulphate treatment prior to discharge to EVO Dry Creek from December 31, 2033 onward	September 30, 2023
	F2 Pit Erickson Creek Natal Pit	EVO SRF Phase III	15,000	• Convey mine-influenced water from Erickson Creek and Natal Pit to SRF • Discharge equivalent proportion of treated effluent from Erickson Creek to Erickson Creek • Discharge equivalent proportion of treated effluent from Natal Pit to Bodie Creek	December 31, 2027
	EVO Dry Creek	EVO SRF Phase IV	3,000	• Convey mine-influenced water from EVO Dry Creek to SRF • Discharge equivalent proportion of treated effluent to EVO Dry Creek, with the returned water possibly being subject to sulphate treatment prior to discharge to EVO Dry Creek	December 31, 2036
	Baldy Ridge Pit Erickson Creek Natal Pit	BRP SRF	5,000	• Convey mine-influence water from Erickson and Natal (not treated at the EVO SRF) to the BRP SRF • Discharge equivalent proportion of treated effluent from Erickson Creek to Erickson Creek • Discharge equivalent proportion of treated effluent from Natal Pit to Bodie Creek	December 31, 2042
GHO	Greenhills Creek	GHC treatment	3,000	• Convey mine-influenced water from Greenhills Creek to treatment • Discharge treated effluent to Greenhills Creek	December 31, 2027
	Cougar South Pit Leask, Wolfram and Thompson Porter Creek	CSP SRF	5,000	• Convey mine-influenced water from Leask Creek, Wolfram Creek, Thompson Creek, and Porter Creek to SRF • Discharge treated effluent to Thompson Creek(e)	June 30, 2042
Total[(f)]			**206,500**		

AWTF = Active Water Treatment Facility; AWTF-S = Active Water Treatment Facility South; BRP = Baldy Ridge Pit; CSP = Cougar South Pit; EVO = Elkview Operations; FRO = Fording River Operations; FRO-N = Fording River Operations North; GHC = Greenhills Creek; LCO = Line Creek Operations; RWQM = Regional Water Quality Model; SRF = Saturated Rock Fill; WLC = West Line Creek; m^3/d = cubic metre per day.

(a) The operational date is the date when facility commissioning activities are complete, any subsequent ramp-up activities are complete, and the facility is operating as designed.

(b) Collection and treatment of Kilmarnock Creek groundwater is planned to begin by December 31, 2026.

(c) Collection and treatment of Mine Services Area West is planned to begin by June 30, 2023.

(d) Collection and treatment of West Line Creek groundwater is planned to begin by December 31, 2029.

(e) This is a simplified assumption for early planning purposes. The water return conveyance will be assessed during project design.

(f) The total maximum hydraulic capacity excludes the capacities for the Kilmarnock, Upper Line Creek, Horseshoe Creek, and No Name Creek diversions, as well as conveyance and supplementation in LCO Dry Creek.

Table 1-2: Mitigation Included in the 2020 Regional Water Quality Model for the 2022 Implementation Plan Adjustment for Sulphate

Site	Sources Targeted for Treatment / Diversion	Treatment Vessel / Associated Diversions	Maximum Hydraulic Capacity (m^3/d)	Associated Diversions and Conveyance of Mine-Influenced Water	Operational Date in the 2020 RWQM[a]
FRO	Swift Creek Cataract Creek Kilmarnock Creek[b]	FRO AWTF-S	8,500	• Convey combined Swift/Cataract and Kilmarnock to the AWTF • Treated effluent directed to nitrate and selenium treatment	December 31, 2026
	Upper Kilmarnock Creek	Kilmarnock Creek Diversion	86,000	• Convey upper Kilmarnock Creek downstream of Kilmarnock intake	December 31, 2021
	Clode Creek Liverpool Ponds/Swift Pit Post Ponds Eagle Pond	FRO-N treatment	12,500	• Convey water from Clode, Liverpool Ponds/Swift Pit, Post Ponds and Eagle Pond to treatment • Treated effluent directed to nitrate and selenium treatment	December 31, 2030
LCO	West Line Creek surface water Mine Services Area West[c] Line Creek	WLC AWTF Phase I	2,500	• Convey West Line Creek, Mine Services Area West, and Line Creek to AWTF • Treated effluent directed to nitrate and selenium treatment	December 31, 2025
	West Line Creek surface water Mine Services Area West West Line Creek groundwater[d] Line Creek	WLC AWTF Phase II	2,500		December 31, 2030
	Upper Line Creek Horseshoe Creek No Name Creek	Upper Line Creek Diversion Horseshoe Creek Diversion No Name Creek Diversion	42,000	• Convey water from unaffected areas in Upper Line Creek, Horseshoe Creek and No Name Creek downstream of the Line Creek intake	December 31, 2025
	LCO Dry Creek	LCO Dry Creek treatment Phase I	2,500	• Convey mine-influenced water from LCO Dry Creek to treatment • Treated effluent directed to nitrate and selenium treatment	December 31, 2029
		LCO Dry Creek treatment Phase II	2,500		December 31, 2032
		LCO Dry Creek treatment Phase III	2,500		December 31, 2037
	LCO Dry Creek	Conveyance / Supplementation	30,000	• Convey water from LCO Dry Creek to the Fording River • Supplement flow in LCO Dry Creek with water from the Fording River	March 29, 2023
EVO	EVO Dry Creek	EVO Dry Creek treatment Phase I	2,500	• Convey mine-influenced water from EVO Dry Creek to treatment • Discharge treated effluent to EVO Dry Creek	December 31, 2033
		EVO Dry Creek treatment Phase II	2,000		December 31, 2038
Total[e]			**38,000**		

AWTF = Active Water Treatment Facility; AWTF-S = Active Water Treatment Facility South; EVO = Elkview Operations; FRO = Fording River Operations; FRO-N = Fording River Operations North; LCO = Line Creek Operations; RWQM = Regional Water Quality Model; WLC = West Line Creek; m^3/d = cubic metre per day.

(a) The operational date is the date when facility commissioning activities are complete, any subsequent ramp-up activities are complete, and the facility is operating as designed.

(b) Collection and treatment of Kilmarnock Creek groundwater is planned to begin by December 31, 2026.

(c) Collection and treatment of Mine Services Area West is planned to begin by June 30, 2023.

(d) Collection and treatment of West Line Creek groundwater is planned to begin by December 31, 2029.

(e) The total maximum hydraulic capacity excludes the capacities for the Kilmarnock, Upper Line Creek, Horseshoe Creek, and No Name Creek diversions, as well as conveyance and supplementation in LCO Dry Creek.

2 Projected Concentrations of Nitrate, Selenium and Sulphate with the 2022 Implementation Plan Adjustment

Monthly average concentrations of nitrate, selenium, and sulphate at Order Stations, compliance points and in LCO Dry Creek projected to be above SPOs, compliance limits, targeted receiving environment objectives and/or discharge criteria are summarized in Tables 2-1 to 2-3, respectively.

Projected monthly average concentrations of nitrate, selenium, and sulphate at Order Stations, compliance points and in LCO Dry Creek are shown in Figures 2-1 to 2-8, respectively. Two figures are shown with monthly average selenium concentrations in Koocanusa Reservoir: one from the 2020 RWQM and one from the Koocanusa Reservoir Module. The Koocanusa Reservoir Module accounts for dam operations and storage volumes in the reservoir (Teck 2021b). The format of the figures is as follows:

- The x-axis runs from the start of 2004 (for selenium and sulphate) or 2006 (for nitrate) to the end of 2140. The start date corresponds to the start of the calibration period for the 2020 RWQM. The end date (2140) corresponds to the modelled time period at which all permitted waste rock has been deposited and the lag associated with that rock has passed (i.e., all waste rock is contributing nitrate, selenium, and sulphate load) and water volumes in all mine pits are either being actively managed or are decanting to the receiving environment.
- Projected 10th percentile (P_{10}), 50th percentile (P_{50}), and 90th percentile (P_{90}) monthly average concentrations produced using the 2020 RWQM are shown as solid orange, blue and grey lines, respectively.
- Measured monthly average concentrations are shown as green points.
- Modelled information shown prior to 2020 was developed based on calibrated flows. Those shown thereafter were developed using multiple climate realizations, as described in the 2020 update (Teck 2021a).
- Compliance limits and discharge criteria are shown as a solid black line, SPOs and targeted environment receiving objectives are shown as a solid green line.
- The fully effective dates for the SRFs and AWTFs have been excluded from these figures for visual simplicity.

The 2022 IPA includes active management of the water volume in Natal Pit at EVO (i.e., 5,000 m^3/day of water is pumped year-round from Natal Pit to the EVO SRF until December 31, 2027 and 20,000 m^3/d of water is pumped year-round from Natal Pit to the EVO SRF from January 1, 2028 onward, thereby controlling the timing of pit filling and decant), and passive management of other pits (i.e., all other pits are allowed to passively fill and decant over time, without active management of pit water volumes).

Projected hardness values used to calculate the hardness-dependant SPOs for nitrate at the GHO Fording River Compliance Point (GH_FR1; 0200378) and in the Fording River downstream of Line Creek (LC_LC5; 0200028) are presented in Tables 2-4 and 2-5, respectively. Projected hardness values used to calculate the hardness-dependent targeted receiving environment objective in LCO Dry Creek are presented in Table 2-6. For all locations and each year, the hardness-dependant SPO or targeted receiving environment objective for nitrate is calculated using the minimum hardness value from the month when the maximum nitrate concentration is projected to occur.

Table 2-1: Summary of Projected Monthly Average Nitrate Concentrations above Site Performance Objectives or Compliance Limits between 2022 and 2140

Location		Year[a]	Month	Maximum Projected Concentration (mg/L)	Corresponding SPO / Limit (mg/L)	Maximum Magnitude of Exceedance (mg/L)
Order Stations	Fording River downstream of Greenhills Creek (GH_FR1; 0200378)	2022 to 2023	August to April	20.9	14.0[b]	6.9
	Elk River upstream of Grave Creek (EV_ER4; 0200027)	2022 to 2025	August to April	6.7	4.0	2.6
		2026 to 2027	November to March	4.0	3.5	0.5
	Elk River downstream of Michel Creek (EV_ER1; 0200393)	2022 to 2025	July to August and October to April	4.1	3.0	1.1
Compliance Points	FRO Compliance Point (FR_FRABCH; E223753)	2022 to 2023	August to May	29.5	18.0	11.5
		2024 to 2028	August to May	19.8	12.0	7.8
	GHO Fording River Compliance Point (GH_FR1; 0200378)	2022 to 2023	August to April	20.9	14.0	6.9
		2024 to 2027	August to April	15.2	11.0	4.2
	LCO Compliance Point (LC_LCDSSLCC; E297110)	2022 to 2025	January to December	13.2	7.0	6.2
LCO Dry Creek	LCO Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)	2022 to 2024	June to April	96.6	15.0	81.6

FRO = Fording River Operations; EVO = Elkview Operations; LCO = Line Creek Operations; SPO = Site Performance Objective; mg/L = milligrams per litre.

(a) Compliance summary is for 2022 and onward; historical compliance is based on monthly average measured concentrations for samples collected at the Order Stations and compliance points and therefore not included in this summary table.

(b) SPOs for nitrate at GH_FR1 as of 2023 are hardness dependent based on the following formula: Level 1 benchmark for the Fording River N as mg/L = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$. Values in the table above were calculated based on a hardness of 360 mg/L.

Table 2-2: Summary of Projected Monthly Average Selenium Concentrations above Site Performance Objectives or Compliance Limits between 2022 and 2140

Location		Year[a]	Month	Maximum Projected Concentration (µg/L)	Corresponding SPO / Limit (µg/L)	Maximum Magnitude of Exceedance (µg/L)
Order Stations	Fording River downstream of Greenhills Creek (GH_FR1; 0200378)	2022 to 2023	December to April and August to September	85	63	22
		2024 to 2025	January to March	60	57	3
	Fording River downstream of Line Creek (LC_LC5; 0200028)	2022 to 2023	August and September and December to March	64	51	13
		2024 to 2026	August to March	50	40	10
	Elk River upstream of Grave Creek (EV_ER4; 0200027)	2022 to 2023	December to March	27	23	4
		2024 to 2025	December to March	22	19	2
	Koocanusa Reservoir (RG_DSELK; E300230	2022 to 2027	February to May	2.8	2.0	0.8
Compliance Points	FRO Compliance Point (FR_FRABCH; E223753)	2022 to 2023	August and January to April	122	85	37
		2024 to 2027	November to April	73	58	15
	GHO Fording River Compliance Point (GH_FR1; 0200378)	2022 to 2023	December to April and August to September	85	63	22
		2024 to 2025	January to March	60	57	3
	LCO Compliance Point (LC_LCDSSLCC; E297110)	2022 to 2025	September to April	69	50	19
LCO Dry Creek	LCO Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)	2022 to 2023	July to April	198	70	128

FRO = Fording River Operations; LCO = Line Creek Operations; SPO = Site Performance Objective; µg/L = micrograms per litre.
(a) Compliance summary is for 2022 and onward; historical compliance is based on monthly average measured concentrations for samples collected at the Order Stations and compliance points and therefore not included in this summary table.

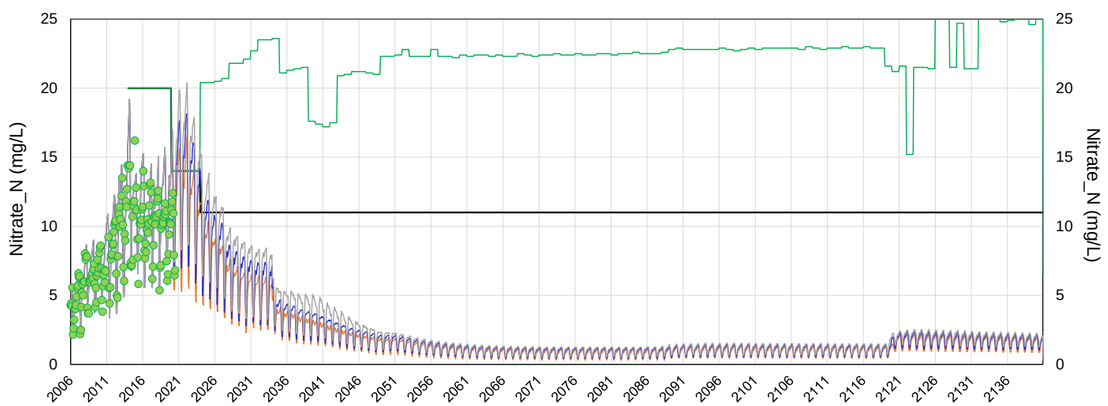
Table 2-3: Summary of Projected Monthly Average Sulphate Concentrations above Site Performance Objectives or Compliance Limits between 2022 and 2140

Location		Year[(a)]	Month	Maximum Projected Concentration (mg/L)	Corresponding SPO / Limit (mg/L)	Maximum Magnitude of Exceedance (mg/L)
Order Stations	Fording River downstream of Greenhills Creek (GH_FR1; 0200378)	2026	March	433	429	4
Compliance Points	GHO Fording River Compliance Point (GH_FR1; 0200378)	2026	March	433	429	4
	LCO Compliance Point (LC_LCDSSLCC; E297110)	2023 to 2025	February and March	470	429	41
LCO Dry Creek	LCO Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)	2022 to 2023	February and March	548	499	49

LCO = Line Creek Operations; SPO = Site Performance Objective; mg/L = milligrams per litre.
(a) Compliance summary is for 2022 and onward; historical compliance is based on monthly average measured concentrations for samples collected at the Order Stations and compliance points and therefore not included in this summary table.

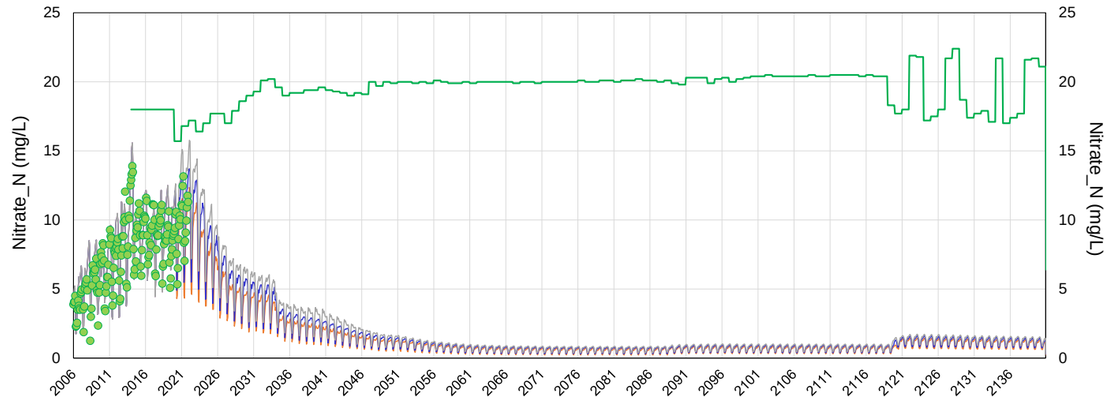
Figure 2-1: Projected Monthly Average Concentrations of Nitrate at Order Stations between 2006 and 2140

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)



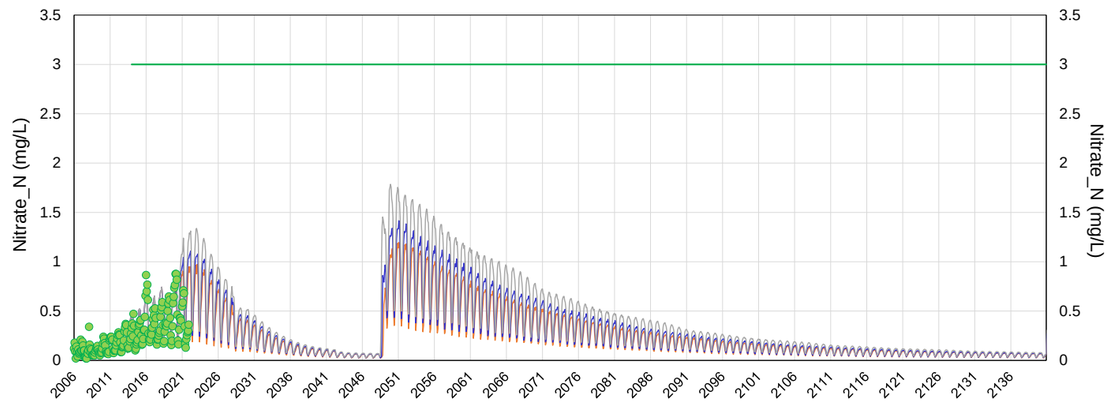
Note: This location is also the GHO Fording River Compliance Point. Site Performance Objective is hardness dependent from 2023 onward and is calculated using the following formula: N (in mg-N/L) = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$.; it varies with time to reflect projected hardness concentrations in the month when maximum monthly nitrate concentrations are projected to occur. Projected concentrations increase in 2120 because Swift Pit at Fording River Operations is modelled to spill.

(b) Fording River downstream of Line Creek (LC_LC5; 0200028)



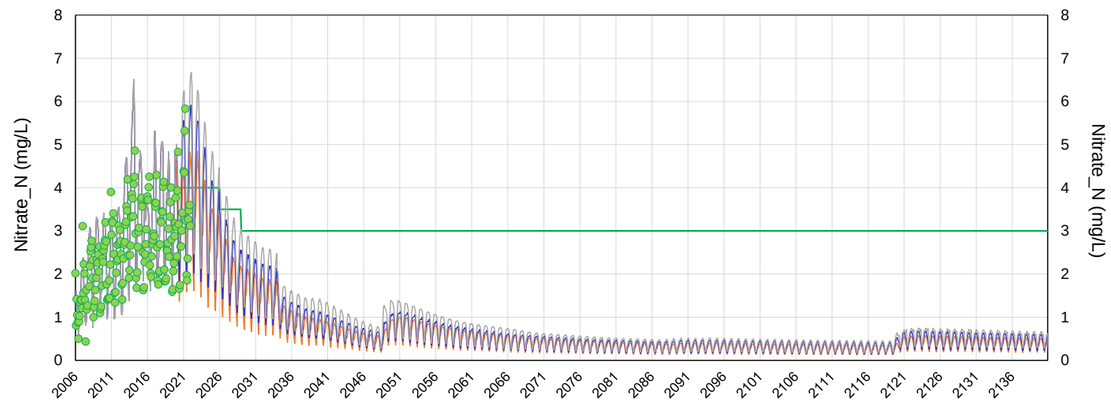
Note: Site Performance Objective is hardness dependent from 2019 onward and is calculated using the following formula: N (in mg-N/L) = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$.; it varies with time to reflect projected hardness concentrations in the month when maximum monthly nitrate concentrations are projected to occur. Projected concentrations increase in 2120 because Swift Pit at Fording River Operations is modelled to spill.

(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)



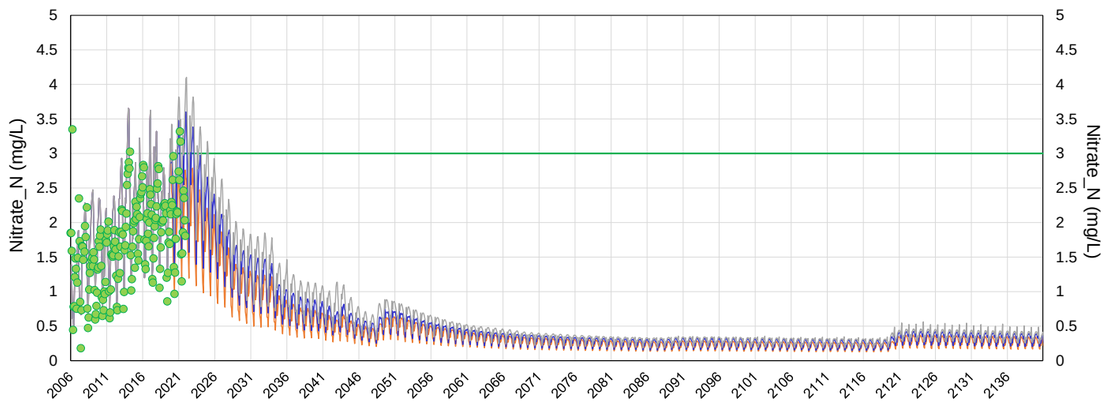
Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)



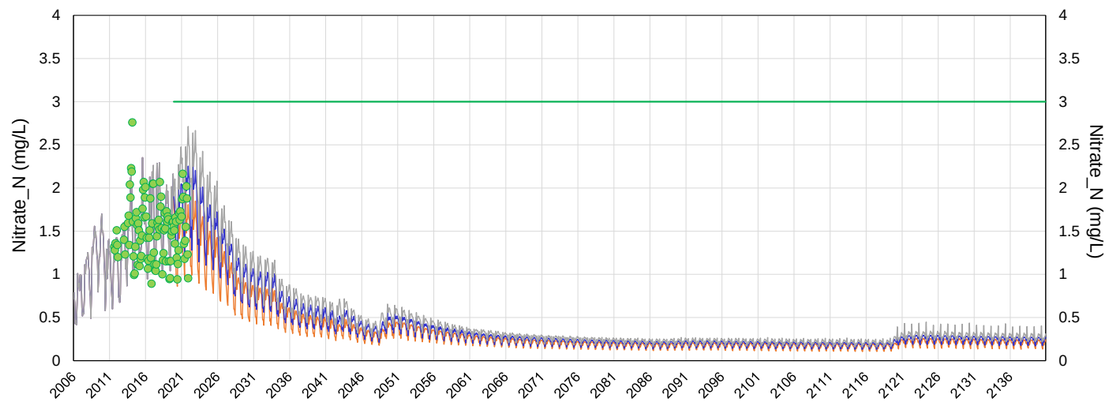
Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill. Projected concentrations increase in 2120 because Swift Pit at Fording River Operations is modelled to spill.

(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



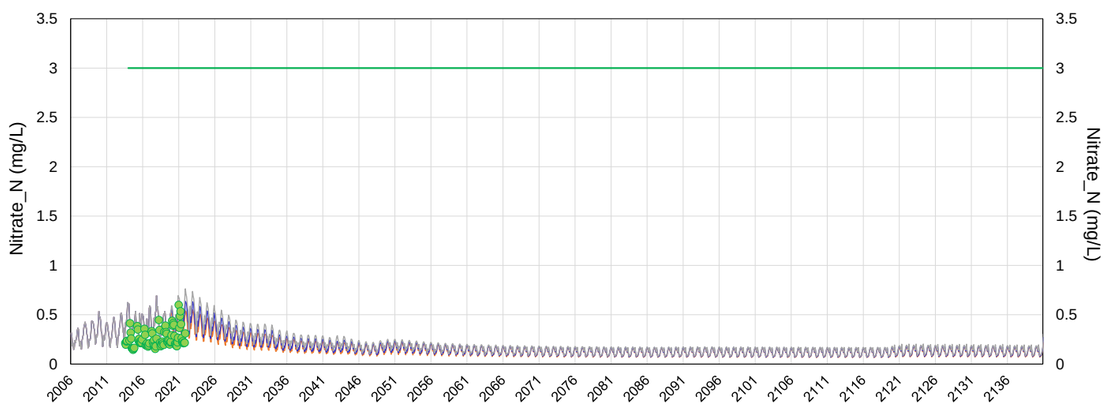
Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill. Projected concentrations increase in 2120 because Swift Pit at Fording River Operations is modelled to spill.

(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill. Projected concentrations increase in 2120 because Swift Pit at Fording River Operations is modelled to spill.

(g) Koocanusa Reservoir (RG_DSELK; E300230)



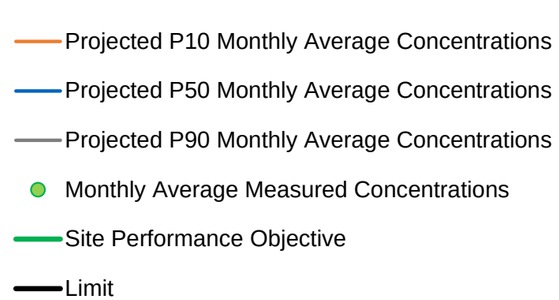
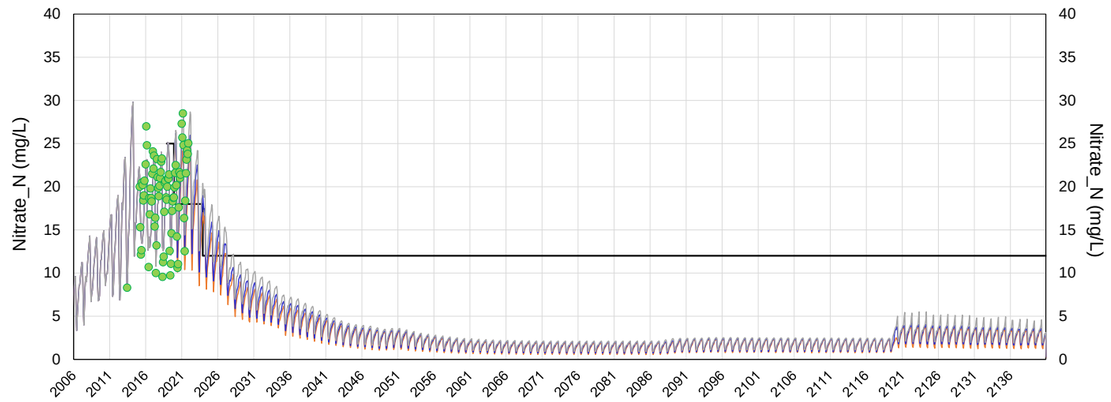


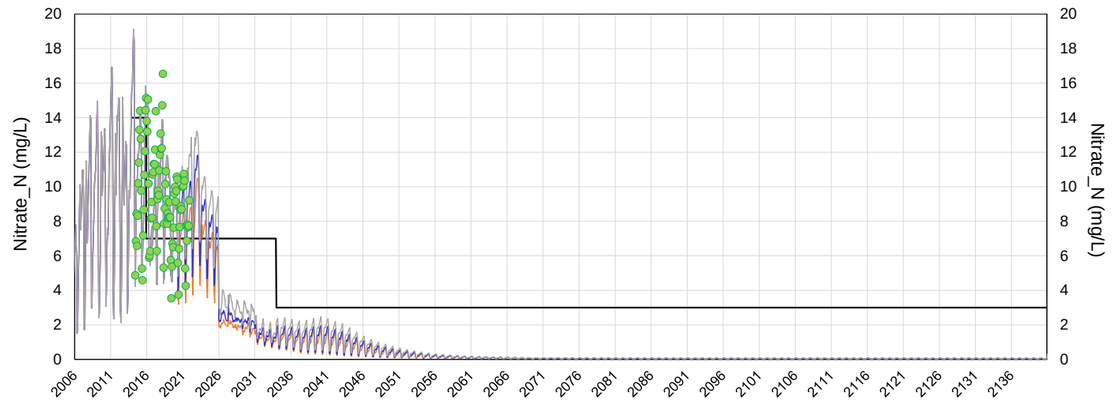
Figure 2-2: Projected Monthly Average Concentrations of Nitrate at Compliance Points between 2006 and 2140

(a) FRO Compliance Point (FR_FRABCH; E223753)

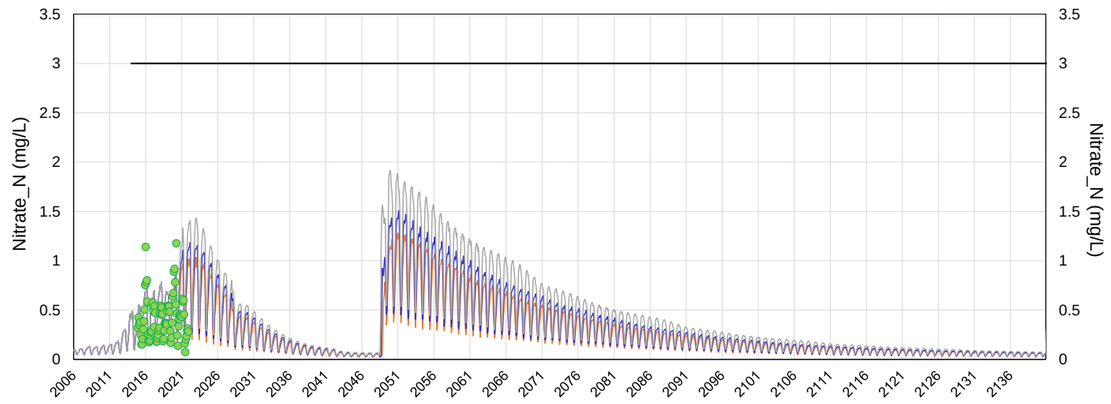


Note: Projected concentrations increase in 2120 because Swift Pit at Fording River Operations is modelled to spill.

(b) LCO Compliance Point (LC_LCDSSLCC; E297110)

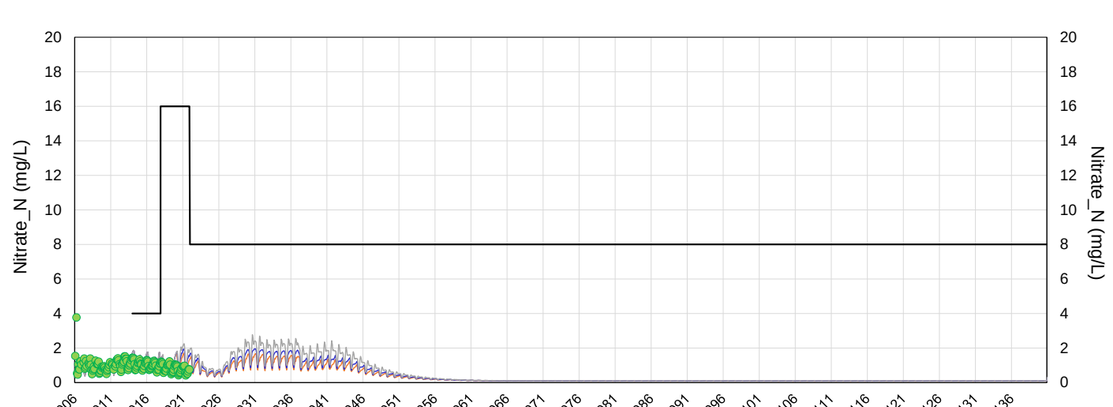


(c) GHO Elk River Compliance Point (GH_ERC; E300090)

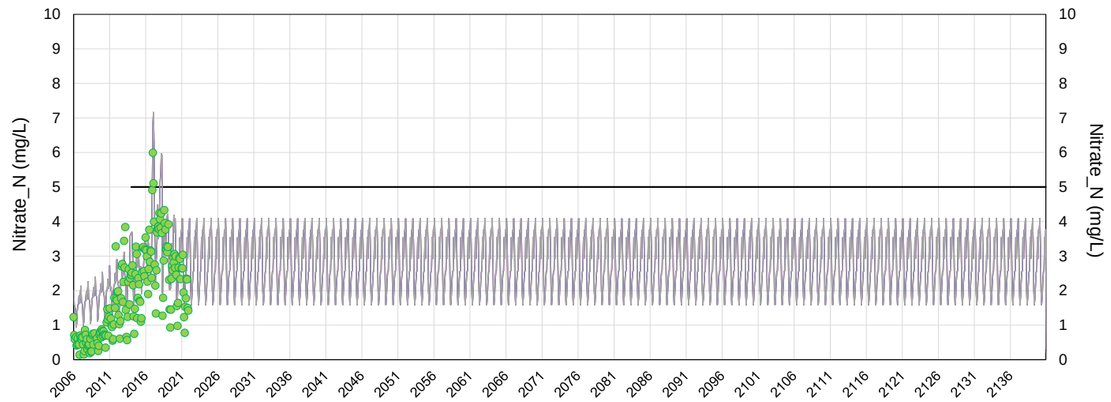


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

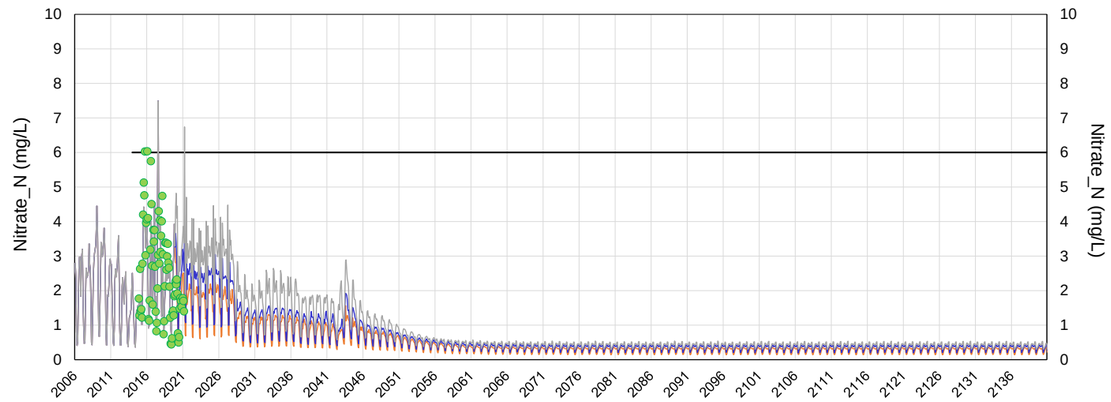
(d) EVO Harmer Compliance Point (EV_HC1; E102682)



(e) CMO Compliance Point (CM_MC2; E258937)



(f) EVO Michel Creek Compliance Point (EV_MC2; E300091)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

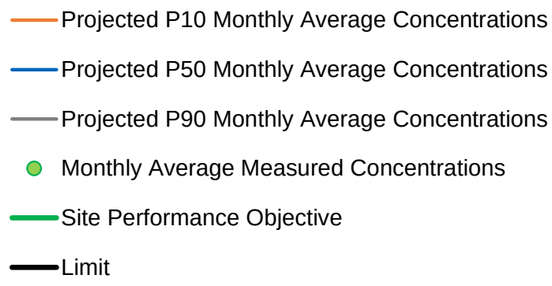
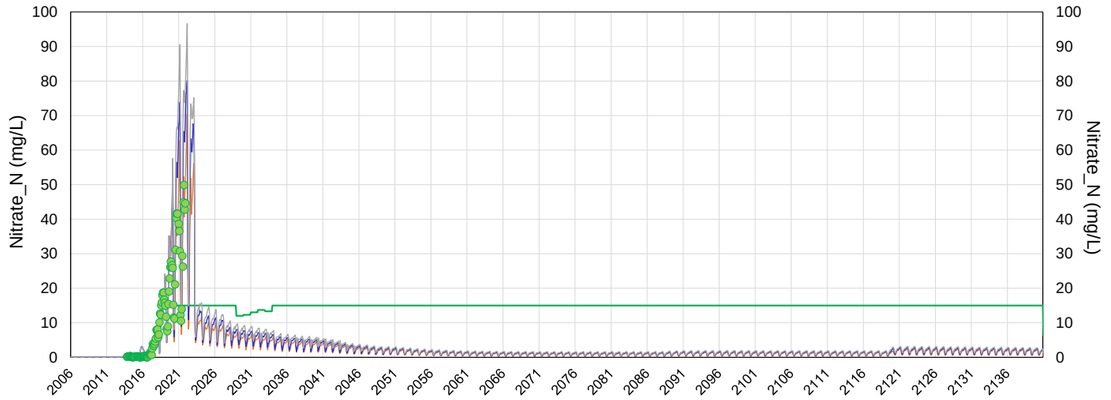
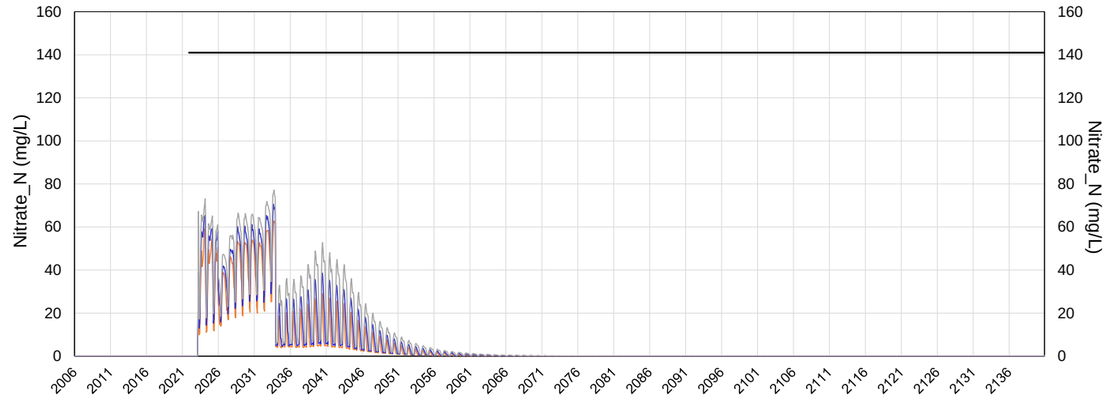


Figure 2-3: Projected Monthly Average Nitrate Concentrations in LCO Dry Creek from 2006 to 2140

(a) LCO Dry Creek downstream of the Sedimentation Ponds (LC_DCDS; E295210)



(b) LCO Dry Creek - Conveyance Water



Projected P10 Monthly Average Concentrations

Projected P50 Monthly Average Concentrations

Projected P90 Monthly Average Concentrations

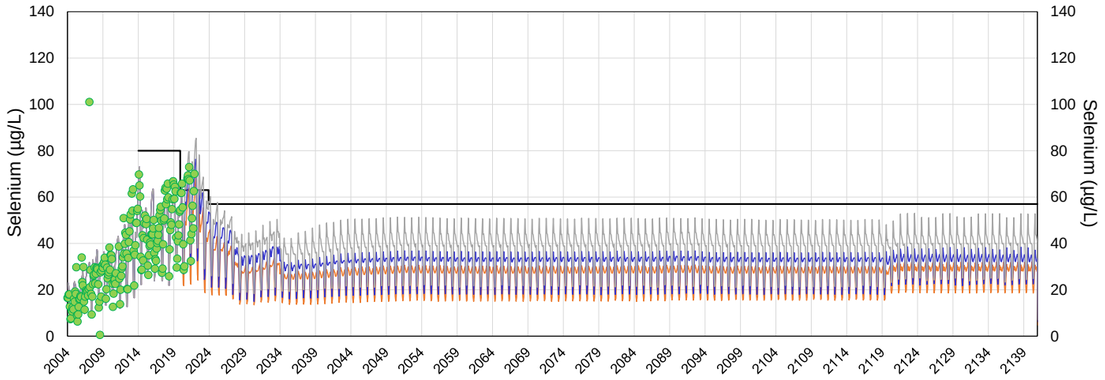
Monthly Average Measured Concentrations

Targeted Receiving Environment Objective

Discharge Criteria

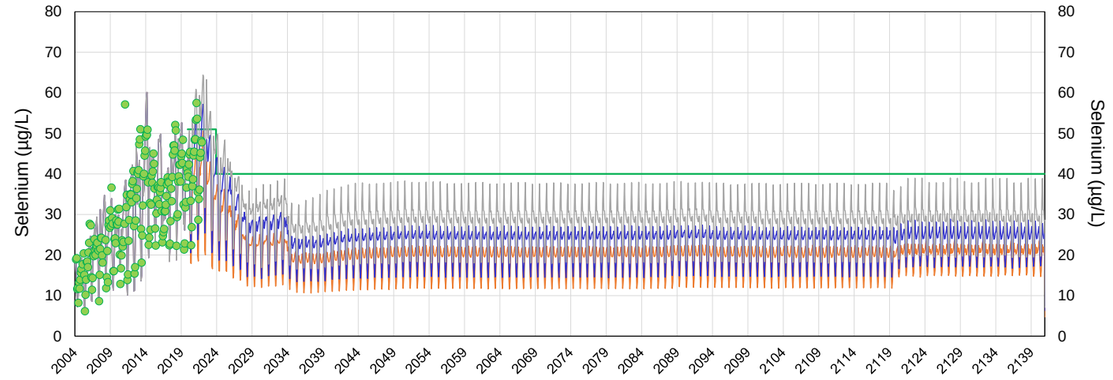
Figure 2-4: Projected Monthly Average Concentrations of Selenium at Order Stations between 2004 and 2140

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)



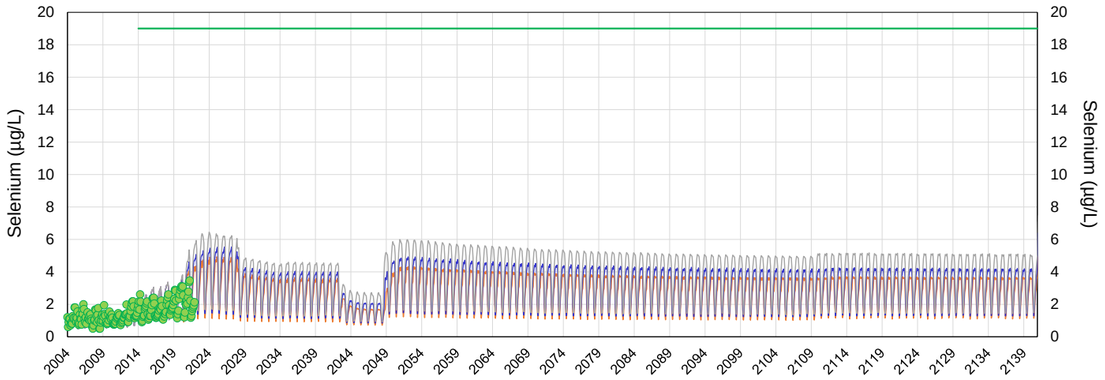
Note: This location is also the GHO Fording River Compliance Point. Projected concentrations increase in 2120 because Swift Pit at Fording River Operations is modelled to spill.

(b) Fording River downstream of Line Creek (LC_LC5; 0200028)



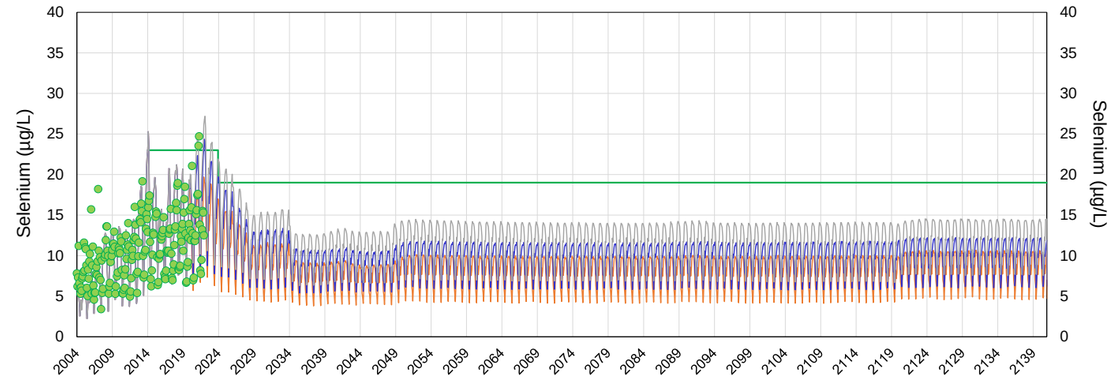
Note: Projected concentrations increase in 2120 because Swift Pit at Fording River Operations is modelled to spill.

(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)



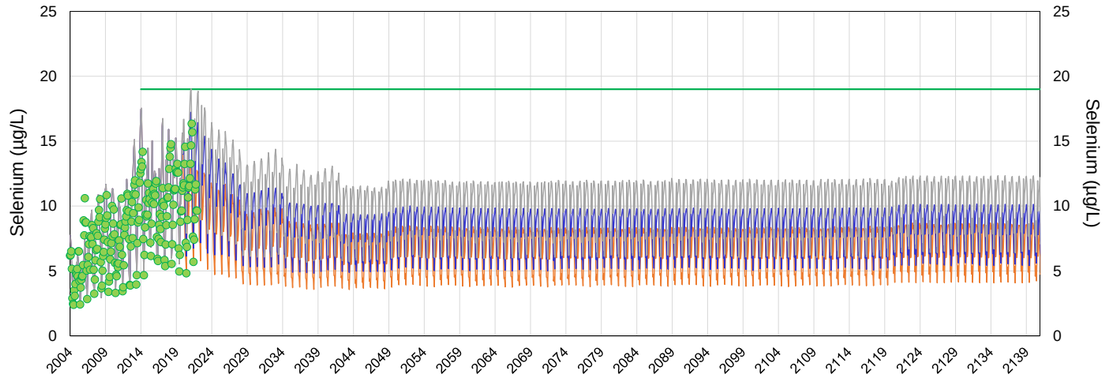
Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)

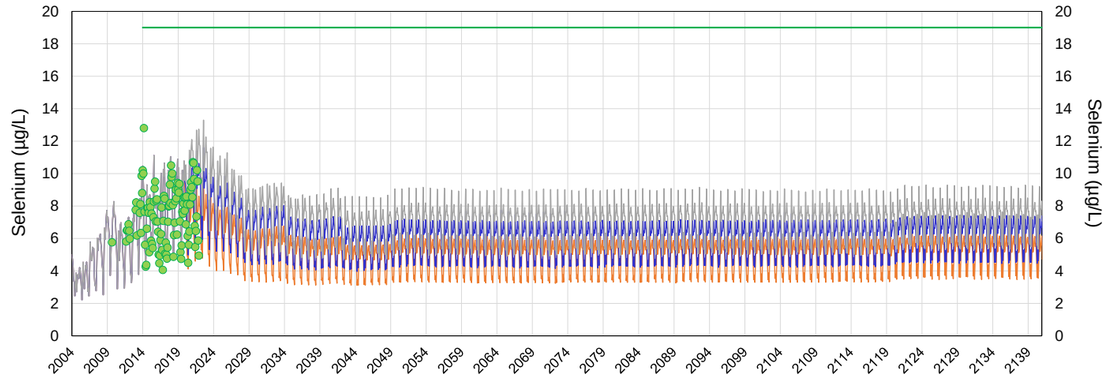


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill. Projected concentrations increase in 2120 because Swift Pit at Fording River Operations is modelled to spill.

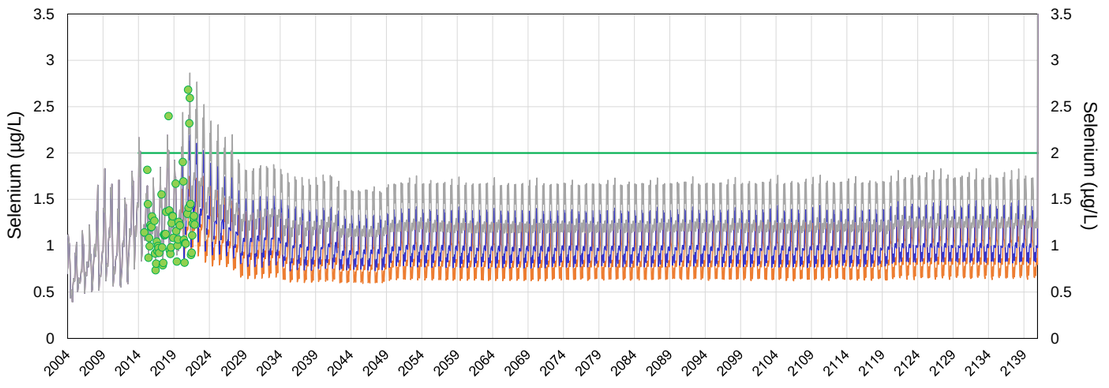
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



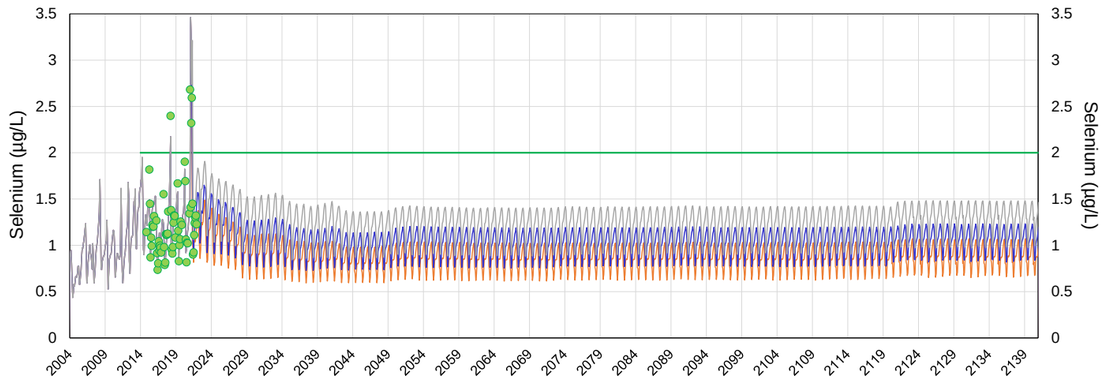
(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



(g) Koocanusa Reservoir (RG_DSELK; E300230) - 2020 Regional Water Quality Model



(h) Koocanusa Reservoir (RG_DSELK; E300230) - Koocanusa Reservoir Module



Projected P10 Monthly Average Concentrations

Projected P50 Monthly Average Concentrations

Projected P90 Monthly Average Concentrations

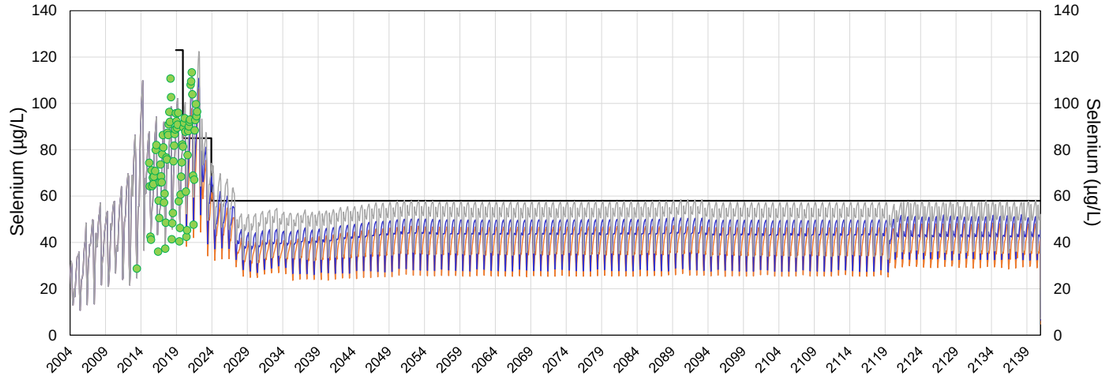
Monthly Average Measured Concentrations

Site Performance Objective

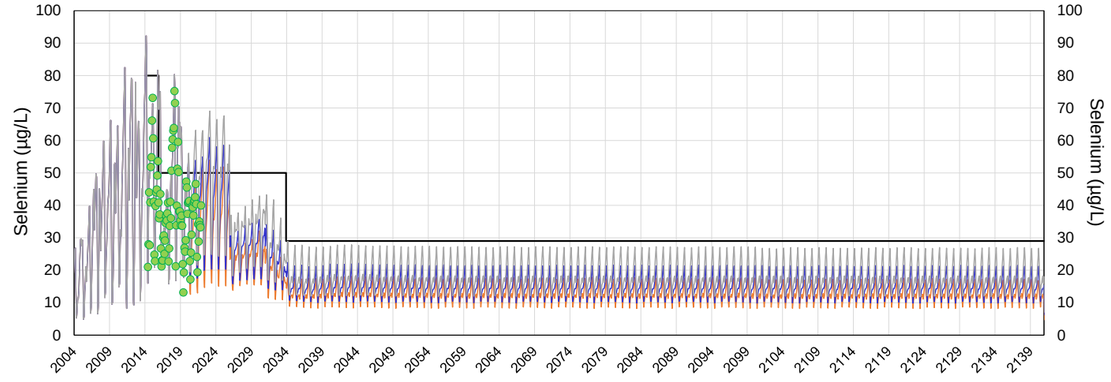
Limit

Figure 2-5: Projected Monthly Average Concentrations of Selenium at Compliance Points between 2013 and 2140

(a) FRO Compliance Point (FR_FRABCH; E223753)

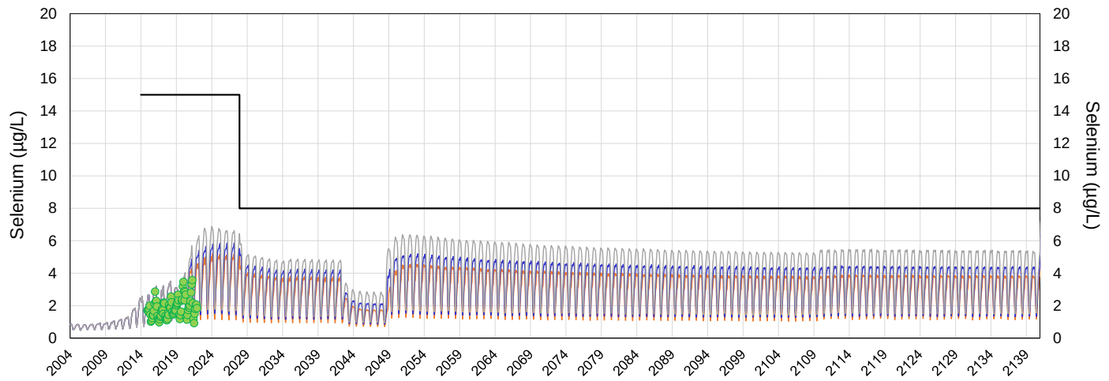


(b) LCO Compliance Point (LC_LCDSSLCC; E297110)

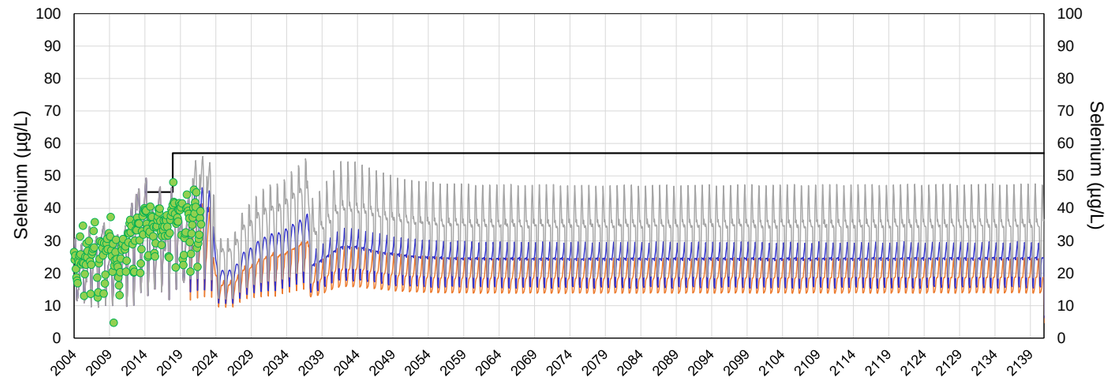


Note: Projected concentrations increase in 2120 because Swift Pit at Fording River Operations is modelled to spill.

(c) GHO Elk River Compliance Point (GH_ERC; E300090)

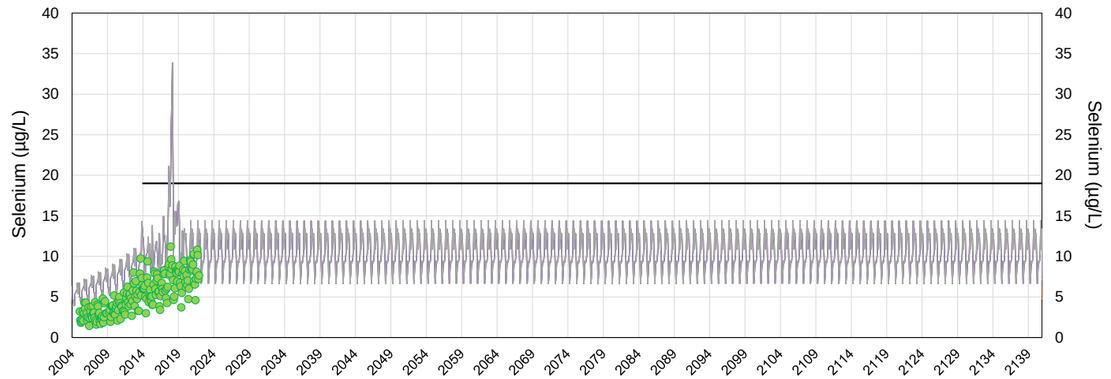


(d) EVO Harmer Compliance Point (EV_HC1; E102682)

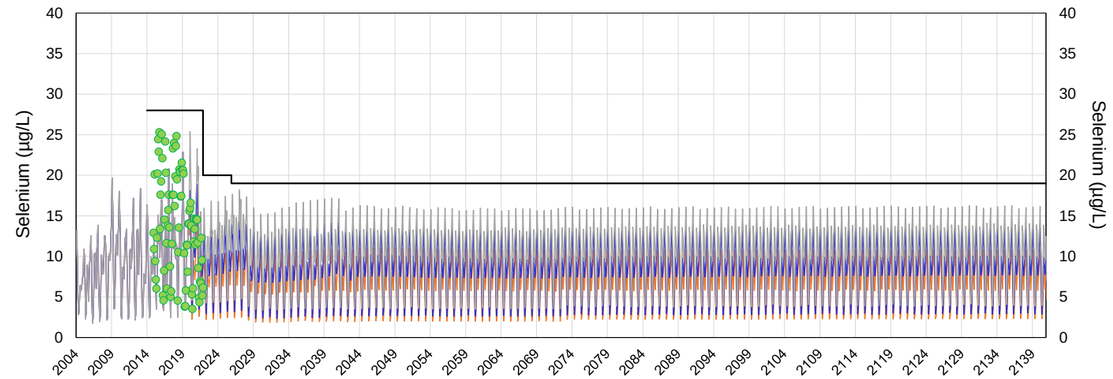


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) CMO Compliance Point (CM_MC2; E258937)



(f) EVO Michel Creek Compliance Point (EV_MC2; E300091)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

Projected P10 Monthly Average Concentrations

Projected P50 Monthly Average Concentrations

Projected P90 Monthly Average Concentrations

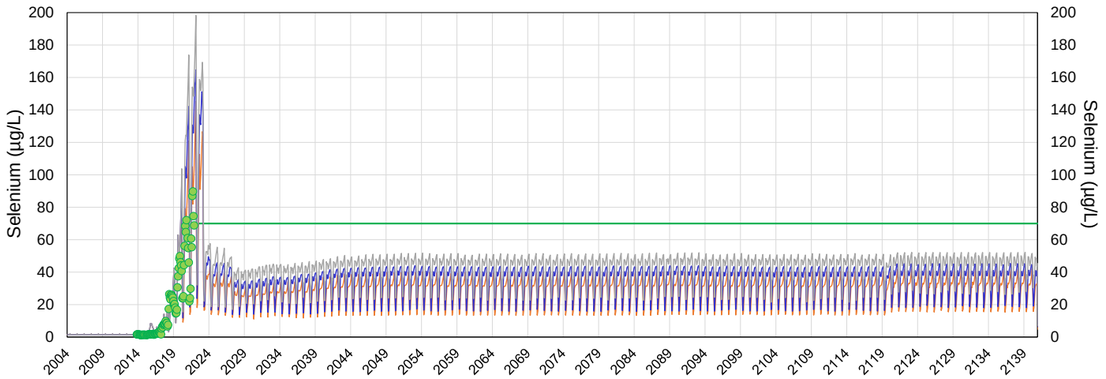
Monthly Average Measured Concentrations

Site Performance Objective

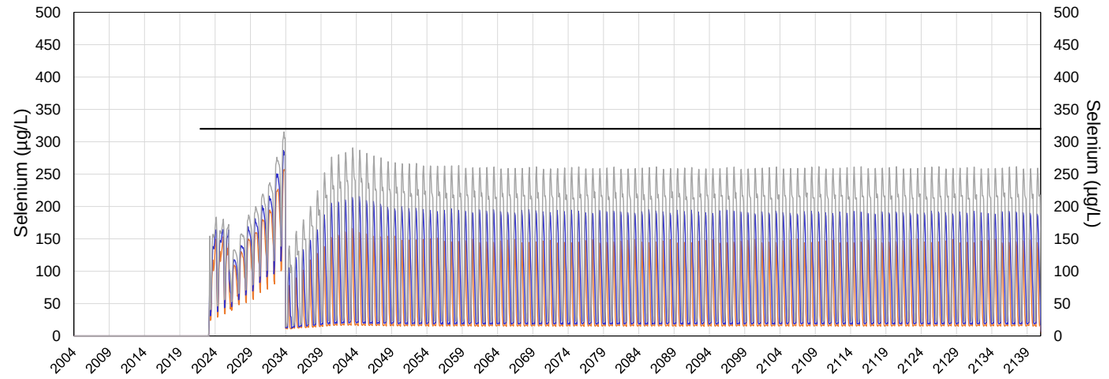
Limit

Figure 2-6: Projected Monthly Average Selenium Concentrations in LCO Dry Creek from 2004 to 2140

(a) LCO Dry Creek downstream of the Sedimentation Ponds (LC_DCDS; E295210)



(b) LCO Dry Creek - Conveyance Water



Projected P10 Monthly Average Concentrations

Projected P50 Monthly Average Concentrations

Projected P90 Monthly Average Concentrations

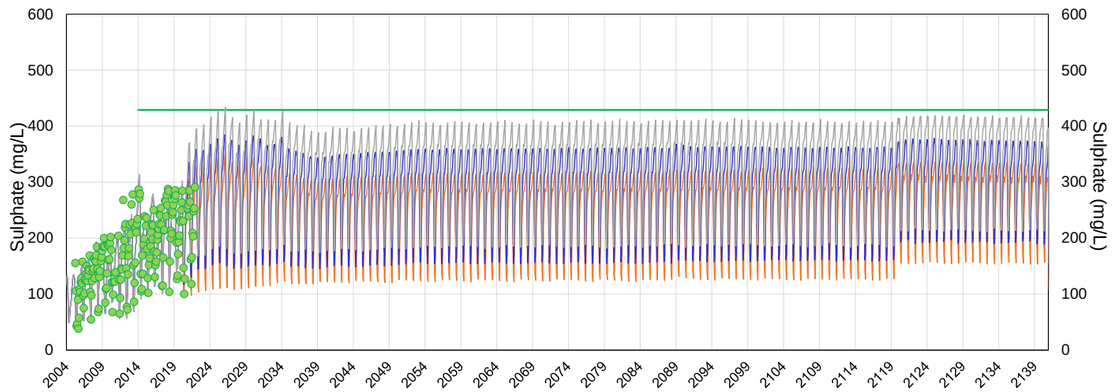
Monthly Average Measured Concentrations

Targeted Receiving Environment Objective

Discharge Criteria

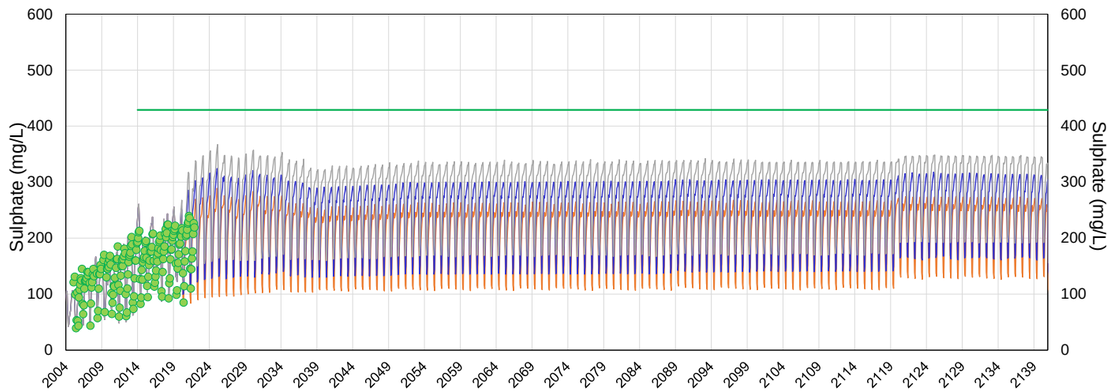
Figure 2-7: Projected Monthly Average Concentrations of Sulphate at Order Stations between 2004 and 2140

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)



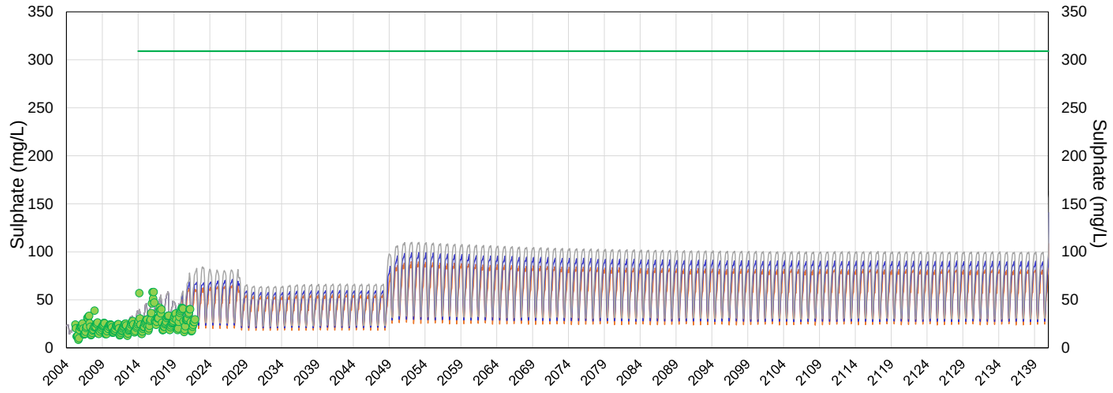
Note: This location is also the GHO Fording River Compliance Point. Projected concentrations increase in 2120 because the Swift Pit at Fording River Operations is modelled to spill.

(b) Fording River downstream of Line Creek (LC_LC5; 0200028)



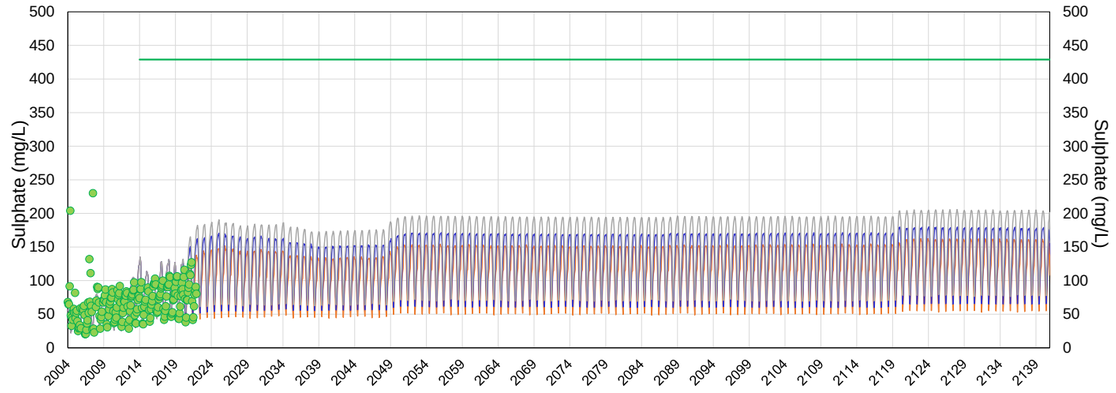
Note: Projected concentrations increase in 2120 because the Swift Pit at Fording River Operations is modelled to spill.

(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)



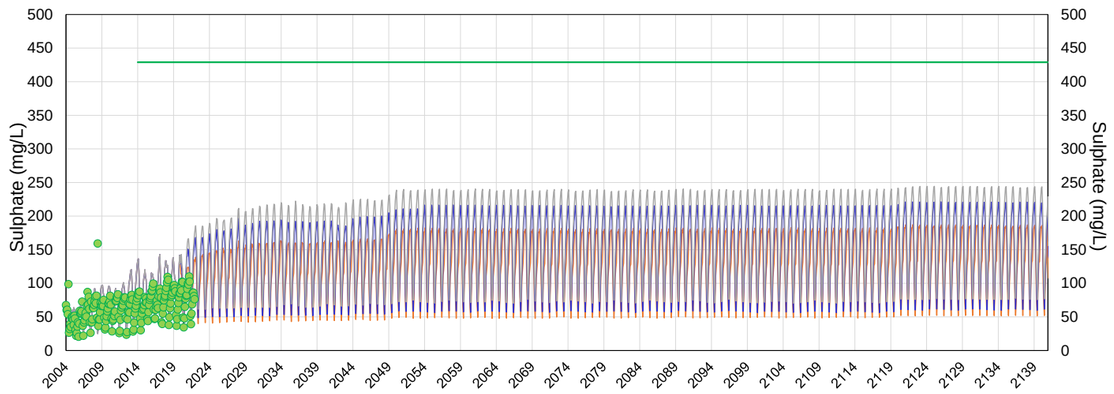
Note: Projected concentrations increase in 2050 because the Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)

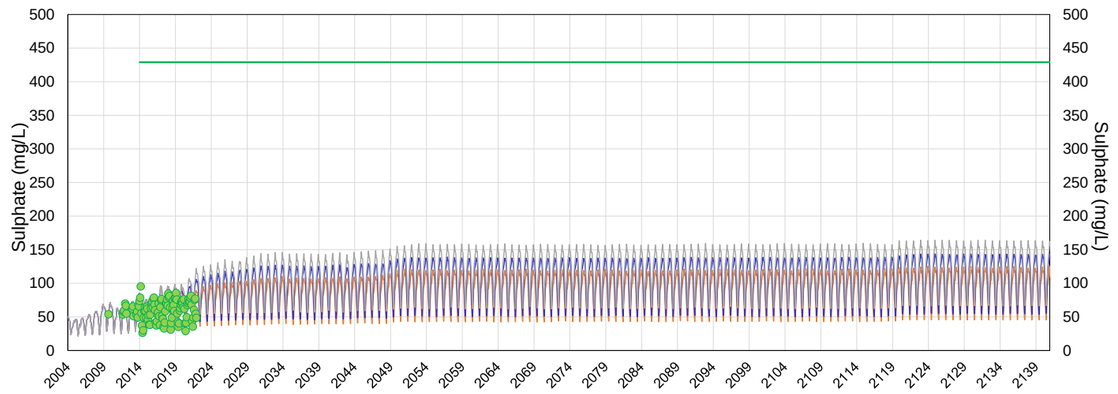


Note: Projected concentrations increase in 2050 because the Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

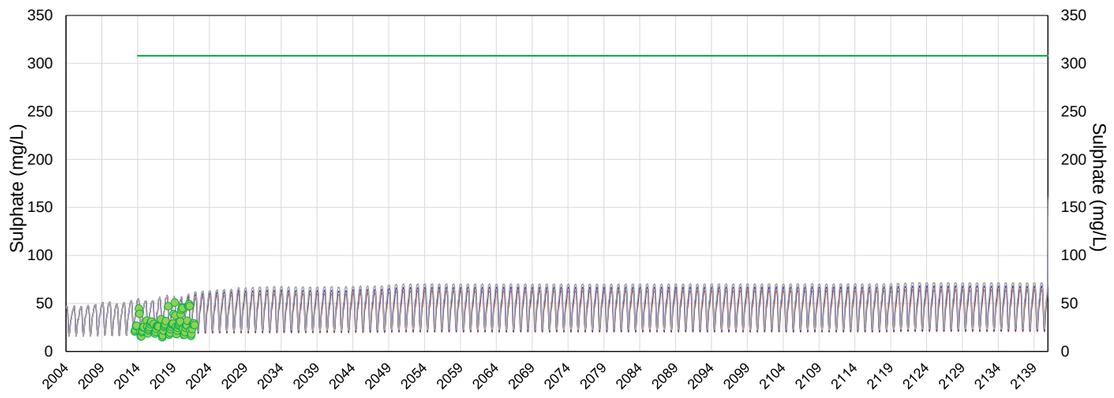
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



(g) Koocanusa Reservoir (RG_DSELK; E300230)



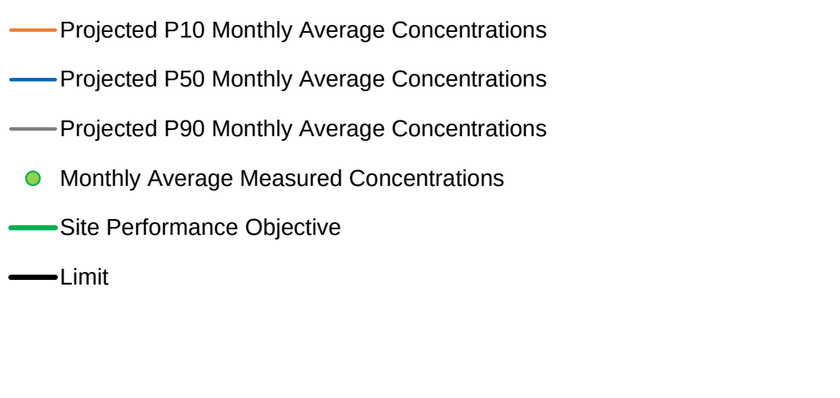
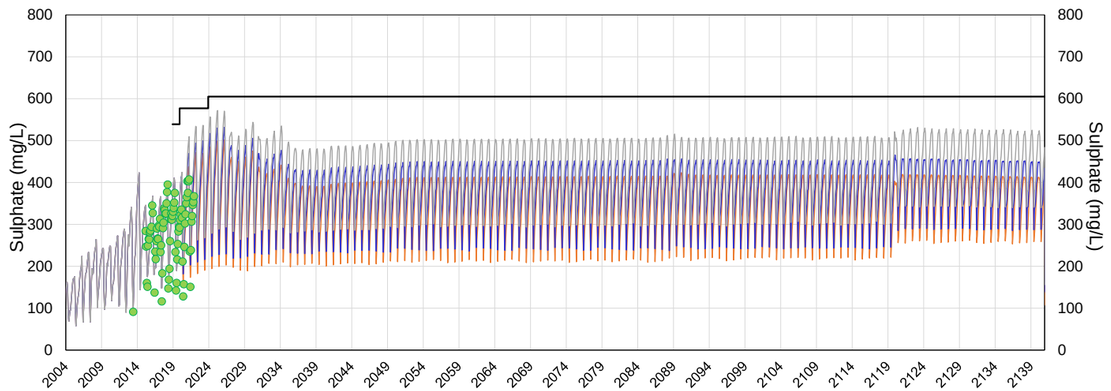


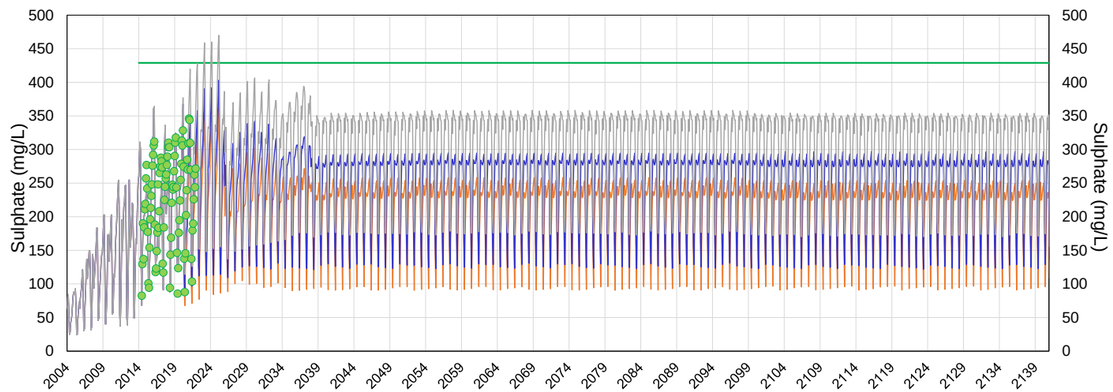
Figure 2-8: Projected Monthly Average Concentrations of Sulphate at Compliance Points between 2004 and 2140

(a) FRO Compliance Point (FR_FRABCH; E223753)

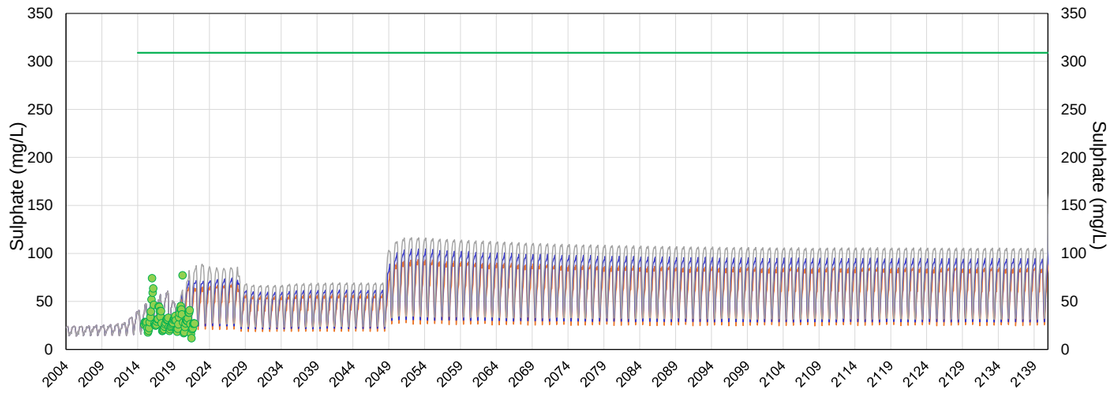


Note: Projected concentrations increase in 2120 because the Swift Pit at Fording River Operations is modelled to spill.

(b) LCO Compliance Point (LC_LCDSSLCC; E297110)

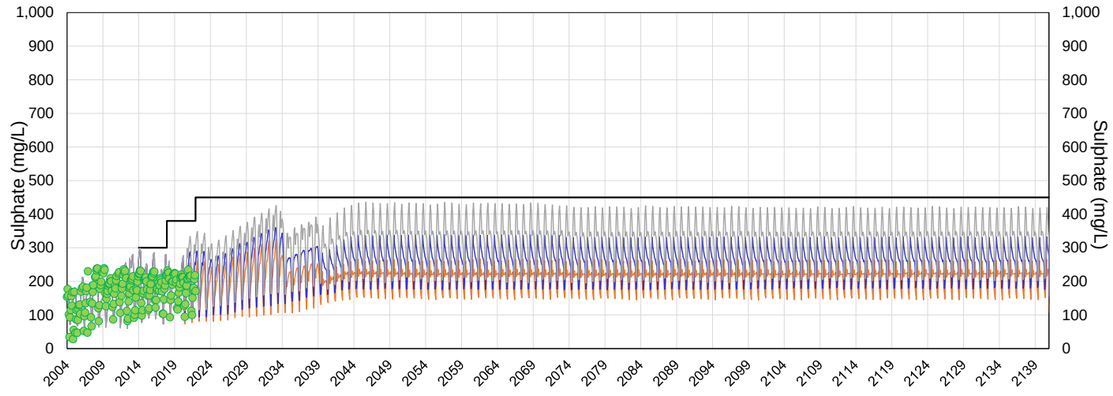


(c) GHO Elk River Compliance Point (GH_ERC; E300090)

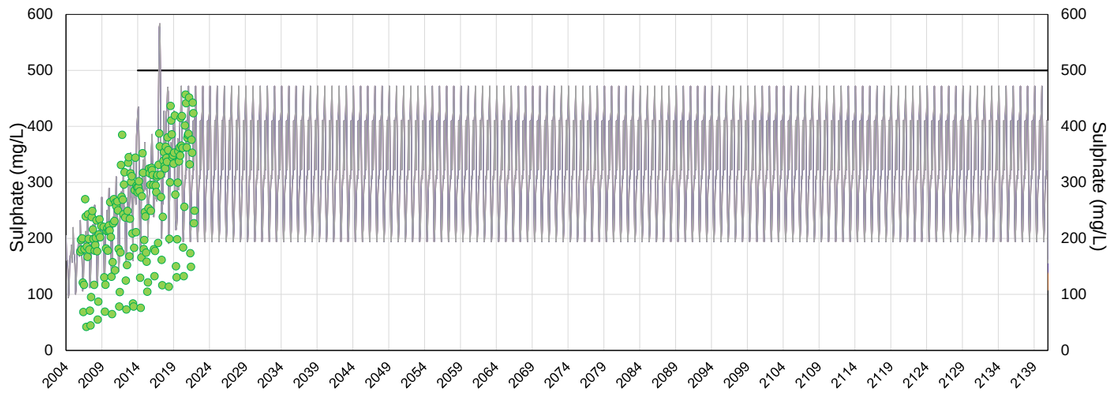


Note: Projected concentrations increase in 2050 because the Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

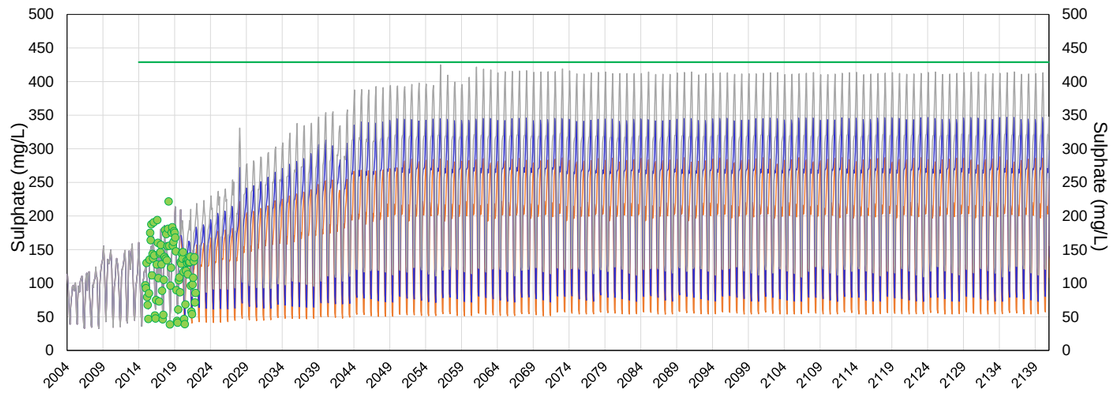
(d) EVO Harmer Compliance Point (EV_HC1; E102682)



(e) CMO Compliance Point (CM_MC2; E258937)



(f) EVO Michel Creek Compliance Point (EV_MC2; E300091)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

Projected P10 Monthly Average Concentrations

Projected P50 Monthly Average Concentrations

Projected P90 Monthly Average Concentrations

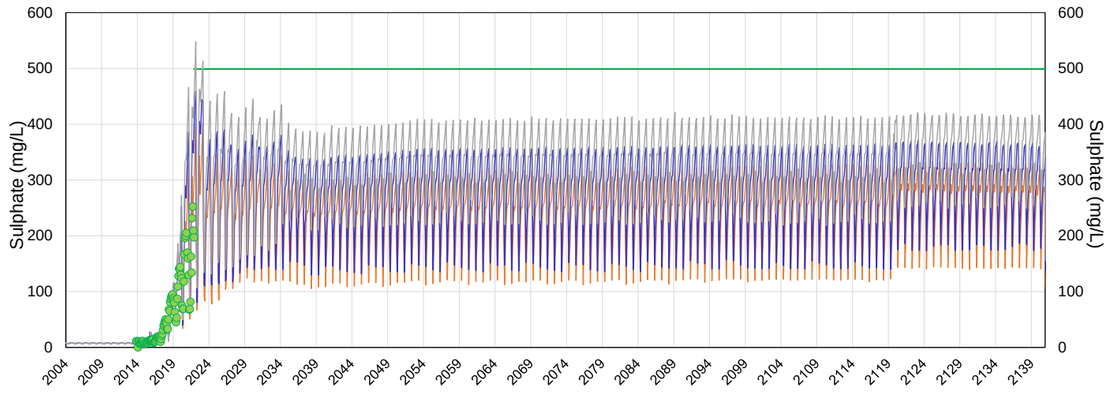
Monthly Average Measured Concentrations

Site Performance Objective

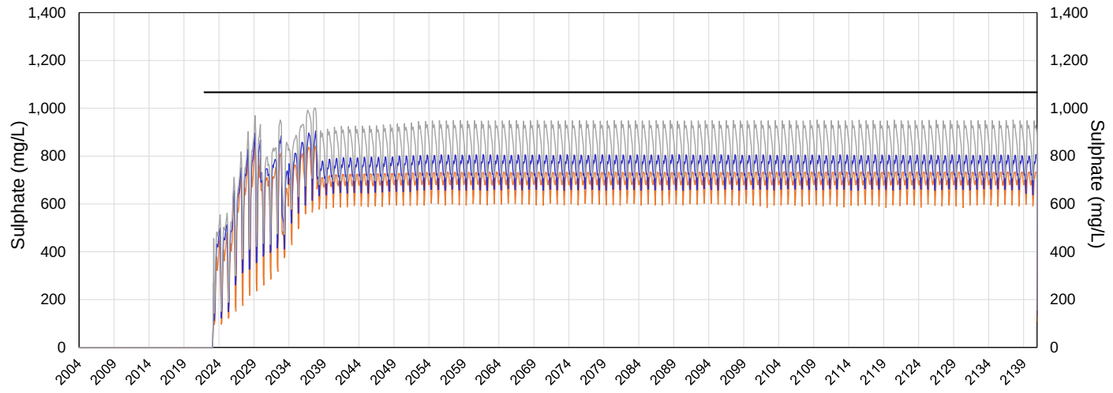
Limit

Figure 2-9: Projected Monthly Average Sulphate Concentrations in LCO Dry Creek from 2004 to 2140

(a) LCO Dry Creek downstream of the Sedimentation Ponds (LC_DCDS; E295210)



(b) LCO Dry Creek - Conveyance Water



Projected P10 Monthly Average Concentrations

Projected P50 Monthly Average Concentrations

Projected P90 Monthly Average Concentrations

Monthly Average Measured Concentrations

Targeted Receiving Environment Objective

Discharge Criteria

Table 2-4: Projected Hardness Concentrations used to Calculate the Site Performance Objective for Nitrate at the GHO Fording River Compliance Point (GH_FR1; 0200378)

Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)
2020	589	2036	704	2052	753	2068	742	2084	748	2100	755	2116	760	2132	849
2021	643	2037	707	2053	738	2069	739	2085	745	2101	754	2117	757	2133	840
2022	655	2038	711	2054	738	2070	738	2086	744	2102	758	2118	755	2134	840
2023	648	2039	583	2055	737	2071	741	2087	743	2103	757	2119	715	2135	819
2024	674	2040	577	2056	753	2072	741	2088	747	2104	756	2120	701	2136	824
2025	674	2041	569	2057	738	2073	743	2089	753	2105	757	2121	713	2137	839
2026	679	2042	578	2058	736	2074	741	2090	756	2106	756	2122	501	2138	837
2027	683	2043	692	2059	735	2075	741	2091	754	2107	755	2123	710	2139	814
2028	720	2044	695	2060	739	2076	745	2092	753	2108	759	2124	710	2140	845
2029	719	2045	702	2061	736	2077	742	2093	754	2109	755	2125	708		
2030	730	2046	700	2062	740	2078	741	2094	753	2110	754	2126	846		
2031	751	2047	698	2063	739	2079	744	2095	752	2111	758	2127	845		
2032	775	2048	694	2064	739	2080	744	2096	757	2112	757	2128	709		
2033	777	2049	736	2065	739	2081	741	2097	753	2113	758	2129	817		
2034	778	2050	737	2066	738	2082	744	2098	752	2114	757	2130	707		
2035	697	2051	739	2067	738	2083	743	2099	755	2115	756	2131	708		

mg/L = milligrams per litre.

Table 2-5: Projected Hardness Concentrations used to Calculate the Site Performance Objective for Nitrate in the Fording River downstream of Line Creek (LC_LC5; 0200028)

Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)
2020	518	2036	635	2052	662	2068	663	2084	667	2100	674	2116	679	2132	591
2021	556	2037	636	2053	658	2069	659	2085	664	2101	673	2117	675	2133	566
2022	569	2038	640	2054	661	2070	658	2086	663	2102	676	2118	674	2134	718
2023	541	2039	641	2055	659	2071	661	2087	662	2103	675	2119	606	2135	562
2024	562	2040	648	2056	663	2072	661	2088	666	2104	675	2120	585	2136	574
2025	584	2041	640	2057	660	2073	663	2089	657	2105	676	2121	595	2137	586
2026	587	2042	639	2058	658	2074	661	2090	656	2106	675	2122	723	2138	714
2027	561	2043	635	2059	657	2075	661	2091	670	2107	674	2123	722	2139	716
2028	593	2044	630	2060	661	2076	665	2092	670	2108	678	2124	567	2140	697
2029	616	2045	635	2061	658	2077	661	2093	671	2109	674	2125	580		
2030	627	2046	633	2062	661	2078	660	2094	658	2110	673	2126	594		
2031	639	2047	660	2063	660	2079	664	2095	668	2111	676	2127	718		
2032	664	2048	652	2064	660	2080	664	2096	672	2112	676	2128	741		
2033	669	2049	660	2065	660	2081	661	2097	662	2113	677	2129	618		
2034	649	2050	659	2066	659	2082	664	2098	668	2114	676	2130	576		
2035	629	2051	662	2067	658	2083	663	2099	671	2115	675	2131	586		

mg/L = milligrams per litre.

Table 2-6: Projected Hardness Concentrations used to Calculate the Targeted Receiving Environment Objective for Nitrate in LCO Dry Creek downstream of the Sedimentation Ponds (LC_DCDS; E295210)

Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)	Year	Hardness (mg/L)
2020	751	2036	615	2052	753	2068	721	2084	729	2100	737	2116	775	2132	845
2021	977	2037	663	2053	732	2069	719	2085	727	2101	735	2117	739	2133	852
2022	1124	2038	660	2054	730	2070	717	2086	725	2102	740	2118	737	2134	849
2023	945	2039	664	2055	729	2071	722	2087	724	2103	738	2119	717	2135	822
2024	682	2040	578	2056	750	2072	758	2088	768	2104	775	2120	727	2136	830
2025	680	2041	574	2057	728	2073	724	2089	739	2105	739	2121	856	2137	841
2026	680	2042	569	2058	733	2074	722	2090	740	2106	738	2122	861	2138	844
2027	687	2043	561	2059	732	2075	721	2091	737	2107	736	2123	837	2139	819
2028	730	2044	659	2060	752	2076	725	2092	734	2108	771	2124	830	2140	845
2029	396	2045	653	2061	715	2077	723	2093	738	2109	737	2125	787		
2030	407	2046	661	2062	720	2078	721	2094	737	2110	735	2126	849		
2031	430	2047	656	2063	718	2079	726	2095	735	2111	740	2127	856		
2032	454	2048	651	2064	755	2080	765	2096	739	2112	776	2128	825		
2033	439	2049	701	2065	720	2081	721	2097	736	2113	741	2129	860		
2034	566	2050	728	2066	719	2082	726	2098	734	2114	739	2130	854		
2035	593	2051	729	2067	717	2083	725	2099	739	2115	738	2131	844		

mg/L = milligrams per litre.

3 Projected Influent Concentrations and Load Reductions at the Proposed Saturated Rock Fills and Active Water Treatment Facilities

A summary of the projected monthly average influent concentrations of nitrate, selenium, and sulphate are shown in Tables 3-1 and 3-2. The summary statistics represent the projected average, minimum, and maximum P_{50} monthly average influent concentrations from the year when treatment is fully effective to the end of 2053. Tables 3-1 and 3-2 also include a summary of the projected P_{50} monthly average loads of nitrate, selenium, and sulphate removed by each treatment vessel. Influent concentrations of nitrate and loads of nitrate removed by each treatment vessel decrease with time because of the underlying declining trend in nitrate in the numerical model. It is acknowledged that long-term nitrate projections are uncertain and subject to update based on the potential influence of exchangeable ammonium. Influent concentrations of selenium and sulphate and loads of selenium and sulphate removed by each treatment vessel increase with time as mining and waste rock placement progress. Monthly average influent concentrations of nitrate, selenium, and sulphate, along with the monthly average loads of nitrate, selenium, and sulphate removed by each treatment vessel are provided in Appendix A. Monthly hydrographs of treated flows are provided in Appendix B.

Table 3-1: Projected Influent Concentrations and Load Reductions for Nitrate and Selenium at the Saturated Rock Fills and Active Water Treatment Facilities

Treatment Facility	Constituent	Monthly Average Influent Concentration[a,b,c]	Monthly Average Load Reduction (kg/d)[a,b]
FRO-N 1 SRF	Nitrate	39 (11 - 160)	653 (79.1 - 1,570)
	Selenium	294 (104 - 403)	6.2 (0.51 - 9)
FRO-N 2 SRF	Nitrate	30 (0.37 - 150)	368 (<0.1 - 1,400)
	Selenium	352 (51 - 603)	4.1 (<0.1 - 7.2)
Eagle 6 SRF	Nitrate	95 (3.1 - 440)	113 (0.16 - 338)
	Selenium	420 (159 - 1,450)	0.81 (0.21 - 2.6)
FRO AWTF-S	Nitrate	37 (2.6 - 110)	619 (11.4 - 1,380[d])
	Selenium	639 (378 - 813)	11 (5.5 - 14)
WLC AWTF	Nitrate	7 (0.52 - 40)	44 (<0.1 - 244[e])
	Selenium	281 (178 - 356)	2 (1.2 - 2.3)
NLC SRF	Nitrate	29 (2.3 - 63)	633 (82.7 - 1,330)
	Selenium	262 (143 - 431)	6.6 (1.8 - 10)
CSP SRF	Nitrate	110 (0.83 - 280)	487 (3.76 - 1,280)
	Selenium	268 (232 - 298)	1.2 (1 - 1.3)
Greenhills Creek	Nitrate	0.8 (<0.1 - 4.8)	2.06 (<0.1 - 5.73)
	Selenium	333 (207 - 401)	0.77 (0.56 - 0.95)
EVO SRF	Nitrate	28 (8.9 - 41)	928 (259 - 1,510)
	Selenium	242 (130 - 347)	8.4 (2.4 - 14)
BRP SRF	Nitrate	23 (7.5 - 110)	88.6 (23.7 - 411)
	Selenium	151 (139 - 174)	0.61 (0.42 - 0.76)

AWTF = Active Water Treatment Facility; BRP = Baldy Ridge Pit; CSP = Cougar South Pit; EVO = Elkview Operations; FRO = Fording River Operations; FRO-N = Fording River Operations North; FRO-S = Fording River Operations South; LCO = Line Creek Operations; NLC = North Line Creek; WLC = West Line Creek; SRF = Saturated Rock Fill.

(a) Values presented are the projected mean (minimum - maximum) 50th percentile (P_{50}) monthly average concentrations.
(b) The time frame used for the calculation of statistics is from the year when the SRF or AWTF is fully operational to 2053.
(c) Influent concentrations for selenium are reported in micrograms per litre. Influent concentrations for nitrate are reported in milligrams per litre.
(d) The nitrate design load removal at the FRO AWTF-S is 1,400 kg/d. The maximum load reduction across the AWTF does not equal 1,400 kg/d because there is nitrate in the treated effluent (i.e., 2 mg-N/L at the FRO AWTF-S).
(e) The nitrate design load removal at the WLC AWTF is 250 kg/d. The maximum load reduction across the AWTF does not equal 250 kg/d because there is nitrate in the treated effluent (i.e., 1 mg-N/L at the WLC AWTF).

Table 3-2: Projected Influent Concentrations and Load Reductions for Sulphate Treatment

Treatment Area	Monthly Average Influent Concentration (mg/L)[a,b]	Monthly Average Load Reduction (kg/d)[a,b]
FRO-N	1,360 (757 - 1,680)	15,200 (8,520 - 18,900)
FRO-S	2,000 (379 - 2,130)	15,300 (2,900 - 16,300)
LCO Dry Creek	1,560 (344 - 2,080)	9,080 (774 - 13,300)
LCO Line Creek	915 (806 - 1,270)	3,670 (1,910 - 4,060)
EVO Dry Creek	1,410 (1,150 - 1,570)	4,700 (2,520 - 6,370)

EVO = Elkview Operations; FRO-N = Fording River Operations North; FRO-S = Fording River Operations South; LCO = Line Creek Operations; mg/L = milligrams per litre; kg/d = kilograms per day.
(a) Values presented are the projected mean (minimum - maximum) 50th percentile (P_{50}) monthly average concentrations.
(b) The time frame used for the calculation of statistics is from the year when treatment is fully operational to 2053.

4 Sensitivity Analyses

Seven sensitivity analyses were conducted to identify how projected water quality under the 2022 IPA may change with changes to model input assumptions. The seven analyses involved:

- changes to model inputs related to water availability of sources targeted for treatment
- changes to model inputs related to nitrate content of waste rock spoils
- changes to model inputs related to selenium and sulphate release rates
- changes to model inputs related to climate (i.e., evaluation of how projections may vary as a result of climate change)
- changes to model inputs related to selenium effluent quality
- changes to model inputs related to instream sinks (selenium and nitrate only)
- changes to model inputs related to improvements in blasting practices (nitrate only)

Several updates were made to the 2020 RWQM after the sensitivity analyses were completed. The updates consisted of:

- Addressing model under-projection in March at Koocanusa Reservoir as outlined in Annex A. The monthly average relative bias value of 2.3 for selenium that was used in March was replaced with the annual average relative bias value of 1.2. The relative bias value in March was modified to address model under-prediction in March due to limited measured data (i.e., five samples) and reflects feedback received from KNC.
- Modifying entrainment of in-situ water at the Eagle 6 Pit SRF. The entrainment of in-situ water was calculated to be 8% at the Eagle 6 Pit SRF and was incorporated into the 2020 RWQM by adjusting the proportion of total effluent that is treated water versus untreated (i.e., in-situ) water as outlined in Annex A. The percentage of treated effluent that is in-situ water was assumed to decrease from 8% to 3% over a 15-year timeframe in the 2020 RWQM used to complete the sensitivity analyses.
- Correcting an error in waste rock volumes in Cataract Creek in 2019. An additional 171,784 back cubic metres (BCM) of waste rock was added to Cataract Creek in 2019.
- Modifying release of nitrate from submerged waste rock in Natal Pit West at EVO as outlined in Annex A. The equation used to calculate the release of nitrate from submerged waste rock in Natal Pit West was updated to exclude the time component (i.e., the mass of nitrate does not accumulate over the time between waste rock placement and waste rock submergence).

The updates listed above were not included in the version of the 2020 RWQM that was used for the sensitivity analyses.

Projected monthly average concentrations of nitrate, selenium, and sulphate at Order Stations, compliance points and in LCO Dry Creek for each analysis are shown in Appendices C to I.

4.1 Changes to Model Inputs Related to Water Availability

Water availability refers to the RWQM input values that inform the proportion of total watershed yield that is expected to be captured at each intake location for conveyance to an SRF or AWTF. Water availabilities for sources targeted for treatment in the 2022 IPA are provided in Annex B. The values assigned to water availability at most sources in the 2020 RWQM were set based on the proportion of total watershed yield that is assumed to be readily available as surface flow. At two sources (i.e., West Line Creek and Kilmarnock Creek), capture of some of the subsurface flow that would otherwise bypass the intake is also represented in the 2020 RWQM.

A sensitivity analysis was undertaken to identify how future projections could change with changes to water availability. Water availabilities at the following four sources were varied individually, while water availabilities of other sources were unchanged:

- Clode Creek
- Kilmarnock Creek groundwater
- West Line Creek groundwater
- Erickson Creek

The range in water availabilities considered in the sensitivity analysis are outlined in Table 4-1.

Table 4-1: Water Availabilities Considered in the Sensitivity Analysis

Source	Water Availability								
	2022 IPA	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8
Kilmarnock Creek - groundwater	75%	80%	50%	75%	75%	75%	75%	75%	75%
Clode Creek	85%	85%	85%	75%	60%	85%	85%	85%	85%
West Line Creek - groundwater	60%	60%	60%	60%	60%	50%	70%	60%	60%
Erickson Creek	95%	95%	95%	95%	95%	95%	95%	85%	70%

% = percent.

These sources were selected for the sensitivity analysis because they contain appreciable volumes of waste rock and are areas with ongoing investigations to characterize groundwater bypass and surface water - groundwater interactions. Thus, model projections downstream of these locations can be used to identify how future projections could change with changes to groundwater capture.

The sensitivity analysis was conducted with a focus on the nearest downstream Compliance Point. The 2020 RWQM was run with the 20 individual flow realizations and model output (i.e., individual weekly estimates) was processed to generate temporally-connected monthly average concentrations for each realization. The resulting monthly datasets were summarized by calculating P_{10}, P_{50}, and P_{90} values across the 20 realizations for each future month and each future year.

Projected monthly average concentrations of nitrate, selenium, and sulphate at the nearest downstream compliance points, with and without changes to water availability are shown in Appendix C.

Overall, increasing the water availability of sources targeted for treatment resulted in a decrease in projected concentrations at the nearest downstream compliance point, while decreasing the water availability of sources targeted for treatment resulted in the opposite effect (i.e., an increase in projected concentrations). This general pattern is not surprising, as reduced water availability equates to less water being available for and ultimately receiving treatment. However, the level of response at the nearest downstream compliance point to a similar level of change to water availability differed among the locations tested (i.e., same percentage change to water availability did not lead to a consistent comparable percentage change in constituent concentrations at the nearest downstream compliance point).

The sensitivity of projected concentrations at the FRO Compliance Point (FR_FRABCH; E223753) to changes to the water availability of Kilmarnock Creek groundwater was low relative to the other sources considered in the analysis. Increasing the water availability of Kilmarnock Creek groundwater from 75% to 80% (i.e., a change of 7% relative to the base assumption [5% / 75% = 7%]) resulted in a decrease in projected maximum P_{90} monthly average selenium concentrations (i.e., projected peak concentrations) by 1%, on average, at the FRO Compliance Point. Decreasing the water availability from 75% to 50% (i.e., a change of 33% relative to the base assumption [25% / 75% = 33%]) resulted in an increase in projected peak concentrations by 5%, on average, at the FRO Compliance Point (Table 4-2). Thus, while collection of Kilmarnock Creek groundwater is an important element of the 2022 IPA, uncertainty in the assumption related to groundwater availability would appear to have a limited influence on projected peak concentrations in the Fording River.

Table 4-2: Projected Selenium Concentrations at the FRO Compliance Point (FR_FRABCH; E223753) with and without Changes to Water Availability

Year[a]	Projected Maximum P_{90} Monthly Average Selenium Concentrations (µg/L)					Relative Difference (%)[b]			
	2022 IPA (Kilmarnock 75%; Clode 85%)	Kilmarnock 80%	Kilmarnock 50%	Clode 75%	Clode 60%	Kilmarnock 80%	Kilmarnock 50%	Clode 75%	Clode 60%
2024	73	n/a	n/a	74	74	n/a	n/a	1%	2%
2025	70	n/a	n/a	71	71	n/a	n/a	1%	2%
2026	67	n/a	n/a	68	69	n/a	n/a	1%	2%
2027	64	63	64	64	64	0%	0%	0%	1%
2028	52	52	54	53	53	-1%	3%	2%	2%
2029	52	52	54	53	53	-1%	3%	2%	2%
2030	52	52	54	53	54	-1%	4%	2%	2%
2031	53	53	56	55	55	-1%	4%	2%	3%
2032	54	54	56	55	55	-1%	4%	2%	3%
2033	55	54	57	56	56	-1%	4%	2%	2%
2034	53	53	56	54	55	-1%	5%	2%	3%

Table 4-2: Projected Selenium Concentrations at the FRO Compliance Point (FR_FRABCH; E223753) with and without Changes to Water Availability

Year[a]	Projected Maximum P_{90} Monthly Average Selenium Concentrations (µg/L)					Relative Difference (%)[b]			
	2022 IPA (Kilmarnock 75%; Clode 85%)	Kilmarnock 80%	Kilmarnock 50%	Clode 75%	Clode 60%	Kilmarnock 80%	Kilmarnock 50%	Clode 75%	Clode 60%
2035	53	52	55	53	54	-1%	5%	2%	3%
2036	53	52	56	54	54	-1%	6%	2%	3%
2037	54	53	57	55	56	-1%	6%	2%	4%
2038	53	52	56	54	55	-1%	6%	2%	4%
2039	54	53	57	55	56	-1%	6%	2%	4%
2040	54	53	57	55	56	-1%	6%	2%	4%
2041	54	54	57	55	56	-1%	6%	2%	4%
2042	55	54	58	56	57	-1%	6%	2%	4%
2043	55	55	59	56	58	-1%	6%	2%	4%
2044	55	55	59	56	58	-1%	6%	2%	4%
2045	56	55	59	57	58	-1%	6%	2%	4%
2046	57	56	60	58	59	-1%	6%	2%	4%
2047	57	56	60	58	59	-1%	6%	2%	4%
2048	57	56	60	58	59	-1%	6%	2%	4%
2049	57	57	60	58	59	-1%	6%	2%	4%
2050	58	57	61	59	60	-1%	6%	2%	4%
2051	58	57	61	59	60	-1%	6%	2%	4%
2052	58	57	61	59	60	-1%	6%	2%	4%
2053	58	57	61	59	60	-1%	6%	2%	4%
Average						-1%	5%	2%	3%

µg/L = micrograms per litre; n/a = not applicable; % = percent.
(a) Start year corresponds to year when collection of Clode Creek is assumed to begin.
(b) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA. Negative values indicate a decrease in projected concentrations compared to the 2022 IPA.

Similarly, the sensitivity of projected concentrations at the FRO Compliance Point to changes to the water availability in Clode Creek was low relative to the other sources considered in the analysis. Decreasing the water availability in Clode Creek from 85% to 75% (i.e., a change of 12% relative to the base assumption [10% / 85% = 12%]) resulted in an increase in projected peak concentrations by 2%, on

average, at the FRO Compliance Point. Decreasing the water availability from 85% to 60% (i.e., a change of 29% relative to the base assumption [25% / 85% = 29%]) resulted in an increase in projected peak concentrations by 3%, on average, at the FRO Compliance Point (Table 4-2).

These results should not be interpreted to mean that the collection of groundwater from Kilmarnock Creek or water from Clode Creek are not relevant to achieving the goals of the 2022 IPA. Rather, they indicate that the results outlined in the 2022 IPA will not change dramatically if water availability at the two aforementioned areas differ somewhat from those assumed.

The sensitivity of projected concentrations at the LCO Compliance Point (LC_LCDSSLCC; E297110) to changes to the water availability of West Line Creek groundwater was moderate relative to the other sources considered in the analysis. Increasing the water availability of West Line Creek groundwater from 60% to 70% (i.e., a change of 17% relative to the base assumption [10% / 60% = 17%]) resulted in a decrease in projected peak concentrations by 8%, on average, at the LCO Compliance Point. Decreasing the water availability from 60% to 50% (i.e., a change of 17% relative to the base assumption [10% / 60% = 17%]) resulted in an increase in projected peak concentrations by 8%, on average, at the LCO Compliance Point (Table 4-3).

Table 4-3: Projected Selenium Concentrations at the LCO Compliance Point (LC_LCDSSLCC; E297110) with and without Changes to Water Availability

Year[a]	Projected Maximum P_{90} Monthly Average Selenium Concentrations (µg/L)			Relative Difference (%)[b]	
	2022 IPA 60%	West Line 70%	West Line 50%	West Line 70%	West Line 50%
2030	43	43	43	-1%	0%
2031	43	43	43	0%	0%
2032	42	42	42	0%	-1%
2033	36	37	35	3%	-2%
2034	29	31	27	7%	-7%
2035	28	30	25	9%	-9%
2036	28	30	25	8%	-9%
2037	27	30	25	10%	-10%
2038	27	30	24	10%	-10%
2039	27	30	25	10%	-10%
2040	27	30	25	10%	-10%
2041	28	30	25	10%	-10%
2042	28	30	25	9%	-10%
2043	28	30	25	9%	-10%
2044	28	30	25	9%	-10%
2045	28	30	25	9%	-10%

Table 4-3: Projected Selenium Concentrations at the LCO Compliance Point (LC_LCDSSLCC; E297110) with and without Changes to Water Availability

Year[a]	Projected Maximum P_{90} Monthly Average Selenium Concentrations (µg/L)			Relative Difference (%)[b]	
	2022 IPA 60%	West Line 70%	West Line 50%	West Line 70%	West Line 50%
2046	27	30	25	10%	-10%
2047	28	30	25	10%	-10%
2048	27	30	25	9%	-10%
2049	27	30	25	10%	-10%
2050	27	29	24	10%	-10%
2051	27	29	24	10%	-10%
2052	27	29	24	10%	-10%
2053	27	29	24	10%	-10%
Average				8%	-8%

µg/L = micrograms per litre; % = percent.

(a) Start year corresponds to year when collection of West Line Creek groundwater is assumed to begin.

(b) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA. Negative values indicate a decrease in projected concentrations compared to the 2022 IPA.

The sensitivity of projected concentrations at the EVO Michel Creek Compliance Point (EV_MC2; E300091) to changes to the water availability in Erickson Creek was high relative to the other sources considered in the analysis. Decreasing the water availability in Erickson Creek from 95% to 85% (i.e., a change of 11% relative to the base assumption [10% / 95% = 11%]) resulted in an increase in projected peak concentrations by 10%, on average, at the EVO Michel Creek Compliance Point. Decreasing the water availability from 95% to 70% (i.e., a change of 26% relative to the base assumption [25% / 95% = 26%]) resulted in an increase in projected peak concentrations by 27%, on average, at the EVO Michel Creek Compliance Point (Table 4-4).

The sensitivity of projected concentrations at the FRO Compliance Point to changes to the water availabilities of Kilmarnock Creek groundwater and Clode Creek was low relative to the other sources considered in the analysis because there are multiple sources with high selenium loads and instream concentrations targeted for treatment at FRO (see Table 2-3 in Annex B). The sensitivity of projected concentrations at the EVO Michel Creek Compliance Point to changes to the water availability in Erickson Creek was high relative to the other sources considered in the analysis because Erickson Creek has high selenium loads and instream concentrations relative to other sources (i.e., Natal Pit) targeted for treatment at EVO (see Table 2-6 in Annex B). In other words, the larger the contribution of an individual tributary to instream concentrations at the downstream compliance point, the more sensitive projected concentrations at that location will be to changes to/uncertainty in the water availability at the intake location of that tributary.

Table 4-4: Projected Selenium Concentrations at the EVO Michel Creek Compliance Point (EV_MC2; E300071) with and without Changes to Water Availability

Year[a]	Projected Maximum P_{90} Monthly Average Selenium Concentrations (µg/L)			Relative Difference (%)[b]	
	2022 IPA 95%	Erickson 85%	Erickson 70%	Erickson 85%	Erickson 70%
2022	16	16	17	1%	6%
2023	17	17	18	1%	6%
2024	17	17	18	1%	6%
2025	17	18	18	2%	6%
2026	18	18	19	2%	7%
2027	18	19	20	2%	8%
2028	17	18	20	4%	13%
2029	16	18	20	11%	27%
2030	15	17	20	11%	30%
2031	15	17	20	11%	32%
2032	15	17	20	12%	32%
2033	16	18	21	13%	31%
2034	16	18	21	14%	30%
2035	17	18	21	11%	28%
2036	17	19	21	12%	29%
2037	17	19	21	10%	27%
2038	17	19	22	10%	27%
2039	17	19	22	11%	27%
2040	17	19	22	12%	27%
2041	17	19	22	11%	27%
2042	16	18	21	13%	34%
2043	16	18	22	14%	36%
2044	16	18	22	13%	35%
2045	16	18	22	13%	36%
2046	16	18	22	14%	38%
2047	16	18	22	15%	39%
2048	16	18	22	15%	39%
2049	16	18	22	14%	37%
2050	16	18	22	13%	36%

Table 4-4: Projected Selenium Concentrations at the EVO Michel Creek Compliance Point (EV_MC2; E300071) with and without Changes to Water Availability

Year[a]	Projected Maximum P_{90} Monthly Average Selenium Concentrations (µg/L)			Relative Difference (%)[b]	
	2022 IPA 95%	Erickson 85%	Erickson 70%	Erickson 85%	Erickson 70%
2051	16	18	22	14%	37%
2052	16	18	22	14%	37%
2053	16	18	22	15%	38%
Average				10%	27%

µg/L = micrograms per litre; % = percent.
(a) Start year corresponds to year when collection of Erickson Creek is assumed to begin.
(b) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA. Negative values indicate a decrease in projected concentrations compared to the 2022 IPA.

4.2 Changes to Model Inputs Related to Nitrate Content

In the 2020 update, explosives residue that is generated during blasting was understood to be the only source of nitrate released from waste rock (Teck 2021a). Once in the spoil, the nitrate dissolved into water percolating through the spoil, and was gradually leached out of the spoil over time. The rate at which nitrate was washed out of a given volume of waste rock was dependent on leaching efficiency. The higher the leaching efficiency, the faster the nitrate washed out of the spoil.

More recently, the conceptual model for nitrate release from waste rock was expanded to include another source of nitrogen: naturally occurring ammonium. Naturally occurring ammonium can be released from particles of waste rock through ion exchange and may be present at concentrations comparable to or greater than typically expected concentrations in explosives residue. Explosives residue is present on particle surfaces and is immediately available for leaching. In contrast, exchangeable ammonium must diffuse out of particles resulting in time lag which is short for fine particles and longer for coarse particles, and influenced by the breakdown of rock overtime. The current understanding is that both processes (i.e., explosives residue and exchangeable ammonium) can be approximated as a flush, with explosives residue yielding the initial nitrate loading and exchangeable ammonium yielding a tail which is higher than the pre-mining baseline.

The 2020 RWQM has not been updated to include a second source of nitrogen (i.e., exchangeable ammonium) because it was a recent finding; however, the conceptual and numerical models for nitrate release from waste rock will be updated to include exchangeable ammonium for the next model update in 2023.

A sensitivity analysis was undertaken to identify how future projections could change with a simplistic consideration of exchangeable ammonium. The analysis involved decreasing the leaching efficiency[1] applied to waste rock spoils in the model by 50% beginning January 1, 2020. The lower the leaching efficiency, the slower the nitrate washes out of the spoil resulting in a tail with higher nitrate concentrations. It is acknowledged that the approach is simplistic. It is intended to support an understanding of the change to the tail of the projected nitrate concentrations and is expected to poorly represent projected nitrate concentrations in the near term. The analysis was conducted with a focus on Order Stations and Compliance Points in the Fording River watershed where nitrate concentrations are projected to be above SPOs and/or compliance limits in the near-term. The 2020 RWQM was run with the 20 individual flow realizations and model output (i.e., individual weekly estimates) was processed to generate temporally-connected monthly average concentrations for each realization. The resulting monthly datasets were summarized by calculating P_{10}, P_{50}, and P_{90} values across the 20 realizations for each future month and each future year.

Projected monthly average concentrations of nitrate at Order Stations and compliance points in the Fording River watershed, as well as in LCO Dry Creek, with and without changes to nitrate content in waste rock spoils are shown in Appendix D.

Overall, reducing the leaching efficiency applied to waste rock spoils in the model by 50% beginning on January 1, 2020 resulted in lower projected concentrations of nitrate at Order Stations and compliance points in the Fording River watershed and in LCO Dry Creek from 2020 to the late 2030s or early 2040s, depending on the location, and higher projected concentrations from the late 2030s or early 2040s onward. This pattern is not surprising because reducing the leaching efficiency means that nitrate is washed out of the spoil more slowly resulting initially in lower projected concentrations and eventually in prolonged and higher projected concentrations.

Although reducing the leaching efficiency applied to waste rock spoils in the model by 50% beginning on January 1, 2020 resulted in higher projected concentrations at Order Stations and compliance points in the Fording River watershed and in LCO Dry Creek from the late 2030s or early 2040s onward, the absolute differences in projected concentrations were small (i.e., less than 1 mg-N/L). The small absolute differences in projected concentrations are not surprising because SRFs and AWTFs were sized so that projected selenium concentrations would be below SPOs and Compliance Limits. By 2033, there will be enough hydraulic capacity at the SRFs and AWTFs in the Fording River watershed to treat the prolonged and elevated nitrate concentrations that would result from a 50% reduction in leaching efficiency.

Reducing the leaching efficiency applied to waste rock spoils in the model by 50% beginning on January 1, 2020 resulted in:

- A decrease in projected maximum P90 monthly average nitrate concentrations (i.e., projected peak concentrations) at the FRO Compliance Point (FR_FRABCH; E223753) ranging from 3% to 38% between 2020 and 2034 and an increase in projected peak concentrations ranging from 0% to 26% between 2035 and 2053 (Table 4-5).

[1] Leaching efficiency is the rate at which nitrate washes out of a given volume of waste rock. The higher the leaching efficiency, the faster the nitrate washes out of a spoil. The lower the leaching efficiency, the slower the nitrate washes out of the spoil resulting in a tail with higher nitrate concentrations.

- A decrease in projected peak concentrations at LCO Dry Creek downstream of the Sedimentation Ponds (LC_DCDS; E295210) ranging from 1% to 46% between 2020 and 2039 and an increase in projected peak concentrations ranging from 0% to 31% between 2040 and 2053 (Table 4-5).
- A decrease in projected peak concentrations at the LCO Compliance Point (LC_LCDSSLCC; E297110) ranging from 3% to 37% between 2020 and 2042 and an increase in projected peak concentrations ranging from 0% to 102% between 2043 and 2053 (Table 4-5).

The influence of leaching efficiency at Order Stations in the Fording River was similar in terms of absolute and relative change (Table 4-6). As noted above, when peak nitrate concentrations were projected to increase, the absolute differences in projected peak concentrations were less than 1 mg-N/L at all locations.

Although the numerical model has not been updated to include a second source of nitrogen (i.e., exchangeable ammonium), the results of this sensitivity analysis indicate that exchangeable ammonium may have limited influence on projected peak concentrations in the Fording River watershed because treatment vessels, sized for selenium compliance, will be large enough to treat prolonged and elevated nitrate concentrations. That being said, it is acknowledged that this sensitivity analysis is a simplified approach meant to consider the concept of exchangeable ammonium. The concept of exchangeable ammonium will be incorporated into the numerical model as part of the next model update in 2023.

Table 4-5: Projected Nitrate Concentrations at Compliance Points in the Fording River Watershed and in LCO Dry Creek with and without Changes to Nitrate Content

Year	Projected Maximum P_{90} Monthly Average Nitrate Concentrations (mg/L)											
	FR_FRABCH				LC_DCDS				LC_LCDSSLCC			
	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]
2020	27	23	-3.1	-12%	72	39	-33	-46%	11	7.7	-3.5	-31%
2021	28	18	-10	-36%	91	50	-41	-45%	12	7.5	-4.4	-37%
2022	29	18	-11	-38%	97	56	-41	-42%	13	8.4	-4.8	-36%
2023	24	15	-8.8	-36%	75	47	-28	-38%	13	8.4	-4.8	-36%
2024	20	13	-7.0	-35%	16	10	-5.5	-35%	11	7.3	-3.3	-31%
2025	18	12	-5.7	-32%	14	10	-4.5	-31%	9.8	6.8	-3.0	-30%
2026	17	12	-4.6	-28%	14	10	-3.9	-28%	4.0	2.9	-1.1	-27%
2027	15	11	-3.9	-25%	12	9.1	-3.1	-25%	3.8	2.9	-0.9	-22%
2028	12	10	-2.5	-20%	10	8.0	-2.3	-22%	3.5	2.9	-0.6	-18%
2029	11	9.4	-1.9	-17%	9.5	7.7	-1.8	-19%	3.4	2.9	-0.5	-15%
2030	10	9.0	-1.5	-14%	9.0	7.6	-1.4	-16%	3.1	2.8	-0.4	-11%
2031	10	9.0	-1.2	-12%	8.8	7.6	-1.2	-14%	2.5	2.1	-0.5	-19%
2032	9.5	8.8	-0.8	-8%	8.3	7.5	-0.8	-10%	2.4	2.0	-0.4	-16%
2033	9.1	8.6	-0.4	-5%	8.0	7.4	-0.6	-8%	2.2	1.9	-0.3	-13%
2034	8.3	8.1	-0.2	-3%	7.6	7.2	-0.4	-5%	2.4	2.1	-0.3	-13%
2035	7.2	7.2	0.0	0%	6.7	6.4	-0.2	-4%	2.4	2.1	-0.3	-13%
2036	7.0	7.0	0.0	1%	6.4	6.2	-0.2	-3%	2.3	2.1	-0.2	-10%
2037	6.8	6.8	0.1	1%	6.2	6.0	-0.2	-3%	2.2	2.0	-0.2	-8%

Table 4-5: Projected Nitrate Concentrations at Compliance Points in the Fording River Watershed and in LCO Dry Creek with and without Changes to Nitrate Content

Year	Projected Maximum P_{90} Monthly Average Nitrate Concentrations (mg/L)											
	FR_FRABCH				LC_DCDS				LC_LCDSSLCC			
	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]
2038	6.3	6.5	0.2	3%	5.9	5.8	-0.1	-1%	2.3	2.1	-0.2	-8%
2039	5.9	6.3	0.3	6%	5.8	5.8	0.0	-1%	2.4	2.2	-0.2	-9%
2040	5.4	5.9	0.5	10%	5.6	5.6	0.0	0%	2.5	2.2	-0.2	-10%
2041	5.0	5.7	0.7	14%	5.3	5.5	0.2	3%	2.4	2.2	-0.2	-7%
2042	4.6	5.4	0.8	18%	5.1	5.3	0.1	3%	2.2	2.1	-0.1	-3%
2043	4.2	5.2	0.9	22%	4.8	5.0	0.2	4%	2.1	2.1	0.0	0%
2044	4.0	4.9	0.9	23%	4.1	4.7	0.6	16%	1.8	1.9	0.1	6%
2045	3.8	4.7	0.9	24%	3.8	4.5	0.7	19%	1.6	1.8	0.2	14%
2046	3.7	4.6	0.9	23%	3.6	4.4	0.8	21%	1.3	1.6	0.3	23%
2047	3.6	4.5	0.8	23%	3.4	4.2	0.8	24%	1.1	1.5	0.4	32%
2048	3.4	4.3	0.8	24%	3.2	4.0	0.8	26%	0.98	1.4	0.4	40%
2049	3.3	4.1	0.8	26%	2.9	3.8	0.9	29%	0.86	1.3	0.4	49%
2050	3.4	4.1	0.7	20%	2.9	3.7	0.8	27%	0.74	1.2	0.4	60%
2051	3.4	4.0	0.6	18%	2.9	3.6	0.7	26%	0.63	1.1	0.5	73%
2052	3.2	3.9	0.7	20%	2.7	3.5	0.8	28%	0.54	1.0	0.5	88%
2053	3.1	3.7	0.7	22%	2.5	3.3	0.8	31%	0.47	0.95	0.5	102%

mg/L = milligrams per litre; % = percent.

(a) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA. Negative values indicate a decrease in projected concentrations compared to the 2022 IPA.

Table 4-6: Projected Nitrate Concentrations at Order Stations in the Fording River Watershed with and without Changes to Nitrate Content

Year	Projected Maximum P_{90} Monthly Average Nitrate Concentrations (mg/L)							
	GH_FR1				LC_LC5			
	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]
2020	18	15	-2.8	-15%	14	11	-2.5	-18%
2021	20	13	-6.7	-34%	15	10	-4.9	-33%
2022	20	13	-7.6	-37%	16	10	-5.9	-37%
2023	18	11	-6.6	-37%	14	9.1	-5.3	-37%
2024	15	10	-5.3	-35%	12	8.0	-4.2	-34%
2025	14	9.4	-4.4	-32%	11	7.6	-3.5	-31%
2026	12	8.7	-3.5	-29%	8.8	6.2	-2.5	-29%
2027	11	8.5	-2.9	-25%	8.1	6.0	-2.1	-26%
2028	9.9	7.6	-2.3	-24%	7.2	5.5	-1.7	-24%
2029	9.3	7.4	-1.9	-20%	6.8	5.4	-1.4	-20%
2030	8.8	7.3	-1.5	-17%	6.5	5.3	-1.1	-18%
2031	8.6	7.3	-1.3	-15%	6.2	5.2	-1.0	-16%
2032	8.3	7.3	-1.1	-13%	6.0	5.2	-0.8	-13%
2033	8.4	7.5	-1.0	-12%	6.0	5.4	-0.7	-11%
2034	6.1	5.8	-0.3	-5%	4.7	4.4	-0.3	-7%
2035	5.2	5.0	-0.1	-3%	3.9	3.8	-0.1	-4%
2036	5.2	5.0	-0.2	-4%	3.8	3.7	-0.1	-2%
2037	5.0	4.9	-0.1	-2%	3.6	3.6	0.0	-1%
2038	5.0	4.9	-0.1	-2%	3.6	3.6	0.0	-1%
2039	5.0	4.9	-0.1	-2%	3.6	3.6	0.0	-1%
2040	4.8	4.8	0.1	1%	3.5	3.5	0.0	0%
2041	4.3	4.6	0.2	5%	3.1	3.3	0.2	7%
2042	4.0	4.4	0.4	10%	2.9	3.2	0.3	10%
2043	3.7	4.2	0.5	14%	2.7	3.1	0.4	14%
2044	3.3	4.0	0.6	20%	2.4	2.8	0.5	20%
2045	2.9	3.7	0.8	26%	2.1	2.7	0.5	24%
2046	2.7	3.5	0.8	30%	2.0	2.5	0.5	24%
2047	2.5	3.2	0.7	30%	1.9	2.3	0.5	25%

Table 4-6: Projected Nitrate Concentrations at Order Stations in the Fording River Watershed with and without Changes to Nitrate Content

Year	Projected Maximum P_{90} Monthly Average Nitrate Concentrations (mg/L)							
	GH_FR1				LC_LC5			
	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[(a)]
2048	2.3	3.1	0.7	32%	1.7	2.2	0.5	29%
2049	2.2	2.9	0.7	32%	1.6	2.1	0.5	32%
2050	2.1	2.8	0.6	31%	1.6	2.0	0.5	31%
2051	2.1	2.7	0.6	28%	1.5	2.0	0.4	29%
2052	2.0	2.6	0.6	29%	1.5	1.9	0.4	31%
2053	1.9	2.5	0.6	30%	1.4	1.8	0.5	34%

mg/L = milligrams per litre; % = percent.

(a) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA. Negative values indicate a decrease in projected concentrations compared to the 2022 IPA.

4.3 Changes to Model Inputs Related to Selenium and Sulphate Release Rates

Results from longer-term humidity cell tests indicate that selenium and sulphate release rates from waste rock decline over time as sulphide minerals are depleted (Teck 2021a). The decline tends to follow first order decay kinetics. The 2020 RWQM includes functionality to maintain selenium and sulphate release rates unchanged over the entire simulation period or to allow the release rates to decline over time, on a sub-catchment by sub-catchment basis, once spoiling in a given area has effectively stopped. The 2020 RWQM has been calibrated and future projections generated assuming no decline in selenium and sulphate release rates over time.

A sensitivity analysis was undertaken to identify how future projections could change with consideration of decay. One decay rate (i.e., Decay Rate 2) was evaluated (Table 4-7; Teck 2021a). This evaluation was conducted with a focus on Order Stations and Compliance Points. The 2020 RWQM was run with the 20 individual flow realizations and model output (i.e., individual weekly estimates) was processed to generate temporally-connected monthly average concentrations for each realization. The resulting monthly datasets were summarized by calculating P_{10}, P_{50}, and P_{90} values across the 20 realizations for each future month and each future year.

Table 4-7: Rate of Decay Applied to Selenium and Sulphate Release Rates Once Spoiling in a Catchment Ceases

Year	Fraction of Initial Release Rate			
	Default Setting	Decay Rate 1	Decay Rate 2	Decay Rate 3
0	1	1	1	1
1	1	0.97	0.98	0.99
10	1	0.71	0.81	0.86
20	1	0.5	0.66	0.75

Table 4-7: Rate of Decay Applied to Selenium and Sulphate Release Rates Once Spoiling in a Catchment Ceases

Year	Fraction of Initial Release Rate			
	Default Setting	Decay Rate 1	Decay Rate 2	Decay Rate 3
30	1	0.35	0.53	0.65
40	1	0.25	0.43	0.56
50	1	0.18	0.35	0.48
60	1	0.12	0.28	0.42
70	1	0.087	0.23	0.36
80	1	0.062	0.18	0.31
90	1	0.043	0.15	0.27
100	1	0.031	0.12	0.23
110	1	0.022	0.1	0.2
120	1	0.015	0.079	0.17
130	1	0.011	0.064	0.15
140	1	0.0076	0.052	0.13
150	1	0.0054	0.042	0.11
160	1	0.0038	0.034	0.1
170	1	0.0027	0.028	0.084
180	1	0.0019	0.022	0.073
190	1	0.0013	0.018	0.063
200	1	0.00094	0.015	0.054

Source: Teck 2021a.

Projected monthly average concentrations of selenium and sulphate at Order Stations and compliance points, with and without application of first order decay to selenium and sulphate release rates are shown in Appendix E.

Overall, application of first order decay to selenium and sulphate release rates resulted in lower projected concentrations of both constituents at all Order Stations and compliance points, once spoiling in upstream areas had effectively stopped. The relative difference in projected concentrations of both constituents with and without application of first order decay to selenium and sulphate release rates increased with time at all Order Stations and compliance points. These patterns are not surprising, as application of first order decay to selenium and sulphate release rates equates to less mass of selenium and sulphate being released from waste rock spoils overtime.

Application of first order decay to selenium release rates resulted in a decrease in projected maximum P_{90} monthly average selenium concentrations (i.e., projected peak concentrations) by approximately 20% in the Fording River, 22% in the Elk River, and 16% in Koocanusa Reservoir in 2053 (Tables 4-8 and 4-9). Similarly, application of first order decay to sulphate release rates resulted in a decrease in projected peak concentrations by approximately 12% in the Fording River, 12% in the Elk River, and 5% in Koocanusa Reservoir in 2053 (Tables 4-10 and 4-11).

Although the 2020 RWQM has been calibrated and future projections generated assuming no decline in selenium and sulphate release rates over time, the body of evidence to support first order decay to selenium and sulphate release rates from waste rock will continue to be developed.

Table 4-8: Projected Selenium Concentrations at Order Stations with and without Changes to Release Rates

Year	Projected Maximum P_{90} Monthly Average Selenium Concentrations (µg/L)																	
	LC_LC5			GH_ER1			EV_ER4			EV_ER1			RG_ELKORES			RG_DSELK		
	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]
2020	54	54	0%	4.7	4.7	0%	23	23	0%	18	18	0%	18	18	0%	2.4	2.4	0%
2021	61	61	0%	5.5	5.5	0%	26	26	0%	19	19	0%	19	19	0%	2.9	2.9	0%
2022	64	64	0%	6.2	6.2	0%	27	27	0%	19	19	0%	19	19	0%	2.8	2.8	0%
2023	55	55	0%	6.4	6.4	0%	24	24	0%	18	18	0%	18	18	0%	2.5	2.5	0%
2024	50	50	0%	6.5	6.5	0%	22	22	0%	16	16	0%	16	16	0%	2.3	2.3	0%
2025	48	48	0%	6.3	6.3	0%	21	21	0%	16	16	0%	16	16	0%	2.3	2.3	0%
2026	41	41	0%	6.2	6.2	0%	19	19	0%	15	15	0%	15	15	0%	2.2	2.2	0%
2027	39	39	0%	6.2	6.2	0%	18	18	0%	15	15	0%	15	15	0%	2.2	2.2	0%
2028	36	36	-1%	5.5	5.5	0%	16	16	0%	14	14	-1%	14	14	-1%	1.9	1.9	-1%
2029	36	36	-1%	4.9	4.9	0%	15	15	-1%	13	13	-1%	13	13	-1%	1.8	1.8	-1%
2030	37	37	-1%	4.8	4.8	0%	15	15	-1%	13	13	-1%	13	13	-1%	1.8	1.8	-1%
2031	37	37	-2%	4.7	4.7	0%	15	15	-1%	14	13	-1%	14	13	-1%	1.9	1.8	-1%
2032	38	38	-2%	4.6	4.6	-1%	16	15	-1%	14	14	-2%	14	14	-2%	1.9	1.8	-2%
2033	39	38	-2%	4.5	4.5	-1%	16	15	-1%	14	14	-2%	14	14	-2%	1.9	1.8	-2%
2034	33	32	-2%	4.5	4.4	-2%	14	13	-2%	13	13	-3%	13	13	-3%	1.8	1.8	-3%
2035	32	32	-2%	4.6	4.5	-3%	13	12	-2%	13	12	-4%	13	12	-4%	1.8	1.7	-3%
2036	33	33	-3%	4.6	4.4	-4%	13	12	-3%	13	13	-4%	13	13	-4%	1.7	1.7	-4%
2037	34	33	-3%	4.6	4.3	-6%	13	12	-3%	13	12	-6%	13	12	-6%	1.7	1.7	-5%
2038	35	34	-3%	4.6	4.2	-7%	13	12	-4%	12	12	-6%	12	12	-6%	1.7	1.6	-5%
2039	36	35	-3%	4.6	4.1	-9%	13	12	-5%	13	12	-7%	13	12	-7%	1.7	1.6	-6%
2040	36	35	-4%	4.5	4.1	-11%	13	13	-5%	13	12	-7%	13	12	-7%	1.8	1.6	-7%
2041	37	35	-5%	4.5	4.0	-12%	13	12	-7%	13	12	-8%	13	12	-8%	1.8	1.6	-7%
2042	37	35	-6%	4.5	3.9	-14%	13	12	-7%	11	10	-9%	11	10	-9%	1.7	1.6	-7%
2043	38	35	-7%	3.2	2.7	-14%	13	12	-8%	12	10	-10%	12	10	-10%	1.6	1.5	-8%
2044	38	35	-8%	2.7	2.3	-15%	13	12	-9%	11	10	-11%	11	10	-11%	1.6	1.5	-9%
2045	37	34	-10%	2.7	2.2	-18%	13	11	-10%	12	10	-12%	12	10	-12%	1.6	1.4	-10%
2046	37	33	-11%	2.6	2.1	-19%	13	11	-12%	11	10	-13%	11	10	-13%	1.6	1.4	-9%
2047	37	32	-13%	2.6	2.1	-20%	13	11	-13%	11	9.7	-14%	11	9.7	-14%	1.6	1.5	-10%
2048	37	32	-14%	4.9	3.9	-21%	13	11	-15%	12	9.8	-16%	12	9.8	-16%	1.6	1.4	-12%

Table 4-8: Projected Selenium Concentrations at Order Stations with and without Changes to Release Rates

Year	Projected Maximum P_{90} Monthly Average Selenium Concentrations (µg/L)																	
	LC_LC5			GH_ER1			EV_ER4			EV_ER1			RG_ELKORES			RG_DSELK		
	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]
2049	37	31	-15%	5.4	4.3	-21%	14	12	-16%	12	9.7	-17%	12	9.7	-17%	1.6	1.4	-12%
2050	37	31	-17%	5.6	4.4	-22%	14	11	-18%	12	9.7	-18%	12	9.7	-18%	1.6	1.4	-14%
2051	36	30	-18%	5.6	4.3	-23%	14	11	-19%	12	9.6	-19%	12	9.6	-19%	1.6	1.4	-15%
2052	36	29	-20%	5.5	4.3	-23%	14	11	-20%	12	9.5	-20%	12	9.5	-20%	1.7	1.4	-15%
2053	36	29	-21%	5.5	4.2	-24%	14	11	-21%	12	9.2	-21%	12	9.2	-21%	1.7	1.4	-16%

µg/L = micrograms per litre; % = percent.

(a) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA. Negative values indicate a decrease in projected concentrations compared to the 2022 IPA.

Table 4-9: Projected Selenium Concentrations at Compliance Points and in LCO Dry Creek with and without Changes to Release Rates

Year	Projected Maximum P_{90} Monthly Average Selenium Concentrations (µg/L)																			
	FR_FRABCH			LC_DCDS			GH_FR1			LC_LCDSSLCC			GH_ERC			EV_HC1			EV_MC2		
	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]
2020	100	100	0%	137	137	0%	70	70	0%	56	56	0%	5	4.9	0%	49	49	0%	25	25	0%
2021	114	114	0%	174	174	0%	80	80	0%	63	63	0%	6	5.8	0%	55	55	0%	23	23	0%
2022	122	122	0%	198	198	0%	85	85	0%	63	63	0%	7	6.6	0%	56	56	0%	16	16	0%
2023	87	87	0%	169	169	0%	69	69	0%	69	69	0%	7	6.8	0%	54	54	0%	17	17	0%
2024	73	73	0%	58	58	0%	60	60	0%	66	66	0%	7	6.9	0%	31	31	0%	17	17	0%
2025	70	70	0%	55	55	0%	58	58	0%	68	68	0%	7	6.8	0%	31	31	0%	17	17	0%
2026	67	67	0%	55	55	0%	54	54	0%	37	37	0%	7	6.6	0%	33	33	0%	18	18	-1%
2027	64	63	0%	49	49	0%	52	51	0%	38	38	0%	7	6.6	0%	39	39	0%	18	18	-1%
2028	52	52	0%	43	43	0%	44	44	-1%	40	40	0%	6	5.8	0%	41	41	0%	17	17	-2%
2029	52	52	0%	41	41	0%	45	44	-1%	42	42	0%	5	5.1	0%	44	44	0%	16	16	-2%
2030	52	52	-1%	42	42	-1%	45	45	-1%	43	42	-1%	5	5.1	0%	46	46	0%	15	15	-3%
2031	53	53	-1%	44	43	-1%	48	47	-1%	43	43	0%	5	5.0	0%	47	47	0%	15	15	-3%
2032	54	53	-1%	44	44	-1%	50	49	-2%	42	42	-1%	5	4.9	-1%	48	48	0%	15	15	-4%
2033	55	54	-1%	45	45	-1%	50	50	-2%	36	36	-1%	5	4.7	-1%	49	49	0%	16	15	-4%
2034	53	52	-1%	45	44	-1%	42	41	-2%	29	29	-1%	5	4.7	-2%	51	51	0%	16	15	-5%
2035	53	52	-1%	45	44	-1%	42	41	-2%	28	27	-1%	5	4.7	-3%	53	53	0%	17	15	-7%
2036	53	52	-2%	45	45	-1%	45	44	-2%	28	27	-1%	5	4.7	-4%	55	55	0%	17	15	-7%
2037	54	53	-2%	46	45	-2%	45	44	-2%	27	27	-2%	5	4.6	-6%	46	46	0%	17	15	-9%
2038	53	52	-2%	47	46	-2%	47	45	-3%	27	26	-3%	5	4.5	-8%	45	45	0%	17	15	-10%
2039	54	52	-2%	47	46	-2%	48	46	-3%	27	26	-4%	5	4.4	-9%	48	48	-1%	17	15	-11%
2040	54	52	-3%	48	47	-2%	49	47	-4%	27	26	-5%	5	4.3	-11%	52	51	-1%	17	15	-12%
2041	54	52	-4%	48	47	-3%	49	47	-5%	28	26	-7%	5	4.2	-13%	54	54	-1%	17	15	-14%
2042	55	52	-5%	50	48	-4%	50	47	-6%	28	26	-8%	5	4.1	-14%	54	54	-1%	16	13	-14%
2043	55	52	-6%	50	48	-5%	50	47	-7%	28	25	-9%	3	2.8	-14%	54	54	-1%	16	13	-16%
2044	55	51	-8%	49	46	-6%	50	46	-8%	28	25	-10%	3	2.4	-16%	53	53	-1%	16	13	-17%
2045	56	51	-9%	50	46	-7%	50	45	-9%	28	24	-11%	3	2.3	-18%	52	51	-2%	16	13	-17%
2046	57	51	-10%	51	46	-9%	50	44	-11%	27	24	-13%	3	2.2	-19%	52	49	-4%	16	13	-18%
2047	57	51	-11%	51	46	-10%	49	44	-12%	28	24	-14%	3	2.1	-21%	51	48	-6%	16	13	-19%
2048	57	50	-12%	51	45	-12%	50	43	-13%	27	23	-15%	5	4.1	-21%	50	46	-8%	16	13	-19%

Table 4-9: Projected Selenium Concentrations at Compliance Points and in LCO Dry Creek with and without Changes to Release Rates

Year	Projected Maximum P_{90} Monthly Average Selenium Concentrations (µg/L)																			
	FR_FRABCH			LC_DCDS			GH_FR1			LC_LCDSSLCC			GH_ERC			EV_HC1			EV_MC2		
	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]
2049	57	49	-14%	51	44	-13%	49	42	-15%	27	23	-17%	6	4.6	-21%	49	45	-10%	16	13	-21%
2050	58	49	-15%	51	44	-14%	49	41	-16%	27	22	-18%	6	4.6	-22%	49	43	-11%	16	13	-22%
2051	58	48	-16%	51	43	-16%	49	40	-18%	27	22	-19%	6	4.6	-23%	49	42	-13%	16	12	-22%
2052	58	47	-18%	51	42	-17%	49	39	-19%	27	21	-20%	6	4.5	-23%	48	41	-15%	16	12	-24%
2053	58	47	-20%	51	42	-19%	49	39	-21%	27	21	-21%	6	4.4	-24%	48	40	-17%	16	12	-25%

µg/L = micrograms per litre; % = percent.

(a) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA. Negative values indicate a decrease in projected concentrations compared to the 2022 IPA.

Table 4-10: Projected Sulphate Concentrations at Order Stations with and without Changes to Release Rates

Year	Projected Maximum P_{90} Monthly Average Sulphate Concentrations (mg/L)																	
	LC_LC5			GH_ER1			EV_ER4			EV_ER1			RG_ELKORES			RG_DSELK		
	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]
2020	279	279	0%	68	68	0%	154	154	0%	159	159	0%	159	159	0%	58	58	0%
2021	318	318	0%	78	78	0%	174	174	0%	173	173	0%	173	173	0%	61	61	0%
2022	338	338	0%	84	84	0%	182	182	0%	186	186	0%	186	186	0%	62	62	0%
2023	347	347	0%	84	84	0%	184	184	0%	185	185	0%	185	185	0%	63	63	0%
2024	356	356	0%	82	82	0%	187	187	0%	189	189	0%	189	189	0%	63	63	0%
2025	367	367	0%	81	81	0%	191	190	0%	197	196	0%	197	196	0%	65	65	0%
2026	348	347	0%	81	81	0%	186	186	0%	194	194	0%	194	194	0%	65	65	0%
2027	347	346	0%	82	82	0%	185	185	0%	197	197	0%	197	197	0%	65	65	0%
2028	343	342	0%	73	73	0%	182	181	0%	211	211	0%	211	211	0%	67	67	0%
2029	350	347	-1%	66	66	0%	181	180	-1%	207	206	-1%	207	206	-1%	67	66	0%
2030	357	353	-1%	64	64	0%	184	182	-1%	211	210	-1%	211	210	-1%	67	67	0%
2031	347	342	-1%	64	64	0%	183	181	-1%	215	213	-1%	215	213	-1%	67	67	0%
2032	347	341	-2%	64	64	0%	183	180	-1%	217	214	-1%	217	214	-1%	68	67	0%
2033	345	338	-2%	64	64	0%	183	180	-2%	218	215	-1%	218	215	-1%	68	67	-1%
2034	352	344	-2%	64	64	0%	186	182	-2%	220	216	-2%	220	216	-2%	68	68	-1%
2035	339	329	-3%	65	65	-1%	179	175	-2%	216	212	-2%	216	212	-2%	67	67	-1%
2036	337	324	-4%	66	65	-1%	179	174	-3%	222	217	-2%	222	217	-2%	67	67	-1%
2037	340	325	-4%	66	64	-2%	176	169	-4%	217	211	-3%	217	211	-3%	67	67	-1%
2038	324	307	-5%	66	64	-3%	172	164	-5%	214	207	-3%	214	207	-3%	67	66	-1%
2039	322	302	-6%	66	64	-4%	173	164	-5%	217	209	-4%	217	209	-4%	67	66	-2%
2040	322	301	-7%	66	63	-5%	173	163	-6%	218	209	-4%	218	209	-4%	68	66	-2%
2041	329	304	-7%	67	63	-6%	173	162	-7%	219	209	-4%	219	209	-4%	68	66	-2%
2042	328	301	-8%	67	62	-6%	174	161	-7%	213	203	-5%	213	203	-5%	67	66	-2%
2043	328	300	-9%	66	62	-7%	174	161	-8%	220	208	-5%	220	208	-5%	68	66	-2%
2044	324	295	-9%	66	61	-8%	174	160	-8%	224	211	-6%	224	211	-6%	68	66	-3%
2045	327	294	-10%	66	60	-9%	174	158	-9%	224	211	-6%	224	211	-6%	68	66	-3%
2046	327	292	-11%	65	59	-10%	173	156	-10%	224	209	-7%	224	209	-7%	68	66	-3%
2047	328	291	-11%	65	58	-11%	173	155	-10%	221	205	-7%	221	205	-7%	68	66	-3%
2048	324	286	-12%	92	83	-10%	180	161	-11%	222	205	-8%	222	205	-8%	68	66	-3%

Table 4-10: Projected Sulphate Concentrations at Order Stations with and without Changes to Release Rates

Year	Projected Maximum P_{90} Monthly Average Sulphate Concentrations (mg/L)																	
	LC_LC5			GH_ER1			EV_ER4			EV_ER1			RG_ELKORES			RG_DSELK		
	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]
2049	327	286	-12%	100	90	-10%	186	165	-11%	226	208	-8%	226	208	-8%	69	66	-4%
2050	322	280	-13%	102	91	-11%	187	165	-12%	235	215	-9%	235	215	-9%	69	67	-4%
2051	324	280	-14%	104	93	-11%	189	166	-12%	236	214	-9%	236	214	-9%	70	67	-4%
2052	323	277	-14%	104	92	-12%	189	165	-13%	233	211	-10%	233	211	-10%	70	67	-5%
2053	327	277	-15%	104	91	-12%	189	163	-14%	234	209	-11%	234	209	-11%	70	66	-5%

mg/L = milligrams per litre; % = percent.

(a) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA. Negative values indicate a decrease in projected concentrations compared to the 2022 IPA.

Table 4-11: Projected Sulphate Concentrations at Compliance Points and in LCO Dry Creek with and without Changes to Release Rates

Year	Projected Maximum P_{90} Monthly Average Sulphate Concentrations (mg/L)																			
	FR_FRABCH			LC_DCDS			GH_FR1			LC_LCDSSLCC			GH_ERC			EV_HC1			EV_MC2		
	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]
2020	424	424	0%	376	376	0%	320	320	0%	377	377	0%	71	71	0%	298	298	0%	193	193	0%
2021	509	509	0%	466	466	0%	370	370	0%	420	420	0%	82	82	0%	334	334	0%	210	210	0%
2022	534	534	0%	548	548	0%	395	395	0%	428	428	0%	88	88	0%	348	348	0%	219	219	0%
2023	536	536	0%	513	513	0%	403	403	0%	459	459	0%	89	89	0%	343	343	0%	223	223	0%
2024	557	556	0%	441	441	0%	416	416	0%	460	460	0%	86	86	0%	312	312	0%	230	230	0%
2025	572	571	0%	454	454	0%	428	428	0%	470	470	0%	85	85	0%	323	323	0%	237	236	0%
2026	570	569	0%	458	458	0%	434	433	0%	332	332	0%	85	85	0%	336	336	0%	240	240	0%
2027	520	518	0%	419	418	0%	415	414	0%	369	369	0%	86	86	0%	351	351	0%	254	253	0%
2028	511	509	0%	412	410	0%	405	403	-1%	384	383	0%	77	77	0%	364	364	0%	331	330	0%
2029	527	524	-1%	430	427	-1%	420	416	-1%	401	398	-1%	68	68	0%	376	376	0%	278	276	0%
2030	544	539	-1%	445	441	-1%	428	423	-1%	407	401	-1%	67	67	0%	392	392	0%	282	281	-1%
2031	506	501	-1%	412	408	-1%	412	406	-1%	386	379	-2%	67	67	0%	404	403	0%	288	286	-1%
2032	505	500	-1%	409	405	-1%	411	404	-2%	403	394	-2%	67	67	0%	416	416	0%	295	292	-1%
2033	522	516	-1%	424	420	-1%	410	402	-2%	373	361	-3%	67	67	0%	426	426	0%	303	300	-1%
2034	534	527	-1%	435	429	-1%	427	417	-2%	360	345	-4%	67	67	0%	385	385	0%	309	306	-1%
2035	495	488	-1%	401	395	-1%	405	394	-3%	374	358	-5%	68	67	-1%	360	359	0%	323	320	-1%
2036	480	468	-2%	391	382	-2%	400	385	-4%	385	367	-5%	69	67	-1%	369	368	0%	338	334	-1%
2037	477	463	-3%	385	375	-3%	401	384	-4%	394	371	-6%	69	67	-2%	376	375	0%	335	330	-1%
2038	480	465	-3%	387	376	-3%	390	371	-5%	350	321	-8%	69	67	-3%	392	391	0%	338	333	-1%
2039	479	463	-3%	385	373	-3%	387	366	-5%	347	314	-10%	69	66	-4%	366	365	0%	347	342	-1%
2040	479	461	-4%	383	370	-3%	388	365	-6%	354	318	-10%	69	66	-5%	389	388	0%	354	348	-2%
2041	486	464	-5%	397	380	-4%	397	371	-7%	353	315	-11%	69	65	-6%	404	403	0%	355	349	-2%
2042	486	462	-5%	392	374	-5%	396	367	-7%	354	312	-12%	69	65	-7%	419	417	0%	334	328	-2%
2043	487	461	-5%	394	374	-5%	396	365	-8%	350	303	-13%	69	64	-7%	426	424	0%	358	350	-2%
2044	485	457	-6%	392	371	-5%	389	357	-8%	353	301	-15%	69	63	-8%	433	431	0%	387	375	-3%
2045	488	459	-6%	396	374	-6%	395	360	-9%	348	295	-15%	69	62	-9%	436	430	-1%	389	377	-3%
2046	489	459	-6%	394	371	-6%	395	359	-9%	343	287	-16%	68	61	-10%	433	420	-3%	387	374	-3%
2047	492	460	-7%	398	372	-6%	399	360	-10%	337	277	-18%	68	60	-11%	432	413	-4%	392	378	-4%
2048	492	457	-7%	397	370	-7%	396	356	-10%	335	272	-19%	97	87	-10%	431	407	-6%	390	375	-4%

Table 4-11: Projected Sulphate Concentrations at Compliance Points and in LCO Dry Creek with and without Changes to Release Rates

Year	Projected Maximum P_{90} Monthly Average Sulphate Concentrations (mg/L)																				
	FR_FRABCH			LC_DCDS			GH_FR1			LC_LCDSSLCC			GH_ERC			EV_HC1			EV_MC2		
	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]
2049	493	458	-7%	398	370	-7%	399	356	-11%	333	266	-20%	106	95	-10%	434	405	-7%	394	377	-4%
2050	497	459	-8%	399	370	-7%	394	350	-11%	331	259	-22%	108	96	-11%	430	395	-8%	393	375	-5%
2051	500	460	-8%	401	370	-8%	397	351	-12%	327	252	-23%	110	98	-11%	433	393	-9%	392	372	-5%
2052	500	456	-9%	404	371	-8%	399	350	-12%	325	246	-24%	110	97	-12%	433	387	-10%	394	371	-6%
2053	501	455	-9%	407	371	-9%	402	350	-13%	323	239	-26%	110	96	-13%	431	381	-12%	396	370	-7%

mg/L = milligrams per litre; % = percent.

(a) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA. Negative values indicate a decrease in projected concentrations compared to the 2022 IPA.

4.4 Changes to Model Inputs Related to Climate

4.4.1 Water Flow

Water flows in the 2020 RWQM are estimated using three different approaches, as outlined in Teck (2021). Water flows in the Fording River watershed (including those at FRO and LCO) and in tributaries at GHO and EVO (mine and non-mine influenced) are simulated using climate inputs, which feed into a snowfall runoff module (SRM) or a waste rock hydrology module. Water flows in the Elk River are estimated directly from measured data, and water flows in Michel Creek upstream of EVO are estimated using a ranked regression relationship that allows for flows in Michel Creek to be estimated from those measured in the Elk River. Given this configuration, the potential influence of climate change on projected water flows was estimated using a three-step approach:

1. Update climate inputs used by the Flow Component of the 2020 RWQM to reflect the potential influence of climate change, then run the model to estimate potential changes to flow in the Fording River watershed and in tributaries at other operations (i.e., along the western face of GHO and at EVO).

2. Develop statistical relationships between Elk River and Fording River flows, so that projected changes to flows in the Fording River under climate change can be used to estimate potential changes to Elk River flows.

3. Estimate potential changes to flow in Michel Creek under climate change using estimated flows in the Elk River under climate change and the previously established ranked regression relationships described in Teck (2021) that link flows in Michel Creek to flows in the Elk River.

Step 1 was conducted using climate information generated from a group of global climate models statistically downscaled to a 10 km grid resolution. This information was obtained through Climatedata.ca and used to estimate the potential influence of climate change on climate variables (e.g., air temperature and precipitation) in the Elk Valley under two representative concentration pathway (RCP) scenarios: RCP 4.5 and RCP 8.5. These two scenarios represent little (RCP 8.5) to moderate (RCP 4.5) global success at controlling greenhouse gas emissions. The potential influence of climate change was evaluated with a focus on two time periods: 2050s (medium term) and 2080s (longer term).

Three climate driven inputs were adjusted within the 2020 RWQM: precipitation, air temperature and evapotranspiration. The adjustments were based on the median output generated from the above-noted climate models and are described below.

Precipitation inputs to the 2020 RWQM were adjusted to reflect estimated changes to mean monthly precipitation rates for the selected RCP scenarios. The projected changes to mean monthly precipitation ranged from -5.6 to +9.0% in the 2050s and from -5.8% to +9.8% in the 2080s across all months for the RCP 4.5 scenario. For the RCP 8.5 scenario, they ranged from -3.2% to +12.2% in the 2050s, and from -11.8% to +21.3% in the 2080s across all months and across the Elk River valley. The largest projected decreases occurred from July to September, while the largest projected increases occurred from March to April and September to November. The projected changes are consistent with those derived by others. For example, PCIC (2021) notes that seasonal precipitation in British Columbia is expected to increase in spring, fall and winter, but is expected decrease in summer relative to past conditions. Under RCP 8.5, mean annual precipitation may change by +2 to +11% by the 2050s and by +5.7 to +20% by the 2080s.

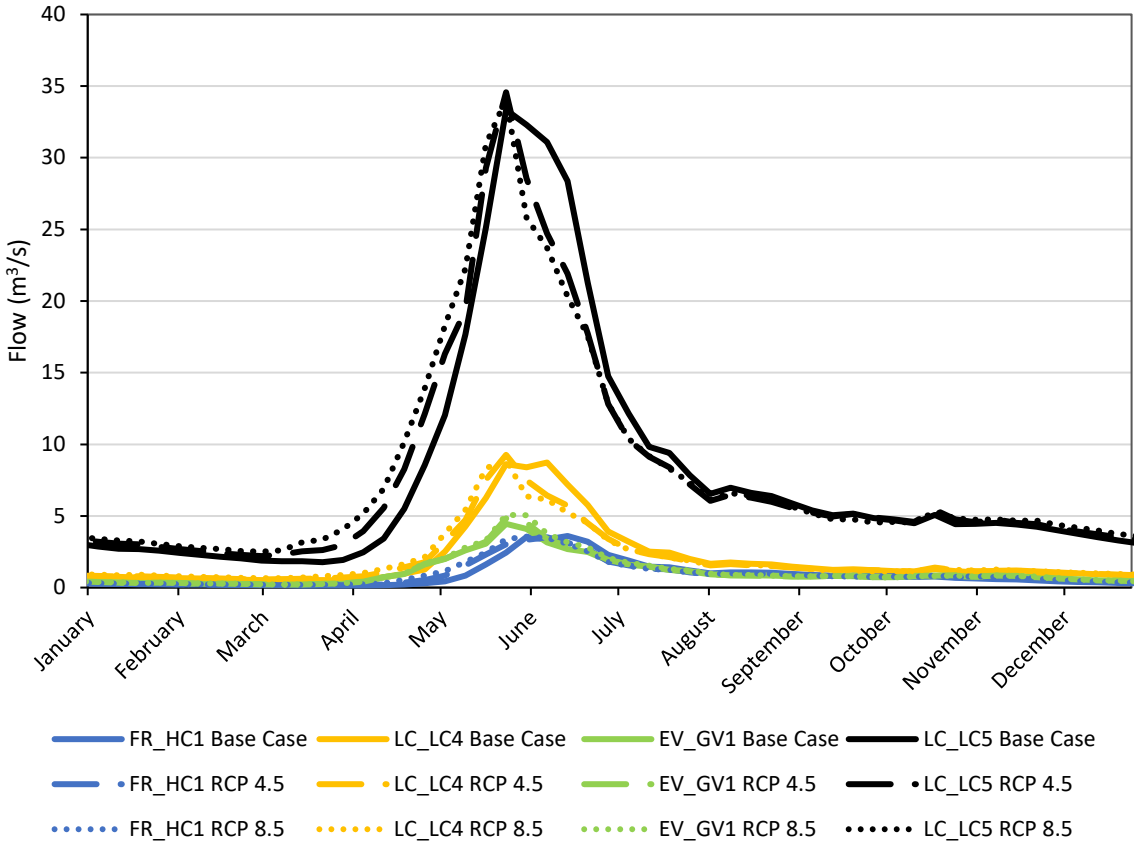
Similarly, for the Kootenay Boundary Region, projected changes to summer precipitation have been estimated at around -6% by the 2050s (Kootenay Boundary Region 2016) and -10% by the 2080s (BC Agriculture and Food Climate Action Initiative 2019), with corresponding changes to mean annual precipitation in the order of +5% in the 2050s to +15% in the 2080s.

Air temperature inputs, namely mean, minimum, and maximum daily temperatures, were adjusted to reflect estimated changes for the selected RCP scenarios. The projected changes to mean monthly temperature ranged from +1.0°C to +1.8°C in the 2050s and +1.5°C to +2.4°C in the 2080s across all months for the RCP 4.5 scenario. For the RCP 8.5 scenario, they ranged from +1.6°C to +2.7°C in the 2050s and +3.2°C to +4.9°C in the 2080s across all months and across the Elk River valley. These estimates were applied within the 2020 RWQM without alteration potentially related to local topography or local climatology. They are directionally consistent with projections developed by others. For example, PCIC (2021) identified an average annual temperature increase across British Columbia in the order of 3.9 to 6.8^{o}C by the 2080s under RCP 8.5, while the BC Agriculture and Food Climate Action Initiative (2019) identified an annual increase of 2.8^{o}C for the Kootenay Boundary Region within the same timeframe across multiple emission scenarios.

Potential evapotranspiration inputs, which are used indirectly by the SRM in the form of a runoff coefficient, were adjusted within the 2020 RWQM for the selected RCP scenarios. The annual average was used, because the SRM contained within the 2020 RWQM relies on a single runoff coefficient. Water flow from waste rock is simulated using the waste rock hydrology module. The waste rock hydrology module calculates evapotranspiration directly from air temperature and precipitation using the Hargreaves-Samani relationship (as detailed in Teck [2021]); thus, no specific update was required to the inputs for this component of the model, beyond the previously described changes to air temperature and precipitation. With respect to the SRM inputs, the projected changes to average annual potential evapotranspiration ranged from +5.4% in the 2050s to +8.5% in the 2080s for the RCP 4.5 scenario. For the RCP 8.5 scenario, they ranged from +8.3% in the 2050s to +17.6% in the 2080s across the Elk River valley. The increase in potential evapotranspiration across scenarios and time periods aligns with / reflects the projected changes to air temperature (i.e., higher air temperatures allow for higher levels of evapotranspiration with all else being equal).

Results of Step 1 indicate that water flows in the Fording River and in associated tributaries are likely to change under the influence of climate change. As illustrated in Figure 4-1, late spring / summer runoff flows are, in general, projected to decrease, while winter flows are, in general, projected to increase. Climate change may also result in summer dry conditions extending later into September and increases to early spring precipitation in March and April may result in earlier freshets. The projected effects of climate change on water flows are more pronounced under RCP 8.5 than under RCP 4.5, in line with the fact that projected changes to precipitation and air temperature are higher under RCP 8.5 than RCP 4.5.

Figure 4-1: Modelled Median Flows for 2080 under Base Case, RCP 4.5 and RCP 8.5 at or near the Mouths of Selected Tributaries (Harmer Creek [FR_HC1], Grave Creek [EV_GC1], Line Creek [LC_LC4] and the Fording River [LC_LC5])



Step 2 involved developing statistical relationships between Elk River and Fording River flows, so that projected changes to flows in the Fording River under climate change could be used to estimate potential changes to Elk River flows. Relationships were developed for two locations in the Elk River: the Elk River Near Natal (ECCC station 08NK016) and the Elk River at Fernie (ECCC station 08NK002). Both relationships were developed to be a function of maximum daily air temperature and flow at the mouth of the Fording River (ECCC station 08NK018). Two relationships were developed for each Elk River location: one for spring freshet (May 1st to June 30th) and one for the remainder portion of the year (July 1st to April 30th). The relationships took the following form, and were developed using information from 2010 to 2019:

Elk River near Natal (ECCC 08NK016)

May 1 to June 30: $Q_{08KN016} = 3.19 \times Q_{08NK018}(i-3)^{0.92} + 2.71 \times T_{max}(i-4)^{0.75}$

Rest of the year: $Q_{08KN016} = 3.19 \times Q_{08NK018}(i-3)^{0.92}$

Elk River at Fernie (ECCC 08NK002)

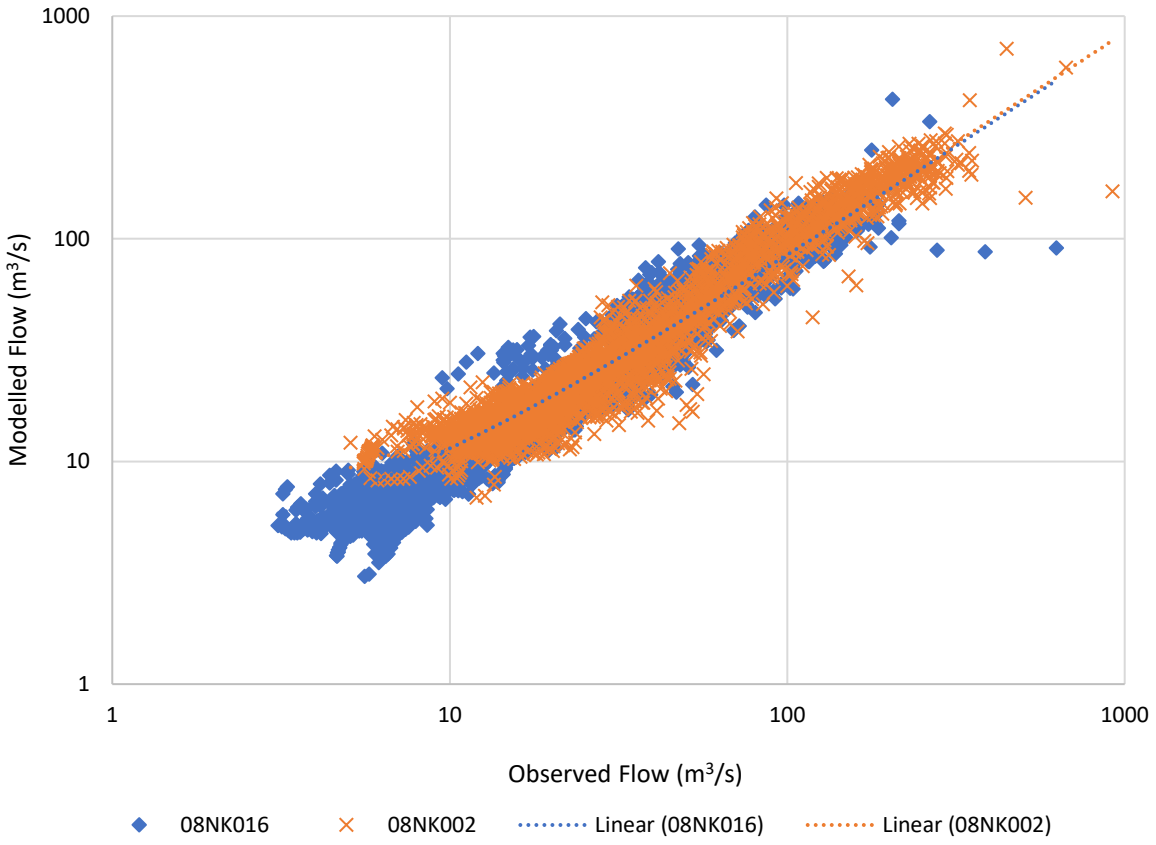
May 1 to June 30: $Q_{08KN002} = 7.19 \times Q_{08NK018}(i-2)^{0.86} + 4.32 \times T_{max}(i-5)^{0.67}$

Rest of the year: $Q_{08KN002} = 7.19 \times Q_{08NK018}(i-2)^{0.86}$

where T_{max} represents the maximum daily air temperature above 0°C, and *i* represents the day in question.

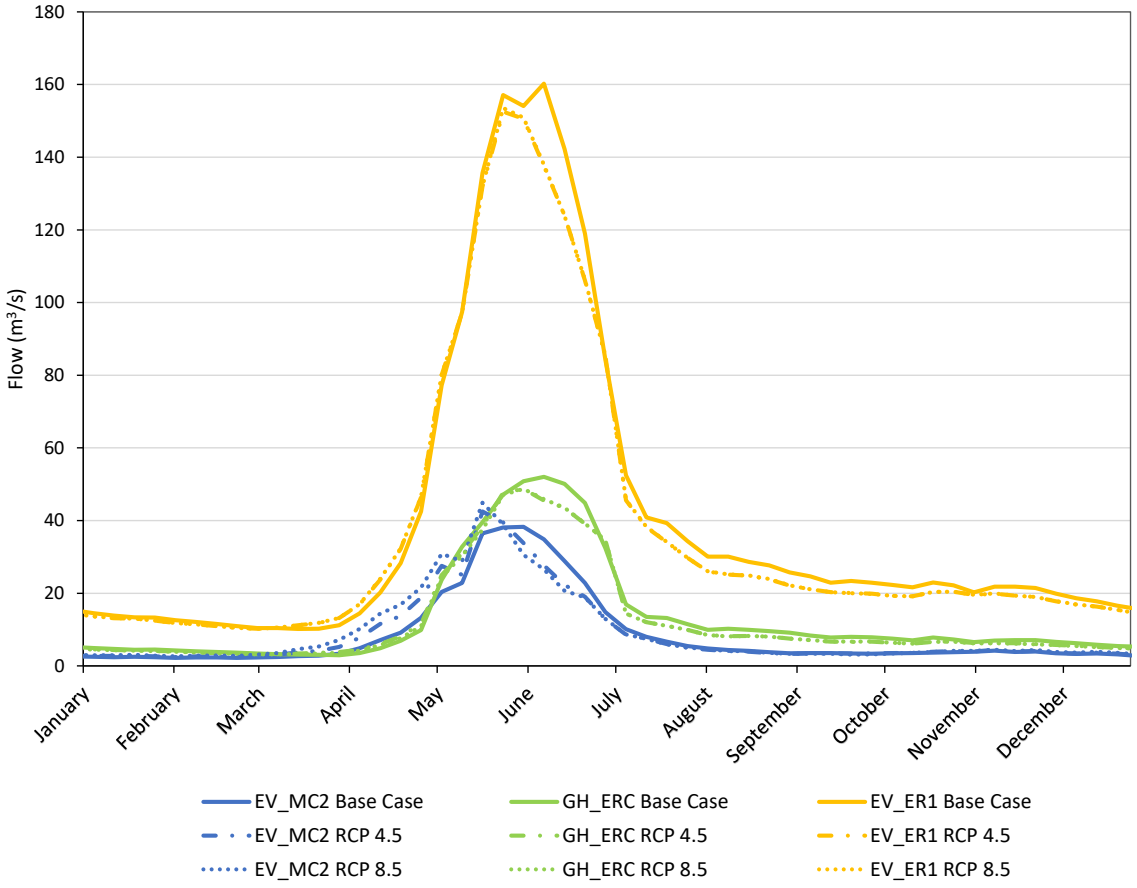
The performance of each set of equations is shown in Figure 4-2. Goodness of fit with the corresponding measured data was evaluated using Nash-Sutcliffe Efficiency (NSE). The equations for the Elk River near Natal had a NSE value of 0.93, whereas those for the Elk River at Fernie had an NSE value of 0.95. An NSE value above 0.75 is considered a very good fit, as per the rating system outlined in Teck (2021).

Figure 4-2: Modelled Flows versus Monitored Flows in the Elk River near Natal and at Fernie between 2010 to 2019



Consistent with the results shown in Figure 4-1, projected flows in the Elk River under the influence of climate change are, in general, lower from June to September, and higher from March to May (Figure 4-3). Projected changes to flows relative to the 2022 IPA base case were greater under RCP 8.5 compared to those under RCP 4.5.

Figure 4-3: Modelled Median Flows for 2080 under Base Case, RCP 4.5 and RCP 8.5 at Selected Mainstem Nodes (Michel Creek downstream of Highway 3 [EV_MC2], GHO Elk River Compliance Point [GH_ERC] and the Elk River downstream of Michel Creek [EV_ER1])



Step 3 involved estimating potential changes to flow in Michel Creek under climate change using estimated flows in the Elk River under climate change and the previously established ranked regression relationships described in Teck (2021). Output from this exercise was consistent with that outlined above, in that flows in Michel Creek under climate change are projected to change. Water flows are projected to increase in March to May, with potential changes being larger under RCP 8.5 than RCP 4.5 (Figure 4-3). They are also projected to decline in June to September, with potential changes again being larger under RCP 8.5 than RCP 4.5.

Potential changes to conditions in Koocanusa Reservoir were not estimated as part of this exercise. Most of the influent flow to Koocanusa Reservoir arrives via the Kootenay River and the Bull River, and there was not a readily available mechanism by which to estimate how influent flows through these two rivers may change in response to climate change. It is not within scope of the 2022 IPA to estimate how dam operations may vary in response to climate change and therefore the sensitivity analysis related to climate change stopped at Elko Reservoir.

4.4.2 Water Quality

The potential influence of climate change on projected concentrations of nitrate, selenium and sulphate was examined by running the Water Quality Component (WQC) of the 2020 RWQM with the flow projections generated as outlined above. The WQC was run twice: once with the flow projections generated using climate inputs related to RCP 4.5, and a second time with the flow projections generated using climate inputs related to RCP 8.5. In both model runs, mitigation measures were as per the 2022 IPA, and projected concentrations of nitrate, selenium, and sulphate at Order Stations, compliance points and in LCO Dry Creek were summarized and compared to those generated without consideration of climate change.

Projected monthly average concentrations of nitrate, selenium, and sulphate at Order Stations, compliance points, and in LCO Dry Creek with and without consideration of potential changes to climate are shown in Appendix F. Overall, consideration of potential changes to climate results in an increase to projected maximum P_{90} monthly average concentrations (i.e., projected peak concentrations) at Order Stations, compliance points, and in LCO Dry Creek. The projected effects of climate change are more pronounced under RCP 8.5 than RCP 4.5, and projected changes to the concentrations of selenium and sulphate are of greater relevance than those of nitrate. Although nitrate concentrations are projected to change with consideration of climate change, the changes are minor (in the order of less than 0.5 mg/L) in comparison to the dominate declining trend that is expected as nitrate is leached from waste rock spoils. It is acknowledged that long-term nitrate projections are uncertain and subject to update based on the potential influence of exchangeable ammonium.

Projected changes to concentrations of selenium and sulphate are similar, in general, across Order Stations, compliance points and in LCO Dry Creek. Projected concentrations of both constituents are typically higher in June to September / October and lower in April and May under either RCP 8.5 or RCP 4.5 compared to the base case. These patterns are illustrated in Figure 4-4 with reference to projected selenium concentrations at the FRO Compliance Point under the base case and under RCP 8.5.

Projected concentrations are typically higher than the base case between June and September / October because projected flows, particularly those originating from non-mining areas, are lower (Figure 4-5) and there is proportionally more mine-influenced flow relative to natural flow in the receiving environment. In other words, although flows from both mine-influenced and non-mine areas are lower with consideration of climate change, the relative change to non-mine flows is larger than that for mine-influenced flows (due to the slower release of water from waste rock spoils), which results in less assimilative capacity in the receiving environment (Figure 4-6).

In April and May, projected concentrations are typically lower than the base case because of the earlier onset of freshet, which results in increased flow with proportionally more water in the receiving environment originating from non-mine areas during this time. Thus, between April and May, there is typically more assimilative capacity in the receiving environment than the base case.

Between November and March, changes to projected concentrations are variable, although projected P_{90} concentrations are higher with consideration of climate change than the base case (Figure 4-4). Flows between November and March are projected to be higher with consideration of climate change, as noted above. However, the degree to which mine-influenced versus non-mine influenced flows increase is variable among individual climate years, which results in different proportions of the total flow in the

receiving environment having originated from mine-influenced areas compared to the base case (Figure 4-6). In some individual climate years, the proportion of mine-influenced water in the environment is higher than the base case. A higher proportion of mine-influenced water yields higher concentrations, which results in higher P_{90} concentrations calculated across the 20 realizations.

Treatment vessels are more likely to have available operating capacity during winter lower flow periods. Thus, there is available treatment capacity for some of the additional mine-influenced flow. However, some of the additional mine-influenced flow will bypass treatment (once capacity within the 2022 IPA is fully allocated and due to intake efficiency) and enter the receiving environment, carrying with it a larger load than the base case (i.e., waste rock spoils are assumed in the 2020 RWQM to be effectively chemostatic, with concentrations being relatively constant over time; thus, more waste rock flow equals more constituents load, some of which bypasses treatment). Hence, even though treatment volumes may be higher, a higher proportion of mine-influenced flow in the receiving environment yields higher concentrations and a higher P_{90} estimate.

Figure 4-4: Projected P90 Monthly Average Selenium Concentrations at the FRO Compliance Point (FR_FRABCH; E223753) With and Without Consideration of Climate Change

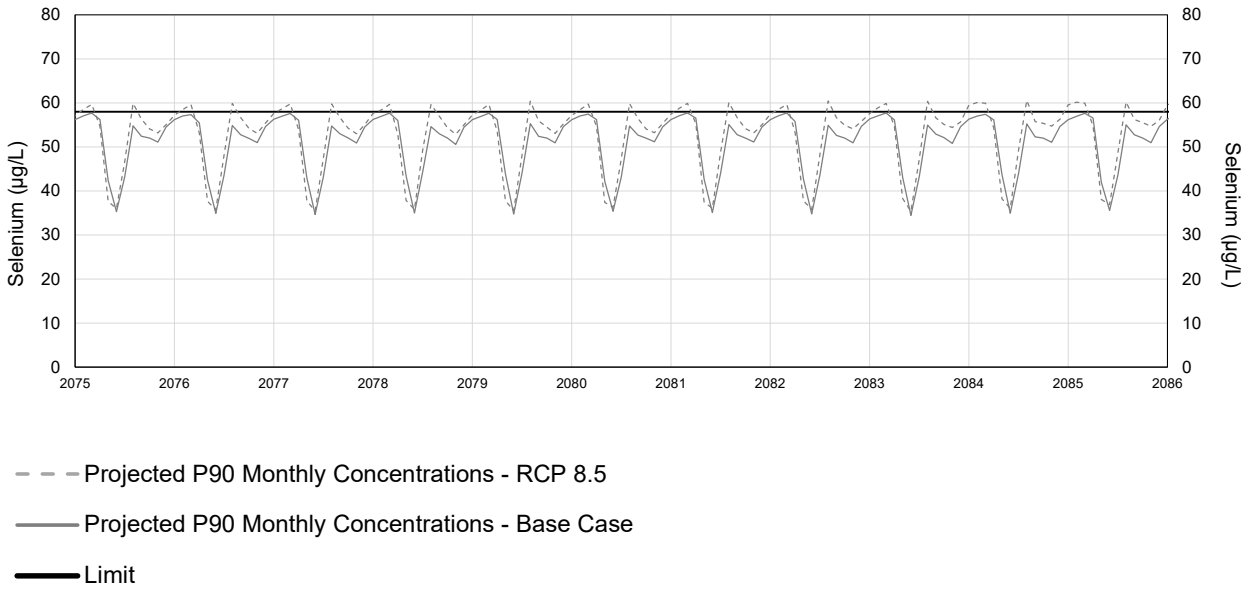


Figure 4-5: Projected P50 Monthly Average Flows at the FRO Compliance Point (FR_FRABCH; E223753) With and Without Consideration of Climate Change

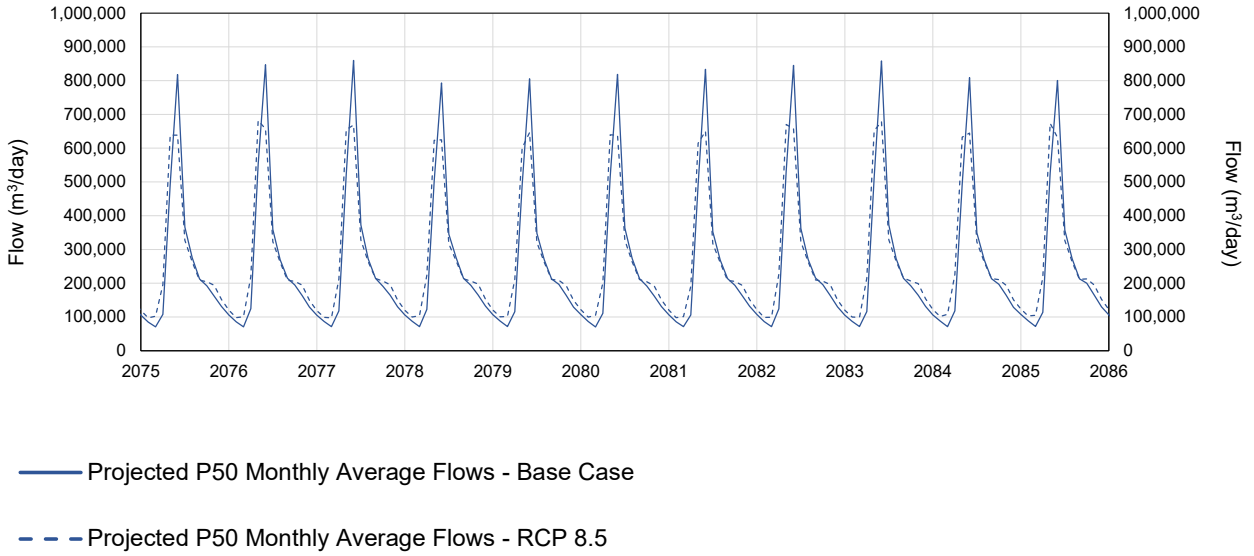
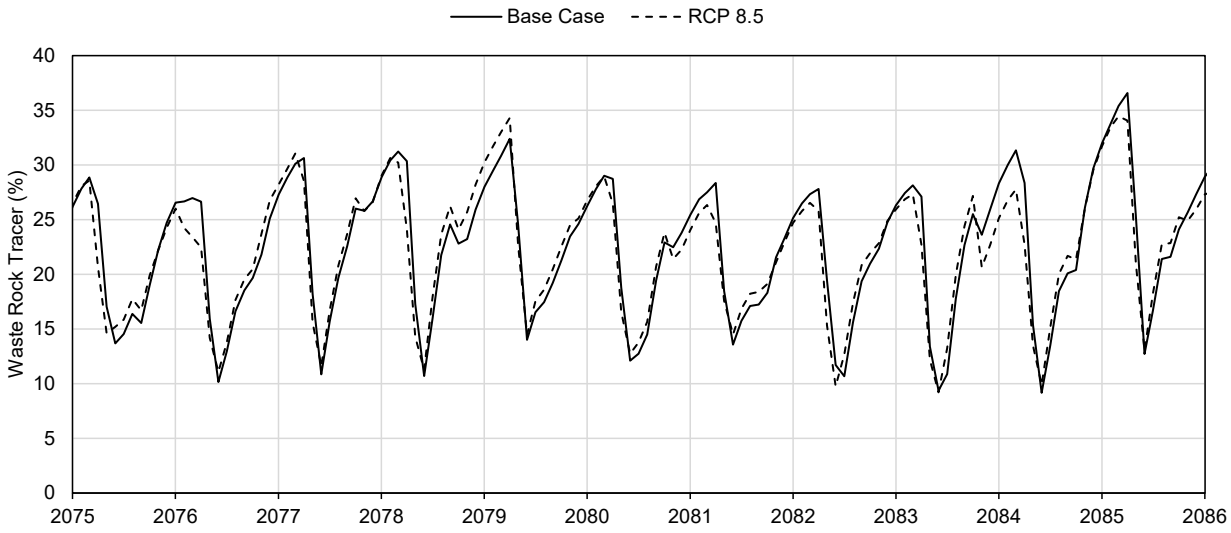


Figure 4-6: Proportion of Mine-Influenced Flow to Natural Flow at the FRO Compliance Point (FR_FRABCH; E223753) with and without Consideration of Climate Change using Realization 1



There are two exceptions to the general patterns outlined above. Projected peak selenium concentrations at the LCO Compliance Point (LC_LCDSSLCC; E297110) are lower with consideration of climate change than under the base case. Similarly, projected peak sulphate concentrations in the Elk River downstream of Michel Creek (EV_ER1; 0200393) are lower with consideration of climate change than under the base case. The underlying drivers for these contradictory model results have not yet been identified; this remains an area of ongoing investigation.

4.5 Changes to Model Inputs Related to Selenium Effluent Quality

Selenium effluent concentrations are expected to decrease over time as Teck gains experience operating biologically-based treatment systems in the Elk Valley. This expectation is reflected in the assumptions used to develop the 2022 IPA. In the 2022 IPA, selenium effluent concentrations at the FRO AWTF-S are assumed to decrease over time, and selenium load removal assumptions at the NLC SRF are assumed to increase over time, as outlined in Table 4-12 and discussed in the main report.

Table 4-12: Summary of Selenium Effluent Assumptions in the 2022 IPA and the Sensitivity Analysis

Treatment Vessel	Base Case: With Improvements to Selenium Effluent Quality	Sensitivity Analysis: Without Improvements to Selenium Effluent Quality
FRO AWTF-S	• 30 µg/L or 95% removal if influent greater than 600 µg/L to December 31, 2025 • 20 µg/L from January 1, 2026 onward	• 30 µg/L or 95% removal if influent greater than 600 µg/L to December 31, 2025 • 30 µg/L from January 1, 2026 onward
FRO-N 1 SRF	95% removal	90% removal
FRO-N 2 SRF	95% removal	90% removal
NLC SRF	• 90% removal to December 31, 2033 • 95% removal from January 1, 2034 onwards	90% removal

AWTF = Active Water Treatment Facility; AWTF-S = Active Water Treatment Facility South; FRO = Fording River Operations; FRO-N = Fording River Operations North; SRF = Saturated Rock Fill; µg/L = micrograms per litre; % = percent.

A sensitivity analysis was undertaken to understand how changes to selenium effluent quality/load removal assumptions at AWTFs and SRFs affect projected selenium concentrations. The changes to selenium effluent quality/load removal assumptions are outlined in Table 4-12. The changes to selenium effluent quality/load removal assumptions at each facility were not evaluated individually, rather they were evaluated as a whole. This analysis was conducted with a focus on Order Stations and Compliance Points. The 2020 RWQM was run with the 20 individual flow realizations and model output (i.e., individual weekly estimates) was processed to generate temporally-connected monthly average concentrations for each realization. The resulting monthly datasets were summarized by calculating P_{10}, P_{50}, and P_{90} values across the 20 realizations for each future month and each future year.

Projected monthly average concentrations of selenium at Order Stations and compliance points, without assumed improvements to selenium effluent quality at the FRO AWTF-S and selenium load removal assumptions at the FRO-N 1 SRF, FRO-N 2 SRF and NLC SRF are shown in Appendix G.

Overall, projected selenium concentrations at Order Stations and compliance points increased without the assumed improvements to selenium effluent quality at the FRO AWTF-S and selenium load removal assumptions at the FRO-N 1 SRF, FRO-N 2 SRF and the NCL SRF. This general pattern is not

surprising, as increasing selenium effluent quality and/or reducing selenium load removal assumptions equates to less load removal across the AWTF or SRF and higher in-stream concentrations.

Projected maximum P_{90} monthly average selenium concentrations (i.e., projected peak concentrations) at the FRO Compliance Point (FR_FRABCH; E300071) increased by 3 µg/L (or 6%), on average, without the assumed improvements to selenium effluent quality and load removal assumptions (Table 4-13). Projected peak concentrations at the LCO Compliance Point (LC_LCDSSLCC; E297110) increased by 3 µg/L (or 18%), on average, without the assumed improvement to the load removal assumption. The increase in projected peak concentrations at downstream Order Stations ranged from <0.1 µg/L to 2 µg/L (or from 3% to 5%), on average, without the assumed improvements to selenium effluent quality and load removal assumptions (Tables 4-14 and 4-15).

These results indicate the assumed improvements to selenium effluent quality and load removal assumptions are relevant to achieving the goals of the 2022 IPA.

Table 4-13: Projected Selenium Concentrations at Selected Compliance Points with and without Improvements to Selenium Effluent Quality

Year[a]	Projected Maximum P_{90} Monthly Average Selenium Concentrations (µg/L)							
	FR_FRABCH				LC_LCDSSLCC			
	2022 IPA	Sensitivity	Absolute Difference	Relative Difference(%)[b]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference(%)[b]
2023	87	88	0	0%	n/a	n/a	n/a	n/a
2024	73	74	1	1%	n/a	n/a	n/a	n/a
2025	70	71	1	2%	n/a	n/a	n/a	n/a
2026	67	69	1	2%	n/a	n/a	n/a	n/a
2027	64	65	2	2%	n/a	n/a	n/a	n/a
2028	52	55	3	6%	n/a	n/a	n/a	n/a
2029	52	55	3	6%	n/a	n/a	n/a	n/a
2030	52	56	3	6%	n/a	n/a	n/a	n/a
2031	53	57	4	7%	n/a	n/a	n/a	n/a
2032	54	58	4	7%	n/a	n/a	n/a	n/a
2033	55	58	4	7%	n/a	n/a	n/a	n/a
2034	53	57	4	7%	29	33	4	13%
2035	53	56	3	7%	28	32	4	14%
2036	53	56	4	7%	28	32	4	15%
2037	54	58	4	7%	27	32	4	16%
2038	53	57	4	7%	27	32	5	17%
2039	54	57	4	7%	27	32	5	18%
2040	54	58	4	7%	27	33	5	19%
2041	54	58	4	8%	28	33	5	20%

Table 4-13: Projected Selenium Concentrations at Selected Compliance Points with and without Improvements to Selenium Effluent Quality

Year[a]	Projected Maximum P_{90} Monthly Average Selenium Concentrations (µg/L)							
	FR_FRABCH				LC_LCDSSLCC			
	2022 IPA	Sensitivity	Absolute Difference	Relative Difference(%)[b]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference(%)[b]
2042	55	59	4	8%	28	33	6	20%
2043	55	60	4	8%	28	34	6	20%
2044	55	60	4	8%	28	33	6	20%
2045	56	60	4	8%	28	33	6	20%
2046	57	61	4	8%	27	33	5	19%
2047	57	61	4	8%	28	33	5	19%
2048	57	61	4	8%	27	32	5	18%
2049	57	62	4	8%	27	32	5	18%
2050	58	62	4	8%	27	32	5	18%
2051	58	62	4	8%	27	31	5	18%
2052	58	62	4	8%	27	31	5	18%
2053	58	62	4	8%	27	31	5	18%
Average			**3**	**6%**			**3**	**18%**

µg/L = micrograms per litre; n/a = not applicable; % = percent.

(a) Start year corresponds to year when the FRO-N 1 SRF is fully effective.

(b) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA. Negative values indicate a decrease in projected concentrations compared to the 2022 IPA.

Table 4-14: Projected Selenium Concentrations at Order Stations in the Fording River with and without Improvements to Selenium Effluent Quality

Year[a]	Projected Maximum P_{90} Monthly Average Selenium Concentrations (µg/L)							
	GH_FR1				LC_LC5			
	2022 IPA	Sensitivity	Absolute Difference	Relative Difference(%)[b]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference(%)[b]
2023	69	69	0	0%	55	55	0	0%
2024	60	61	0	1%	50	50	0	0%
2025	58	58	1	1%	48	49	0	1%
2026	54	55	1	1%	41	41	0	1%
2027	52	53	1	2%	39	40	1	2%
2028	44	45	1	3%	36	37	1	3%
2029	45	46	2	4%	36	38	1	3%
2030	45	47	2	4%	37	39	1	3%
2031	48	50	2	4%	37	38	1	3%
2032	50	51	2	3%	38	39	1	3%
2033	50	52	2	3%	39	40	1	3%
2034	42	45	2	6%	33	35	2	7%
2035	42	45	2	6%	32	35	2	7%
2036	45	47	2	5%	33	36	2	7%
2037	45	48	2	5%	34	36	2	7%
2038	47	49	3	5%	35	37	2	7%
2039	48	51	3	5%	36	38	2	7%
2040	49	52	3	5%	36	39	2	7%
2041	49	52	3	5%	37	39	2	7%

Table 4-14: Projected Selenium Concentrations at Order Stations in the Fording River with and without Improvements to Selenium Effluent Quality

Year[a]	Projected Maximum P_{90} Monthly Average Selenium Concentrations (µg/L)							
	GH_FR1				LC_LC5			
	2022 IPA	Sensitivity	Absolute Difference	Relative Difference(%)[b]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference(%)[b]
2042	50	53	3	6%	37	40	3	7%
2043	50	53	3	6%	38	40	3	7%
2044	50	53	3	6%	38	40	2	7%
2045	50	53	3	6%	37	40	3	7%
2046	50	53	3	6%	37	40	3	7%
2047	49	52	3	6%	37	39	3	7%
2048	50	52	3	6%	37	39	3	7%
2049	49	52	3	6%	37	39	3	7%
2050	49	52	3	6%	37	39	2	7%
2051	49	52	3	6%	36	39	3	7%
2052	49	52	3	6%	36	39	2	7%
2053	49	52	3	6%	36	39	3	7%
Average			2	4%			2	5%

µg/L = micrograms per litre; % = percent.

(a) Start year corresponds to year when the FRO-N 1 SRF is fully effective.

(b) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA. Negative values indicate a decrease in projected concentrations compared to the 2022 IPA.

Table 4-15: Projected Selenium Concentrations at Order Stations in the Elk River with and without Improvements to Selenium Effluent Quality

Year[a]	Projected Maximum P90 Monthly Average Selenium Concentrations (µg/L)															
	EV_ER4				EV_ER1				RG_ELKORES				RG_DSELK			
	2022 IPA	Sensitivity	Absolute Difference	Relative Difference(%)[b]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference(%)[b]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference(%)[b]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference(%)[b]
2023	24	24	0	0%	18	18	0	0%	12	12	0	0%	2.5	2.5	0.0	0%
2024	22	22	0	0%	16	16	0	0%	11	11	0	0%	2.3	2.4	0.0	0%
2025	21	21	0	1%	16	16	0	0%	11	11	0	0%	2.3	2.3	0.0	0%
2026	19	19	0	1%	15	15	0	0%	10	10	0	1%	2.2	2.2	0.0	1%
2027	18	18	0	1%	15	15	0	1%	10	10	0	1%	2.2	2.2	0.0	1%
2028	16	16	0	3%	14	14	0	1%	9.1	9.2	0	2%	1.9	1.9	0.0	1%
2029	15	15	0	3%	13	13	0	2%	9.1	9.2	0	2%	1.8	1.8	0.0	1%
2030	15	16	1	3%	13	14	0	2%	9.2	9.4	0	2%	1.8	1.9	0.0	1%
2031	15	16	1	3%	14	14	0	2%	9.4	10	0	2%	1.9	1.9	0.0	2%
2032	16	16	0	3%	14	14	0	2%	9.4	10	0	2%	1.9	1.9	0.0	2%
2033	16	16	1	4%	14	15	0	2%	9.4	10	0	2%	1.9	1.9	0.0	2%
2034	14	15	1	6%	13	14	0	3%	8.7	8.9	0	3%	1.8	1.9	0.0	2%
2035	13	14	1	7%	13	13	0	3%	8.4	8.7	0	4%	1.8	1.8	0.0	3%
2036	13	13	1	6%	13	14	0	3%	8.7	9.0	0	3%	1.7	1.8	0.1	3%
2037	13	13	1	7%	13	13	0	4%	8.6	8.9	0	3%	1.7	1.8	0.1	3%
2038	13	14	1	8%	12	13	0	4%	8.7	9.0	0	3%	1.7	1.8	0.1	3%
2039	13	14	1	8%	13	13	0	4%	8.8	9.0	0	3%	1.7	1.8	0.1	3%
2040	13	14	1	7%	13	13	1	4%	9.1	9.4	0	3%	1.8	1.8	0.1	3%
2041	13	14	1	7%	13	14	1	4%	9.1	9.4	0	3%	1.8	1.8	0.1	4%
2042	13	14	1	8%	11	12	1	5%	8.6	9.0	0	5%	1.7	1.8	0.1	3%
2043	13	14	1	8%	12	12	1	5%	8.6	9.0	0	4%	1.6	1.7	0.1	4%
2044	13	14	1	9%	11	12	1	5%	8.6	8.9	0	4%	1.6	1.7	0.1	4%
2045	13	14	1	8%	12	12	1	5%	8.5	8.9	0	4%	1.6	1.7	0.1	4%
2046	13	14	1	8%	11	12	1	5%	8.4	8.8	0	4%	1.6	1.7	0.1	4%
2047	13	14	1	8%	11	12	1	5%	8.4	8.7	0	4%	1.6	1.7	0.1	4%
2048	13	14	1	7%	12	12	1	5%	8.5	8.9	0	4%	1.6	1.6	0.1	4%
2049	14	15	1	7%	12	12	1	5%	8.8	9.2	0	4%	1.6	1.7	0.1	3%
2050	14	15	1	7%	12	12	1	4%	8.8	9.1	0	4%	1.6	1.7	0.1	4%
2051	14	15	1	7%	12	12	1	4%	8.8	9.2	0	4%	1.6	1.7	0.1	4%

Table 4-15: Projected Selenium Concentrations at Order Stations in the Elk River with and without Improvements to Selenium Effluent Quality

Year[a]	Projected Maximum P90 Monthly Average Selenium Concentrations (µg/L)															
	EV_ER4				EV_ER1				RG_ELKORES				RG_DSELK			
	2022 IPA	Sensitivity	Absolute Difference	Relative Difference(%)[b]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference(%)[b]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference(%)[b]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference(%)[b]
2052	14	15	1	7%	12	12	1	4%	8.8	9.1	0	4%	1.7	1.8	0.1	3%
2053	14	15	1	7%	12	12	1	5%	8.8	9.2	0	4%	1.7	1.8	0.1	3%
Average			**1**	**5%**			**0.4**	**3%**			**0.3**	**3%**			**0.05**	**3%**

µg/L = micrograms per litre; % = percent.

(a) Start year corresponds to year when the FRO-N 1 SRF is fully effective.

(b) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA. Negative values indicate a decrease in projected concentrations compared to the 2022 IPA.

4.6 Changes to Model Inputs Related to Instream Sinks

The 2020 RWQM maintains a mass balance as it simulates the transport of constituents downstream in the Fording River and Elk River. During the 2020 update, a consistent and increasing over-estimation of measured selenium and nitrate concentrations with distance downstream in the Fording River and Elk River was noted, particularly in low flow periods (Teck 2021a). Addressing this over-estimation was required to achieve a good model calibration. Instream sinks (i.e., load reduction factors) were included in the 2020 RWQM in the Fording River and Elk River and to water leaving Kilmarnock Creek to address the over-prediction of selenium and nitrate concentrations, and thereby improve model performance in terms of replicating measured instream data.

A sensitivity analysis was undertaken to understand how changes to instream sinks affect projected concentrations of nitrate and selenium. The sensitivity analysis involved reducing instream sinks for nitrate and selenium by 50% (Table 4-16). This analysis was conducted with a focus on Order Stations and compliance points. The 2020 RWQM was run with the 20 individual flow realizations and model output (i.e., individual weekly estimates) was processed to generate temporally-connected monthly average concentrations for each realization. The resulting monthly datasets were summarized by calculating P_{10}, P_{50}, and P_{90} values across the 20 realizations for each future month and each future year.

Table 4-16: Load Reduction Factors Applied in the Fording River and Elk River

Node ID	Description	Load Reduction Factor (%)			
		Nitrate		Selenium	
		2020 RWQM	Sensitivity Analysis	2020 RWQM	Sensitivity Analysis
FR_FR2	Fording River upstream of Kilmarnock Creek	-	-	15%	7.5%
FR_FR4	Fording River d/s of Swift Creek and u/s of Cataract Creek	-	-	15%	7.5%
FR_FRCP1	FRO Compliance Point	-	-	-	-
Kilmarnock Creek	Water travelling from Kilmarnock Creek to the Fording River mainstem (i.e., sink applied along the flow paths joining Kilmarnock Creek to the Fording River)	15%	7.5%	15%	7.5%
LC_FRDSDC	Fording River d/s of Dry Creek	-	-	5%	2.5%
LC_LC5	Fording River d/s Line Creek	-	-	5%	2.5%
GH_ERC	GHO Elk River Compliance Point	35%	17.5%	35%	17.5%
EV_ER4	Elk River u/s Grave Creek	10%	5.0%	10%	5.0%
EV_ER2	Elk River u/s Michel Creek	15%	7.5%	15%	7.5%
EV_ER1	Elk River d/s of Michel Creek	15%	7.5%	15%	7.5%

"-" = no load reduction; d/s = downstream; FRO = Fording River Operations; GHO = Greenhills Operations; u/s = upstream.; % = percent.

Projected monthly average concentrations of nitrate and selenium at Order Stations and compliance points in the Fording River and Elk River with and without a 50% reduction to instream sinks are shown in Appendix H.

Overall, reducing instream sinks by 50% resulted in an increase to projected concentrations of nitrate and selenium in the Fording River and the Elk River. Reducing instream sinks by 50% resulted in no change to projected concentrations during much of the open-water period because instream sinks are applied

from September to April at most locations. Reducing instream sinks by 50% resulted in an increase in projected peak concentrations of nitrate and selenium because peak concentrations generally occur in winter when instream sinks are applied.

- Reducing instream sinks by 50% resulted in an increase to projected maximum P_{90} monthly average selenium concentrations (i.e., projected peak concentrations) by (Table 4-17):
    - 12%, on average, at the FRO Compliance Point (FR_FRABCH; E223753)
    - 6%, on average, in the Fording River downstream of Greenhills Creek (GH_FR1; 0200378) and Fording River downstream of Line Creek (LC_LC5; 0200028)
- Reducing instream sinks by 50% resulted in less change to projected peak concentrations in the lower Fording River (i.e., GH_FR1 and LC_LC5) compared to other locations. The change to projected peak concentrations declined over time with the onset of treatment (e.g., a 13% difference in projected peak concentrations in 2022 compared to a 4% difference in 2028 at LC_LC5).
- Reducing instream sinks by 50% resulted in a larger change to projected peak concentrations in the Elk River relative to the Fording River. In the upper Elk River, reducing instream sinks by 50% resulted in an increase to projected peak concentrations of selenium by (Table 4-18):
    - 27%, on average, at the GHO Elk River Compliance Point (GH_ERC; E300090)
    - 26%, on average, in the Elk River upstream of Boivin Creek (GH_ER1; E206661)
- In the lower Elk River, reducing instream sinks by 50% resulted in an increase to projected peak concentrations of selenium by (Table 4-19):
    - 21%, on average, in the Elk River upstream of Grave Creek (EV_ER4; 0200027)
    - 28%, on average, in the Elk River downstream of Michel Creek (EV_ER1; 0200393)
    - 19%, on average, in the Elk River at Elko Reservoir (RG_ELKORES; E294312)
    - 23%, on average, at Koocanusa Reservoir (RG_DSELK; E300230)
- The change to projected peak concentrations is greater in the Elk River compared to the Fording River, in part, because instream sinks are cumulative. Nevertheless, projected peak concentrations of selenium do not increase by 50% when instream sinks are reduced by 50%. Projected peak concentrations increase by as much as 33%, which declines over time to 28% with the onset of treatment as seen at EV_ER1.

Reducing instream sinks by 50% resulted in an increase to projected peak concentrations of selenium in the Fording River and Elk River, which would imply a higher potential risk of non-compliance. However, model error with reduced sinks is also higher (due to changes through the calibration period) as shown in Figure 4-7, so confidence in projected concentrations with reduced instream sinks is low. Nevertheless, Teck acknowledges that instream sinks are a key assumption included in the 2020 RWQM, which is why the mass balance investigation was initiated and will continue to resolve residual uncertainties associated with instream sinks.

Projected peak concentrations of nitrate with and without a 50% reduction to instream sinks show the same patterns as selenium (i.e., greater change in the Elk River compared to the Fording River, increase to projected concentrations declines over time with the onset of treatment, increase to projected

concentrations is less than 50% and model error is higher). However, nitrate projections are less sensitive to reduced sinks than selenium, because of the underlying declining trend in nitrate in the numerical model. It is acknowledged that long-term nitrate projections are uncertain and subject to update based on the potential influence of exchangeable ammonia. The projected peak concentrations of nitrate at Order Stations and compliance points in the Fording River and Elk River, with and without a 50% reduction to instream sinks are shown in Tables 4-20 to 4-22.

Table 4-17: Projected Selenium Concentrations at Compliance Points and Order Stations in the Fording River with and without Changes to Instream Sinks

Year	Projected Maximum P_{90} Monthly Average Selenium (µg/L)								
	FR_FRABCH			GH_FR1			LC_LC5		
	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]
2020	100	111	11%	70	78	11%	54	61	12%
2021	114	128	12%	80	89	12%	61	68	12%
2022	122	137	12%	85	96	12%	64	73	13%
2023	87	98	12%	69	77	12%	55	62	12%
2024	73	81	11%	60	67	11%	50	55	11%
2025	70	77	11%	58	64	10%	48	53	10%
2026	67	74	11%	54	60	10%	41	45	11%
2027	64	70	11%	52	57	10%	39	44	11%
2028	52	58	11%	44	46	4%	36	37	4%
2029	52	58	11%	45	46	4%	36	38	4%
2030	52	58	12%	45	47	4%	37	39	4%
2031	53	60	12%	48	50	4%	37	39	4%
2032	54	60	12%	50	51	4%	38	40	4%
2033	55	61	12%	50	52	4%	39	40	4%
2034	53	59	12%	42	44	5%	33	34	4%
2035	53	59	11%	42	44	4%	32	34	4%
2036	53	59	12%	45	46	4%	33	35	4%
2037	54	60	12%	45	47	4%	34	36	4%
2038	53	59	12%	47	49	4%	35	36	4%
2039	54	60	12%	48	50	4%	36	37	4%

Table 4-17: Projected Selenium Concentrations at Compliance Points and Order Stations in the Fording River with and without Changes to Instream Sinks

Year	Projected Maximum P_{90} Monthly Average Selenium (µg/L)								
	FR_FRABCH			GH_FR1			LC_LC5		
	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]
2040	54	60	12%	49	51	4%	36	38	4%
2041	54	61	12%	49	51	4%	37	38	4%
2042	55	62	12%	50	52	4%	37	39	4%
2043	55	62	12%	50	52	4%	38	39	4%
2044	55	62	12%	50	52	4%	38	39	4%
2045	56	63	12%	50	52	4%	37	39	4%
2046	57	63	12%	50	52	4%	37	38	4%
2047	57	64	12%	49	51	4%	37	38	4%
2048	57	64	12%	50	51	4%	37	38	4%
2049	57	64	12%	49	51	4%	37	38	4%
2050	58	65	12%	49	51	4%	37	38	4%
2051	58	65	12%	49	51	4%	36	38	4%
2052	58	65	12%	49	51	4%	36	38	4%
2053	58	65	12%	49	51	4%	36	38	4%
Average			**12%**			**6%**			**6%**

µg/L = micrograms per litre; % = percent.

(a) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA.

Table 4-18: Projected Selenium Concentrations at Compliance Points and Order Stations in the Upper Elk River with and without Changes to Instream Sinks

Year	Projected Maximum P_{90} Monthly Average Selenium (µg/L)					
	GH_ERC			GH_ER1		
	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]
2020	4.9	6.2	27%	4.7	5.9	26%
2021	5.8	7.4	27%	5.5	7	27%
2022	6.6	8.4	27%	6.2	7.9	27%
2023	6.8	8.6	27%	6.4	8.1	27%
2024	6.9	8.7	27%	6.5	8.2	27%
2025	6.8	8.6	27%	6.3	8	27%
2026	6.6	8.4	27%	6.2	7.9	27%
2027	6.6	8.4	27%	6.2	7.9	26%
2028	5.8	7.4	27%	5.5	6.9	26%
2029	5.1	6.5	27%	4.9	6.1	26%
2030	5.1	6.4	27%	4.8	6	26%
2031	5	6.3	27%	4.7	5.9	26%
2032	4.9	6.2	27%	4.6	5.8	26%
2033	4.8	6.1	27%	4.5	5.7	26%
2034	4.8	6	27%	4.5	5.7	26%
2035	4.9	6.2	27%	4.6	5.8	26%
2036	4.9	6.2	27%	4.6	5.8	26%
2037	4.9	6.2	27%	4.6	5.8	26%
2038	4.9	6.2	27%	4.6	5.8	26%
2039	4.8	6.1	27%	4.6	5.8	26%
2040	4.8	6.1	27%	4.5	5.7	26%
2041	4.8	6.1	27%	4.5	5.7	26%
2042	4.8	6.1	27%	4.5	5.7	26%
2043	3.3	4.2	27%	3.2	4	26%
2044	2.9	3.6	27%	2.7	3.5	26%
2045	2.8	3.5	27%	2.7	3.4	26%
2046	2.7	3.5	27%	2.6	3.3	26%
2047	2.7	3.4	27%	2.6	3.3	26%

Table 4-18: Projected Selenium Concentrations at Compliance Points and Order Stations in the Upper Elk River with and without Changes to Instream Sinks

Year	Projected Maximum P_{90} Monthly Average Selenium (µg/L)					
	GH_ERC			GH_ER1		
	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]
2048	5.2	6.6	27%	4.9	6.2	26%
2049	5.8	7.3	27%	5.4	6.9	26%
2050	5.9	7.5	27%	5.6	7.1	27%
2051	5.9	7.5	27%	5.6	7.1	27%
2052	5.9	7.5	27%	5.5	7	27%
2053	5.8	7.4	27%	5.5	6.9	27%
Average			**27%**			**26%**

µg/L = micrograms per litre; % = percent.

(a) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA.

Table 4-19: Projected Selenium Concentrations at Order Stations in the Lower Elk River with and without Changes to Instream Sinks

Year	Projected Maximum P_{90} Monthly Average Selenium (µg/L)											
	EV_ER4			EV_ER1			RG_ELKORES			RG_DSELK		
	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]
2020	23	28	19%	18	24	31%	12	15	26%	2.4	3	23%
2021	26	31	20%	19	25	30%	13	16	29%	2.9	3.6	24%
2022	27	33	20%	19	25	33%	13	16	18%	2.8	3.5	27%
2023	24	29	19%	18	23	31%	12	15	28%	2.5	3.2	27%
2024	22	26	19%	16	21	29%	11	14	27%	2.3	2.9	26%
2025	21	25	19%	16	21	30%	11	14	26%	2.3	2.9	25%
2026	19	22	20%	15	19	29%	10	13	25%	2.2	2.7	24%
2027	18	22	20%	15	20	29%	10	12	25%	2.2	2.7	23%
2028	16	19	20%	14	17	27%	9.1	11	25%	1.9	2.4	22%
2029	15	18	20%	13	17	29%	9.1	11	24%	1.8	2.2	23%
2030	15	18	20%	13	17	28%	9.2	12	25%	1.8	2.3	24%
2031	15	18	20%	14	17	28%	9.4	12	23%	1.9	2.3	24%
2032	16	19	20%	14	18	26%	9.4	11	22%	1.9	2.3	22%
2033	16	19	20%	14	18	26%	9.4	12	22%	1.9	2.3	22%
2034	14	17	21%	13	17	27%	8.7	11	22%	1.8	2.2	22%
2035	13	15	21%	13	16	26%	8.4	10	24%	1.8	2.2	21%
2036	13	15	21%	13	17	26%	8.7	11	21%	1.7	2.1	21%
2037	13	15	21%	13	16	26%	8.6	10	15%	1.7	2.1	21%
2038	13	15	21%	12	16	26%	8.7	10	15%	1.7	2.1	21%
2039	13	16	21%	13	16	26%	8.8	10	16%	1.7	2.1	21%

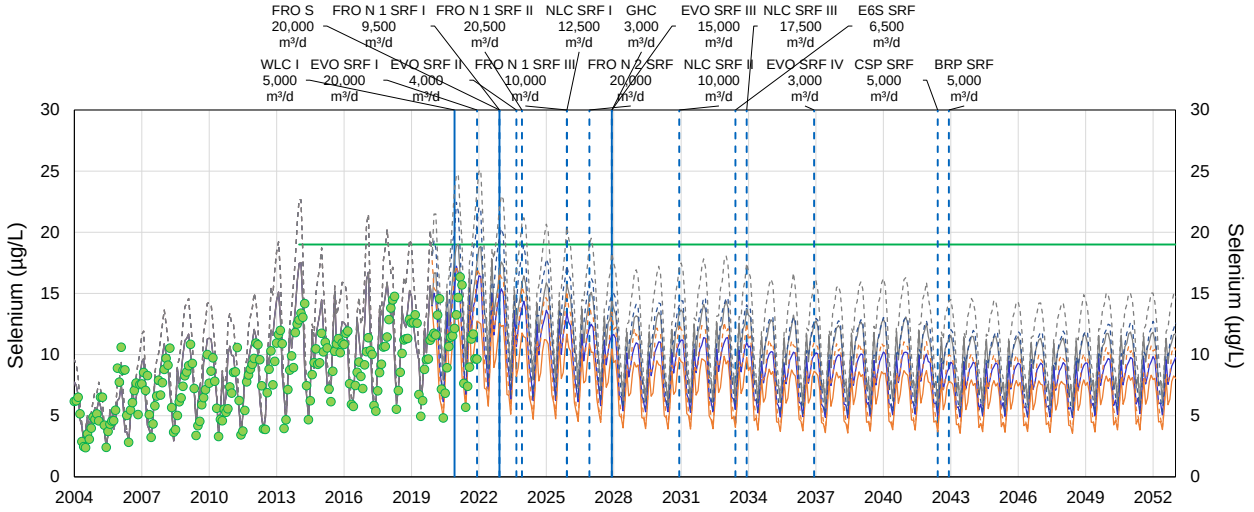
Table 4-19: Projected Selenium Concentrations at Order Stations in the Lower Elk River with and without Changes to Instream Sinks

Year	Projected Maximum P_{90} Monthly Average Selenium (µg/L)											
	EV_ER4			EV_ER1			RG_ELKORES			RG_DSELK		
	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]
2040	13	16	21%	13	16	26%	9.1	10	15%	1.8	2.1	21%
2041	13	16	21%	13	16	25%	9.1	10	15%	1.8	2.1	22%
2042	13	16	21%	11	15	27%	8.6	10	12%	1.7	2.1	23%
2043	13	16	20%	12	15	26%	8.6	9.4	9%	1.6	1.9	22%
2044	13	15	20%	11	14	26%	8.6	9.4	10%	1.6	1.9	21%
2045	13	15	20%	12	14	25%	8.5	9.5	12%	1.6	1.9	21%
2046	13	15	20%	11	14	25%	8.4	10	13%	1.6	1.9	22%
2047	13	15	20%	11	14	25%	8.4	10	14%	1.6	2	22%
2048	13	16	21%	12	15	28%	8.5	9.3	10%	1.6	1.9	21%
2049	14	17	22%	12	15	28%	8.8	10	10%	1.6	2	24%
2050	14	17	22%	12	15	28%	8.8	10	13%	1.6	2	23%
2051	14	17	22%	12	15	27%	8.8	10	14%	1.6	2	23%
2052	14	17	22%	12	15	27%	8.8	10	15%	1.7	2.1	24%
2053	14	17	22%	12	15	28%	8.8	10	14%	1.7	2.1	24%
Average			**21%**			**28%**			**19%**			**23%**

µg/L = micrograms per litre; % = percent.

(a) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA.

Figure 4-7: Projected Monthly Average Selenium Concentrations in the Elk River downstream of Michel Creek (EV_ER1; 0200393) with and without Change to Instream Sinks



- Projected P10 Monthly Average Concentrations - 2022 IPA
- Projected P50 Monthly Average Concentrations - 2022 IPA
- Projected P90 Monthly Average Concentrations - 2022 IPA
- Projected P10 Monthly Average Concentrations - Sensitivity Analysis
- Projected P50 Monthly Average Concentrations - Sensitivity Analysis
- Projected P90 Monthly Average Concentrations - Sensitivity Analysis
- Limit
- Site Performance Objective
- Monthly Average Measured Concentrations

Table 4-20: Projected Nitrate Concentrations at Compliance Points and Order Stations in the Fording River with and without Changes to Instream Sinks

Year	Projected Maximum P_{90} Monthly Average Nitrate (mg/L)								
	FR_FRABCH			GH_FR1			LC_LC5		
	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]
2020	27	28	5%	18	19	4%	14	14	4%
2021	28	29	4%	20	21	4%	15	16	3%
2022	29	30	4%	20	21	4%	16	16	3%
2023	24	25	4%	18	19	4%	14	15	3%
2024	20	21	6%	15	16	5%	12	13	4%
2025	18	19	6%	14	15	5%	11	12	4%
2026	17	18	6%	12	13	5%	8.8	9.2	5%
2027	15	16	6%	11	12	5%	8.1	8.6	5%
2028	12	13	5%	9.9	10	4%	7.2	7.5	4%
2029	11	12	5%	9.3	9.6	4%	6.8	7	3%
2030	10	11	5%	8.8	9.2	4%	6.5	6.7	3%
2031	10	11	4%	8.6	8.9	3%	6.2	6.4	3%
2032	9.5	9.9	4%	8.3	8.6	3%	6	6.2	3%
2033	9.1	9.4	4%	8.4	8.6	3%	6	6.2	3%
2034	8.3	8.6	4%	6.1	6.3	3%	4.7	4.8	3%
2035	7.2	7.6	4%	5.2	5.4	4%	3.9	4	3%
2036	7	7.2	4%	5.2	5.4	3%	3.8	3.9	3%
2037	6.8	7	4%	5	5.2	3%	3.6	3.7	3%
2038	6.3	6.5	4%	5	5.1	3%	3.6	3.7	3%
2039	5.9	6.1	4%	5	5.1	2%	3.6	3.7	2%
2040	5.4	5.6	3%	4.8	4.9	2%	3.5	3.5	2%
2041	5	5.1	3%	4.3	4.4	2%	3.1	3.2	2%
2042	4.6	4.7	3%	4	4.1	2%	2.9	3	2%
2043	4.2	4.4	3%	3.7	3.8	2%	2.7	2.7	2%
2044	4	4.1	2%	3.3	3.4	2%	2.4	2.4	2%
2045	3.8	3.9	2%	2.9	3	2%	2.1	2.2	2%
2046	3.7	3.8	2%	2.7	2.7	2%	2	2	2%
2047	3.6	3.7	2%	2.5	2.5	2%	1.9	1.9	2%

Table 4-20: Projected Nitrate Concentrations at Compliance Points and Order Stations in the Fording River with and without Changes to Instream Sinks

Year	Projected Maximum P_{90} Monthly Average Nitrate (mg/L)								
	FR_FRABCH			GH_FR1			LC_LC5		
	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]
2048	3.4	3.5	2%	2.3	2.4	2%	1.7	1.8	2%
2049	3.3	3.3	2%	2.2	2.2	2%	1.6	1.6	2%
2050	3.4	3.5	1%	2.1	2.2	2%	1.6	1.6	2%
2051	3.4	3.5	2%	2.1	2.1	2%	1.5	1.6	2%
2052	3.2	3.3	2%	2	2	2%	1.5	1.5	2%
2053	3.1	3.1	2%	1.9	1.9	2%	1.4	1.4	2%
Average			**4%**			**3%**			**3%**

mg/L = milligrams per litre; % = percent.

(a) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA.

Table 4-21: Projected Nitrate Concentrations at Compliance Points and Order Stations in the Upper Elk River with and without Changes to Instream Sinks

Year	Projected Maximum P_{90} Monthly Average Nitrate (mg/L)					
	GH_ERC			GH_ER1		
	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]
2020	1.2	1.5	27%	1.1	1.4	27%
2021	1.3	1.7	27%	1.2	1.6	27%
2022	1.4	1.8	27%	1.3	1.7	27%
2023	1.4	1.8	27%	1.3	1.7	27%
2024	1.3	1.7	27%	1.2	1.6	27%
2025	1.2	1.5	27%	1.1	1.4	27%
2026	1	1.3	27%	0.9	1.2	27%
2027	0.9	1.1	27%	0.8	1	27%
2028	0.7	0.9	27%	0.7	0.8	27%
2029	0.6	0.7	27%	0.5	0.7	26%
2030	0.5	0.7	27%	0.5	0.7	26%
2031	0.5	0.6	27%	0.5	0.6	26%
2032	0.4	0.5	27%	0.4	0.5	26%
2033	0.4	0.4	27%	0.3	0.4	26%
2034	0.3	0.4	27%	0.3	0.4	26%
2035	0.3	0.3	27%	0.2	0.3	26%
2036	0.2	0.3	27%	0.2	0.3	26%
2037	0.2	0.2	27%	0.2	0.2	25%
2038	0.2	0.2	27%	0.2	0.2	25%
2039	0.1	0.2	27%	0.1	0.2	25%
2040	0.1	0.2	27%	0.1	0.2	25%
2041	0.1	0.1	27%	0.1	0.1	25%
2042	0.1	0.1	27%	0.1	0.1	24%
2043	0.1	0.1	27%	0.1	0.1	24%
2044	0.1	0.1	27%	0.1	0.1	24%
2045	0.1	0.1	27%	0.1	0.1	23%
2046	0.1	0.1	27%	0.1	0.1	23%
2047	0.1	0.1	27%	0.1	0.1	23%

Table 4-21: Projected Nitrate Concentrations at Compliance Points and Order Stations in the Upper Elk River with and without Changes to Instream Sinks

Year	Projected Maximum P_{90} Monthly Average Nitrate (mg/L)					
	GH_ERC			GH_ER1		
	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]
2048	1.4	1.8	27%	1.3	1.7	27%
2049	1.8	2.3	27%	1.7	2.1	27%
2050	1.8	2.2	27%	1.6	2.1	27%
2051	1.8	2.3	27%	1.7	2.1	27%
2052	1.7	2.2	27%	1.6	2	27%
2053	1.7	2.1	27%	1.6	2	27%
Average			**27%**			**26%**

mg/L = milligrams per litre; % = percent.

(a) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA.

Table 4-22: Projected Nitrate Concentrations at Order Stations in the Lower Elk River with and without Changes to Instream Sinks

Year	Projected Maximum P_{90} Monthly Average Nitrate (mg/L)											
	EV_ER4			EV_ER1			RG_ELKORES			RG_DSELK		
	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]	2022 IPA	Sensitivity	Relative Difference (%)[a]
2020	6.1	6.7	11%	3.6	4.6	27%	2.5	3.1	25%	0.69	0.84	21%
2021	6.5	7.1	11%	3.8	4.8	27%	2.7	3.4	24%	0.76	0.93	22%
2022	6.7	7.4	11%	4.1	5.2	27%	2.7	3.3	24%	0.74	0.89	21%
2023	6.2	6.9	11%	3.8	4.9	27%	2.4	3.0	25%	0.69	0.83	20%
2024	5.4	6.1	12%	3.4	4.3	28%	2.2	2.7	24%	0.64	0.76	19%
2025	4.8	5.4	12%	3.2	4.0	27%	2.1	2.6	24%	0.59	0.71	20%
2026	4	4.5	13%	2.8	3.5	27%	1.8	2.2	24%	0.55	0.65	20%
2027	3.8	4.3	12%	2.6	3.3	27%	1.6	2.0	24%	0.52	0.61	19%
2028	3.3	3.7	11%	2.3	2.8	25%	1.5	1.8	23%	0.48	0.56	18%
2029	3	3.4	11%	2	2.5	24%	1.3	1.6	21%	0.44	0.51	17%
2030	2.9	3.2	11%	1.9	2.4	26%	1.3	1.6	23%	0.42	0.49	17%
2031	2.7	3.0	10%	1.8	2.3	25%	1.2	1.5	22%	0.41	0.48	17%
2032	2.6	2.9	10%	1.9	2.3	23%	1.2	1.4	21%	0.4	0.47	16%
2033	2.6	2.8	9%	1.8	2.3	23%	1.2	1.4	21%	0.4	0.46	14%
2034	2	2.2	10%	1.6	1.9	21%	1	1.2	21%	0.37	0.43	13%
2035	1.7	1.9	10%	1.4	1.7	22%	0.86	1.0	21%	0.34	0.39	12%
2036	1.6	1.7	10%	1.4	1.8	23%	0.87	1.0	19%	0.33	0.38	13%
2037	1.5	1.6	10%	1.2	1.5	20%	0.77	0.9	18%	0.31	0.35	11%
2038	1.4	1.5	9%	1.2	1.4	19%	0.76	0.88	16%	0.3	0.33	12%
2039	1.4	1.5	9%	1.2	1.4	19%	0.74	0.87	18%	0.3	0.33	12%

Table 4-22: Projected Nitrate Concentrations at Order Stations in the Lower Elk River with and without Changes to Instream Sinks

Year	Projected Maximum P_{90} Monthly Average Nitrate (mg/L)											
	EV_ER4			EV_ER1			RG_ELKORES			RG_DSELK		
	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Relative Difference (%)[(a)]
2040	1.3	1.4	9%	1.2	1.4	18%	0.74	0.87	17%	0.3	0.33	11%
2041	1.2	1.4	9%	1.1	1.3	18%	0.69	0.81	18%	0.29	0.32	10%
2042	1.2	1.3	9%	1.1	1.3	16%	0.71	0.83	17%	0.27	0.3	11%
2043	1.1	1.2	8%	1.2	1.4	17%	0.71	0.83	17%	0.29	0.32	12%
2044	1	1.1	8%	1.1	1.3	20%	0.65	0.76	16%	0.28	0.31	10%
2045	0.9	0.97	8%	0.92	1.1	18%	0.58	0.66	15%	0.26	0.29	10%
2046	0.83	0.9	8%	0.82	1	20%	0.52	0.6	15%	0.25	0.27	10%
2047	0.78	0.84	8%	0.76	0.91	20%	0.48	0.55	15%	0.24	0.26	8%
2048	1.2	1.4	20%	0.93	1.2	28%	0.56	0.72	27%	0.24	0.27	13%
2049	1.3	1.6	22%	1	1.2	31%	0.67	0.81	22%	0.25	0.29	15%
2050	1.3	1.6	22%	0.95	1.2	31%	0.65	0.8	24%	0.26	0.3	16%
2051	1.2	1.5	21%	0.93	1.2	32%	0.64	0.77	21%	0.26	0.3	15%
2052	1.2	1.5	22%	0.91	1.2	31%	0.6	0.74	24%	0.26	0.3	16%
2053	1.2	1.4	23%	0.87	1.2	32%	0.59	0.72	21%	0.25	0.29	16%
Average			**12%**			**24%**			**21%**			**15%**

mg/L = milligrams per litre; % = percent.

(a) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA.

4.7 Changes to Model Inputs Related to Blasting Practices

Lining of blast holes began in 2017 at Teck's operations in the Elk Valley, the purpose of which is to limit the loss of explosives prior to blasting. Limiting the loss of explosives reduces the amount of explosive residual associated with freshly blasted waste rock, which, in turn, reduces the release of nitrate from waste rock spoils.

The 2020 RWQM has the ability to account for the use of liners, as per the methods outlined in Teck 2021a. However, for the purposes of the 2022 IPA, liners were assumed to be completely ineffective (i.e., their effectiveness at preventing the loss of explosives prior to blasting is modelled as 0%). A sensitivity analysis was undertaken to understand how changes to this value affect projected concentrations of nitrate. The sensitivity analysis involved increasing liner effectiveness values assigned to lined blast holes at FRO, GHO, LCO and EVO from 0% to 20%. This analysis was conducted with a focus on Order Stations and Compliance Points. The 2020 RWQM was run with the 20 individual flow realizations and model output (i.e., individual weekly estimates) was processed to generate temporally-connected monthly average concentrations for each realization. The resulting monthly datasets were summarized by calculating P_{10}, P_{50}, and P_{90} values across the 20 realizations for each future month and each future year.

Projected monthly average concentrations of nitrate at Order Stations, compliance points and in LCO Dry Creek, with and without improvements to blasting practices are shown in Appendix I.

Overall, increasing the liner effectiveness value assigned to lined blast holes at FRO, GHO, LCO and EVO from 0% to 20% resulted in lower projected concentrations of nitrate at Order Stations, compliance points and in LCO Dry Creek from approximately 2020 to 2053. This pattern is not surprising because the purpose of lining blast holes is to limit the loss of explosives prior to blasting. Limiting the loss of explosives reduces the amount of explosives residual associated with freshly blasted waste rock, which, in turn, reduces the release of nitrate from waste rock spoils.

Increasing the liner effectiveness value assigned to lined blast holes from 0% to 20% resulted in a decrease in projected maximum P_{90} monthly average nitrate concentrations (i.e., projected peak concentrations) by (Table 4-23):

- 0.4 mg-N/L (or 6%), on average, at the FRO Compliance Point (FR_FRABCH; E223753)
- 0.9 mg-N/L (or 8%), on average, at LCO Dry Creek downstream of the Sedimentation Ponds (LC_DCDS; E295210)
- 0.2 mg-N/L (or 8%), on average, at the LCO Compliance Point (LC_LCDSSLCC; E297110)
- 0.1 mg/L (or 8%), on average, at the GHO Elk River Compliance Point (GH_ERC; E300090)
- 0.3 mg-N/L (or 15%), on average, at the EVO Harmer Compliance Point (EV_HC1; E102682)
- 0.3 mg-N/L (or 11%), on average, at the EVO Michel Creek Compliance Point (EV_MC2; E300091)

The influence of liner effectiveness at Order Stations was similar in terms of absolute and relative change (Tables 4-24 and 4-25).

Increasing the liner effectiveness value assigned to lined blast holes at FRO, GHO, LCO and EVO from 0% to 20% would appear to have limited influence on projected peak concentrations at Order Stations, compliance points and in LCO Dry Creek.

Table 4-23: Projected Nitrate Concentrations at Compliance Points and LCO Dry Creek with and without Changes to Blasting Practices

Year	Projected Maximum P_{90} Monthly Average Nitrate Concentrations (mg/L)																							
	FR_FRABCH				LC_DCDS				LC_LCDSSLCC				GH_ERC				EV_HC1				EV_MC2			
	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]
2020	27	26	-0.1	0%	72	69	-3.6	-5%	11	11	0	0%	1.2	1.1	<-0.01	0%	2.1	2.1	0	0%	4.8	4.8	0	0%
2021	28	28	-0.3	-1%	91	86	-4.7	-5%	12	12	0	0%	1.3	1.3	-0.01	-1%	2.3	2.3	0	0%	6.7	6.7	-0.1	-1%
2022	29	28	-0.5	-2%	97	91	-5.8	-6%	13	13	-0.1	-1%	1.4	1.4	-0.04	-3%	2.0	2.0	0	0%	4.1	4.0	-0.1	-2%
2023	24	24	-0.6	-2%	75	70	-4.8	-6%	13	13	-0.1	-1%	1.4	1.4	-0.04	-3%	1.6	1.6	0	0%	3.8	3.7	-0.1	-3%
2024	20	19	-0.3	-1%	16	15	-0.2	-2%	11	10	-0.1	-1%	1.3	1.3	-0.05	-4%	0.9	0.9	0	0%	4.0	3.8	-0.2	-5%
2025	18	18	-0.2	-1%	14	14	-0.2	-2%	9.8	9.4	-0.3	-4%	1.2	1.1	-0.05	-4%	0.8	0.8	0	0%	4.5	4.2	-0.3	-6%
2026	17	16	-0.2	-1%	14	13	-0.3	-2%	4.0	3.7	-0.2	-6%	1.0	0.96	-0.04	-4%	1.1	1.0	-0.1	-8%	4.1	3.8	-0.3	-7%
2027	15	15	-0.3	-2%	12	12	-0.2	-2%	3.8	3.5	-0.3	-7%	0.88	0.83	-0.04	-5%	1.8	1.6	-0.2	-12%	4.5	4.1	-0.3	-8%
2028	12	12	-0.3	-3%	10	9.9	-0.4	-4%	3.5	3.2	-0.2	-7%	0.69	0.66	-0.04	-5%	2.0	1.7	-0.3	-14%	2.8	2.7	-0.2	-6%
2029	11	11	-0.3	-3%	9.5	9.0	-0.4	-5%	3.4	3.1	-0.2	-7%	0.56	0.53	-0.04	-7%	2.5	2.2	-0.3	-12%	2.5	2.3	-0.2	-8%
2030	10	10	-0.4	-4%	9.0	8.5	-0.5	-5%	3.1	2.9	-0.3	-9%	0.55	0.50	-0.05	-9%	2.8	2.4	-0.3	-12%	2.2	2.0	-0.2	-8%
2031	10	9.7	-0.5	-5%	8.8	8.2	-0.5	-6%	2.5	2.4	-0.2	-6%	0.48	0.44	-0.05	-9%	2.7	2.3	-0.4	-13%	2.3	2.1	-0.2	-10%
2032	9.5	9.0	-0.5	-6%	8.3	7.7	-0.5	-6%	2.4	2.2	-0.1	-6%	0.41	0.37	-0.04	-9%	2.5	2.1	-0.3	-14%	2.6	2.3	-0.3	-12%
2033	9.1	8.5	-0.6	-6%	8.0	7.4	-0.6	-7%	2.2	2.0	-0.2	-7%	0.35	0.32	-0.03	-9%	2.5	2.1	-0.3	-14%	2.6	2.3	-0.3	-13%
2034	8.3	7.7	-0.6	-7%	7.6	6.9	-0.6	-8%	2.4	2.2	-0.2	-10%	0.30	0.27	-0.03	-9%	2.5	2.2	-0.4	-14%	2.6	2.2	-0.4	-14%
2035	7.2	6.7	-0.6	-8%	6.7	6.1	-0.6	-9%	2.4	2.2	-0.3	-10%	0.25	0.23	-0.02	-9%	2.5	2.1	-0.4	-15%	2.4	2.1	-0.3	-14%
2036	7.0	6.4	-0.6	-9%	6.4	5.8	-0.6	-9%	2.3	2.1	-0.3	-11%	0.22	0.20	-0.02	-9%	2.6	2.2	-0.4	-16%	2.5	2.2	-0.4	-14%
2037	6.8	6.1	-0.6	-9%	6.2	5.6	-0.6	-10%	2.2	2.0	-0.2	-11%	0.18	0.17	-0.02	-8%	2.3	1.9	-0.4	-16%	2.0	1.7	-0.3	-13%
2038	6.3	5.7	-0.6	-10%	5.9	5.3	-0.6	-11%	2.3	2.0	-0.3	-12%	0.16	0.15	-0.01	-8%	2.1	1.8	-0.3	-16%	2.1	1.8	-0.3	-14%
2039	5.9	5.3	-0.6	-10%	5.8	5.2	-0.6	-11%	2.4	2.1	-0.3	-12%	0.14	0.13	-0.01	-8%	2.3	1.9	-0.4	-16%	2.2	1.8	-0.3	-15%
2040	5.4	4.9	-0.5	-10%	5.6	5.0	-0.6	-11%	2.5	2.2	-0.3	-12%	0.13	0.12	-0.01	-8%	2.3	2.0	-0.4	-16%	2.1	1.8	-0.3	-15%
2041	5.0	4.5	-0.5	-10%	5.3	4.6	-0.7	-12%	2.4	2.1	-0.3	-12%	0.12	0.11	-0.01	-8%	2.4	2.0	-0.4	-16%	2.1	1.8	-0.3	-15%
2042	4.6	4.2	-0.4	-9%	5.1	4.4	-0.7	-14%	2.2	1.9	-0.3	-12%	0.11	0.10	-0.01	-8%	2.2	1.8	-0.4	-16%	2.2	1.9	-0.3	-15%
2043	4.2	3.9	-0.4	-9%	4.8	4.2	-0.7	-14%	2.1	1.8	-0.2	-12%	0.08	0.08	-0.01	-7%	2.0	1.7	-0.3	-17%	3.3	2.8	-0.5	-16%
2044	4.0	3.7	-0.3	-9%	4.1	3.7	-0.4	-10%	1.8	1.6	-0.2	-11%	0.07	0.07	<-0.01	-6%	1.8	1.5	-0.3	-17%	2.7	2.3	-0.4	-16%
2045	3.8	3.5	-0.3	-8%	3.8	3.4	-0.4	-10%	1.6	1.4	-0.2	-11%	0.07	0.07	<-0.01	-5%	1.5	1.3	-0.3	-16%	2.1	1.8	-0.3	-15%
2046	3.7	3.4	-0.3	-9%	3.6	3.2	-0.3	-10%	1.3	1.2	-0.1	-11%	0.07	0.07	<-0.01	-5%	1.3	1.1	-0.2	-16%	1.8	1.6	-0.3	-15%
2047	3.6	3.3	-0.3	-8%	3.4	3.1	-0.3	-9%	1.1	1.0	-0.1	-10%	0.07	0.06	<-0.01	-6%	1.1	0.90	-0.2	-16%	1.7	1.5	-0.3	-15%
2048	3.4	3.2	-0.3	-8%	3.2	2.9	-0.3	-9%	0.98	0.89	-0.09	-9%	1.4	1.2	-0.2	-18%	0.90	0.75	-0.1	-16%	1.7	1.5	-0.3	-15%

Table 4-23: Projected Nitrate Concentrations at Compliance Points and LCO Dry Creek with and without Changes to Blasting Practices

Year	Projected Maximum P_{90} Monthly Average Nitrate Concentrations (mg/L)																							
	FR_FRABCH				LC_DCDS				LC_LCDSSLCC				GH_ERC				EV_HC1				EV_MC2			
	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]
2049	3.3	3.0	-0.2	-8%	2.9	2.7	-0.3	-8%	0.86	0.79	-0.08	-9%	1.8	1.5	-0.3	-18%	0.76	0.64	-0.1	-16%	1.6	1.4	-0.2	-15%
2050	3.4	3.1	-0.3	-8%	2.9	2.7	-0.3	-9%	0.74	0.67	-0.06	-9%	1.8	1.4	-0.3	-18%	0.65	0.55	-0.1	-15%	1.5	1.3	-0.2	-14%
2051	3.4	3.1	-0.3	-8%	2.9	2.6	-0.3	-9%	0.63	0.58	-0.05	-8%	1.8	1.5	-0.3	-18%	0.57	0.48	-0.1	-15%	1.4	1.2	-0.2	-13%
2052	3.2	3.0	-0.2	-8%	2.7	2.5	-0.2	-8%	0.54	0.50	-0.04	-8%	1.7	1.4	-0.3	-18%	0.50	0.42	-0.1	-15%	1.3	1.2	-0.2	-13%
2053	3.1	2.8	-0.2	-7%	2.5	2.3	-0.2	-8%	0.47	0.43	-0.04	-8%	1.7	1.4	-0.3	-18%	0.43	0.37	-0.1	-15%	1.3	1.1	-0.2	-14%
Average			-0.4	-6%			-0.9	-8%			-0.2	-8%			-0.1	-8%			-0.3	-15%			-0.3	-11%

mg/L = milligrams per litre; % = percent.

(a) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA. Negative values indicate a decrease in projected concentrations compared to the 2022 IPA.

Table 4-24: Projected Nitrate Concentrations at Order Stations in the Fording River with and without Changes to Blasting Practices

Year	Projected Maximum P_{90} Monthly Average Nitrate Concentrations (mg/L)							
	GH_FR1				LC_LC5			
	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]
2020	18	18	-0.2	-1%	14	14	-0.1	-1%
2021	20	20	-0.3	-1%	15	15	-0.2	-1%
2022	20	20	-0.4	-2%	16	16	-0.3	-2%
2023	18	17	-0.5	-3%	14	14	-0.3	-2%
2024	15	15	-0.3	-2%	12	12	-0.2	-2%
2025	14	14	-0.3	-2%	11	11	-0.3	-3%
2026	12	12	-0.3	-2%	8.8	8.6	-0.2	-2%
2027	11	11	-0.3	-2%	8.1	7.9	-0.2	-3%
2028	9.9	9.5	-0.4	-4%	7.2	6.9	-0.3	-4%
2029	9.3	8.8	-0.5	-5%	6.8	6.4	-0.4	-5%
2030	8.8	8.3	-0.5	-6%	6.5	6.1	-0.4	-6%
2031	8.6	8.0	-0.6	-7%	6.2	5.8	-0.4	-7%
2032	8.3	7.7	-0.6	-8%	6.0	5.5	-0.5	-8%
2033	8.4	7.7	-0.7	-9%	6.0	5.5	-0.5	-8%
2034	6.1	5.7	-0.5	-8%	4.7	4.3	-0.4	-8%
2035	5.2	4.7	-0.4	-8%	3.9	3.6	-0.3	-8%
2036	5.2	4.6	-0.6	-11%	3.8	3.4	-0.4	-10%
2037	5.0	4.4	-0.6	-11%	3.6	3.2	-0.4	-11%
2038	5.0	4.4	-0.6	-12%	3.6	3.2	-0.4	-12%
2039	5.0	4.4	-0.6	-12%	3.6	3.2	-0.4	-12%
2040	4.8	4.2	-0.6	-12%	3.5	3.1	-0.4	-12%
2041	4.3	3.8	-0.5	-12%	3.1	2.8	-0.4	-12%
2042	4.0	3.6	-0.5	-11%	2.9	2.6	-0.4	-12%
2043	3.7	3.3	-0.4	-11%	2.7	2.4	-0.3	-11%
2044	3.3	2.9	-0.4	-11%	2.4	2.1	-0.3	-11%
2045	2.9	2.6	-0.3	-11%	2.1	1.9	-0.2	-10%
2046	2.7	2.4	-0.2	-9%	2.0	1.8	-0.2	-9%
2047	2.5	2.3	-0.2	-9%	1.9	1.7	-0.2	-9%

Table 4-24: Projected Nitrate Concentrations at Order Stations in the Fording River with and without Changes to Blasting Practices

Year	Projected Maximum P_{90} Monthly Average Nitrate Concentrations (mg/L)							
	GH_FR1				LC_LC5			
	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]
2048	2.3	2.1	-0.2	-9%	1.7	1.6	-0.2	-9%
2049	2.2	2.0	-0.2	-8%	1.6	1.5	-0.1	-8%
2050	2.1	2.0	-0.2	-8%	1.6	1.4	-0.1	-8%
2051	2.1	1.9	-0.2	-8%	1.5	1.4	-0.1	-8%
2052	2.0	1.9	-0.2	-8%	1.5	1.3	-0.1	-8%
2053	1.9	1.8	-0.1	-7%	1.4	1.3	-0.1	-7%
Average			-0.4	-7%			-0.3	-7%

mg/L = milligrams per litre; % = percent.

(a) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA. Negative values indicate a decrease in projected concentrations compared to the 2022 IPA.

Table 4-25: Projected Nitrate Concentrations at Order Stations in the Elk River with and without Changes to Blasting Practices

Year	Projected Maximum P_{90} Monthly Average Nitrate Concentrations (mg/L)																			
	GH_ER1				EV_ER4				EV_ER1				RG_ELKORES				RG_DSELK			
	2022 I PA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[a]
2020	1.1	1.1	0	0%	6.1	6.0	-0.1	-1%	3.6	3.6	-0.02	-1%	2.5	2.5	-0.02	-1%	0.69	0.69	<-0.01	-1%
2021	1.2	1.2	-0.01	-1%	6.5	6.4	-0.1	-2%	3.8	3.8	-0.03	-1%	2.7	2.7	-0.03	-1%	0.76	0.75	-0.01	-1%
2022	1.3	1.3	-0.04	-3%	6.7	6.6	-0.1	-2%	4.1	4.0	-0.1	-2%	2.7	2.6	-0.1	-2%	0.74	0.72	-0.01	-2%
2023	1.3	1.3	-0.04	-3%	6.2	6.1	-0.1	-2%	3.8	3.7	-0.1	-2%	2.4	2.4	-0.1	-2%	0.69	0.68	-0.01	-2%
2024	1.2	1.2	-0.05	-4%	5.4	5.3	-0.1	-2%	3.4	3.3	-0.1	-2%	2.2	2.1	-0.1	-2%	0.64	0.63	-0.01	-2%
2025	1.1	1.0	-0.04	-4%	4.8	4.7	-0.1	-3%	3.2	3.1	-0.1	-3%	2.1	2.0	-0.1	-3%	0.59	0.58	-0.02	-3%
2026	0.94	0.90	-0.04	-4%	4.0	3.9	-0.1	-3%	2.8	2.7	-0.1	-3%	1.8	1.7	-0.1	-3%	0.55	0.53	-0.01	-3%
2027	0.82	0.78	-0.04	-5%	3.8	3.7	-0.1	-3%	2.6	2.5	-0.1	-3%	1.6	1.6	-0.1	-4%	0.52	0.50	-0.01	-3%
2028	0.65	0.62	-0.03	-5%	3.3	3.2	-0.1	-4%	2.3	2.2	-0.1	-5%	1.5	1.4	-0.1	-4%	0.48	0.46	-0.02	-3%
2029	0.53	0.50	-0.03	-7%	3.0	2.9	-0.1	-5%	2.0	1.9	-0.1	-6%	1.3	1.3	-0.1	-6%	0.44	0.42	-0.02	-4%
2030	0.52	0.47	-0.05	-9%	2.9	2.7	-0.2	-6%	1.9	1.8	-0.1	-6%	1.3	1.2	-0.1	-6%	0.42	0.40	-0.02	-4%
2031	0.46	0.42	-0.04	-9%	2.7	2.6	-0.2	-6%	1.8	1.7	-0.1	-7%	1.2	1.1	-0.1	-7%	0.41	0.39	-0.02	-5%
2032	0.39	0.36	-0.04	-9%	2.6	2.4	-0.2	-7%	1.9	1.7	-0.2	-9%	1.2	1.1	-0.1	-8%	0.40	0.38	-0.02	-6%
2033	0.33	0.30	-0.03	-9%	2.6	2.4	-0.2	-8%	1.8	1.7	-0.2	-10%	1.2	1.1	-0.1	-9%	0.40	0.38	-0.03	-7%
2034	0.29	0.26	-0.03	-9%	2.0	1.9	-0.2	-8%	1.6	1.4	-0.2	-10%	1.0	0.91	-0.1	-9%	0.37	0.35	-0.03	-7%
2035	0.24	0.22	-0.02	-9%	1.7	1.5	-0.1	-8%	1.4	1.3	-0.1	-10%	0.86	0.78	-0.1	-9%	0.34	0.32	-0.02	-7%
2036	0.21	0.19	-0.02	-8%	1.6	1.4	-0.1	-9%	1.4	1.3	-0.1	-10%	0.87	0.78	-0.1	-11%	0.33	0.31	-0.02	-7%
2037	0.18	0.17	-0.01	-8%	1.5	1.3	-0.1	-9%	1.2	1.1	-0.1	-11%	0.77	0.68	-0.1	-11%	0.31	0.29	-0.02	-7%
2038	0.16	0.15	-0.01	-8%	1.4	1.3	-0.2	-11%	1.2	1.0	-0.1	-12%	0.76	0.67	-0.1	-12%	0.30	0.28	-0.02	-7%
2039	0.14	0.13	-0.01	-7%	1.4	1.2	-0.2	-11%	1.2	1.0	-0.1	-12%	0.74	0.65	-0.1	-12%	0.30	0.28	-0.02	-7%
2040	0.13	0.12	-0.01	-7%	1.3	1.2	-0.1	-11%	1.2	1.0	-0.1	-13%	0.74	0.65	-0.1	-12%	0.30	0.28	-0.02	-7%
2041	0.12	0.11	-0.01	-7%	1.2	1.1	-0.1	-11%	1.1	0.99	-0.1	-13%	0.69	0.61	-0.1	-12%	0.29	0.27	-0.02	-7%
2042	0.11	0.10	-0.01	-7%	1.2	1.0	-0.1	-10%	1.1	0.99	-0.1	-13%	0.71	0.62	-0.1	-12%	0.27	0.25	-0.02	-8%
2043	0.09	0.08	-0.01	-6%	1.1	0.96	-0.1	-10%	1.2	1.02	-0.2	-13%	0.71	0.62	-0.1	-13%	0.29	0.27	-0.02	-7%
2044	0.08	0.07	<-0.01	-5%	0.98	0.89	-0.1	-10%	1.1	0.93	-0.1	-12%	0.65	0.57	-0.1	-12%	0.28	0.26	-0.02	-7%
2045	0.07	0.07	<-0.01	-4%	0.90	0.81	-0.1	-10%	0.92	0.81	-0.1	-12%	0.58	0.51	-0.1	-12%	0.26	0.25	-0.02	-6%
2046	0.07	0.07	<-0.01	-5%	0.83	0.75	-0.1	-9%	0.82	0.73	-0.1	-11%	0.52	0.46	-0.1	-11%	0.25	0.23	-0.01	-6%
2047	0.07	0.07	<-0.01	-5%	0.78	0.71	-0.1	-9%	0.76	0.67	-0.1	-11%	0.48	0.42	-0.1	-11%	0.24	0.22	-0.01	-6%
2048	1.3	1.1	-0.2	-18%	1.2	1.0	-0.2	-13%	0.93	0.81	-0.1	-13%	0.56	0.49	-0.1	-12%	0.24	0.22	-0.02	-7%

Table 4-25: Projected Nitrate Concentrations at Order Stations in the Elk River with and without Changes to Blasting Practices

Year	Projected Maximum P_{90} Monthly Average Nitrate Concentrations (mg/L)																			
	GH_ER1				EV_ER4				EV_ER1				RG_ELKORES				RG_DSELK			
	2022 I PA	Sensitivity	Absolute Difference	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[(a)]	2022 IPA	Sensitivity	Absolute Difference	Relative Difference (%)[(a)]
2049	1.7	1.4	-0.3	-18%	1.3	1.1	-0.2	-14%	0.95	0.83	-0.1	-13%	0.67	0.57	-0.1	-14%	0.25	0.23	-0.02	-8%
2050	1.6	1.4	-0.3	-18%	1.3	1.1	-0.2	-14%	0.95	0.82	-0.1	-13%	0.65	0.56	-0.1	-14%	0.26	0.24	-0.02	-8%
2051	1.7	1.4	-0.3	-18%	1.2	1.1	-0.2	-13%	0.93	0.81	-0.1	-13%	0.64	0.55	-0.1	-14%	0.26	0.24	-0.02	-7%
2052	1.6	1.3	-0.3	-18%	1.2	1.1	-0.2	-13%	0.91	0.79	-0.1	-13%	0.60	0.52	-0.1	-14%	0.26	0.24	-0.02	-7%
2053	1.6	1.3	-0.3	-18%	1.2	1.0	-0.1	-13%	0.87	0.76	-0.1	-13%	0.59	0.51	-0.1	-14%	0.25	0.23	-0.02	-7%
Average			-0.1	-8%			-0.1	-8%			-0.1	-9%			-0.1	-9%			-0.02	-5%

mg/L = milligrams per litre; % = percent.

(a) Relative difference in projected maximum P_{90} monthly average concentrations was calculated as follows: $(Maximum\ P90\ Monthly\ Average\ Concentration_{Sensitivity\ Analysis} - Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA})/Maximum\ P90\ Monthly\ Average\ Concentration_{2022\ IPA}$. Positive values indicate an increase in projected concentrations compared to the 2022 IPA. Negative values indicate a decrease in projected concentrations compared to the 2022 IPA.

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Appendix A

Projected Influent Concentrations and Load Reductions

Figures

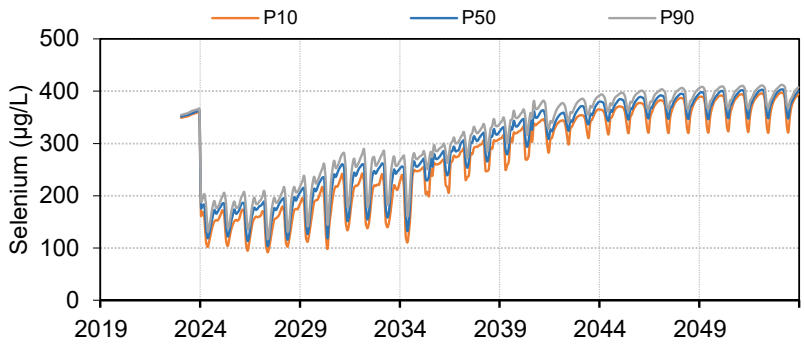
Projected monthly average influent concentrations of nitrate, selenium, and sulphate, as well as the projected monthly average loads of nitrate, selenium, and sulphate removed by each Saturated Rock Fill (SRF) and Active Water Treatment Facility (AWTF) are shown in Figures A-1 to A-15.

The x-axis runs from the start of 2019 to the end of 2053. The start date corresponds to the end of the calibration period for the 2020 RWQM. The end date (2053) corresponds to the modelled time period at which all permitted waste rock has been deposited and the lag associated with that rock has passed (i.e., all waste rock is contributing nitrate, selenium, and sulphate load).

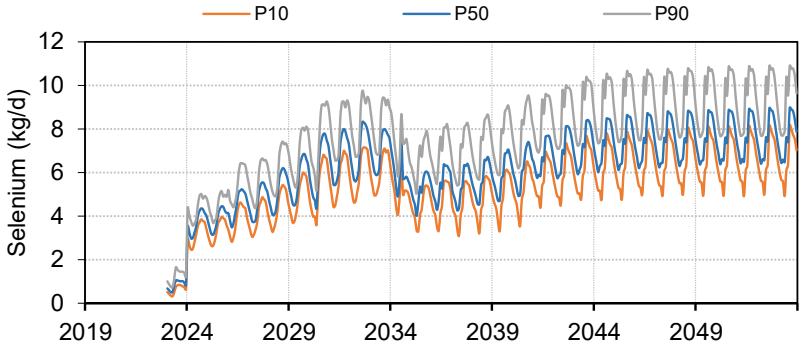
Projected 10^{th} percentile (P_{10}), 50^{th} percentile (P_{50}), and 90^{th} percentile (P_{90}) monthly average influent concentrations and load reductions are presented for each SRF and AWTF.

Figure A-1: Monthly Influent Concentrations and Load Reductions for Selenium and Nitrate at the Fording River Operations North 1 Saturated Rock Fill

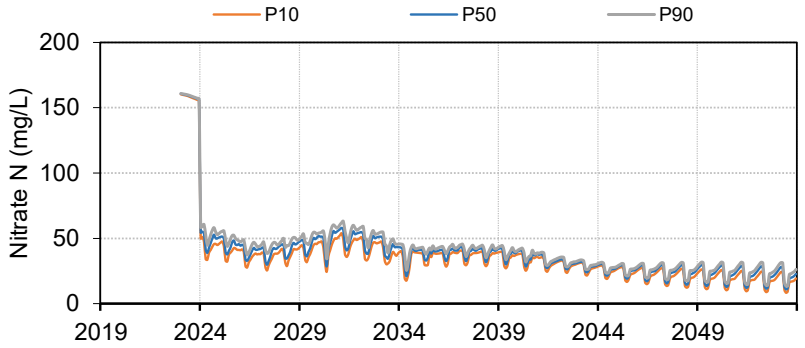
(a) Selenium Influent Concentration



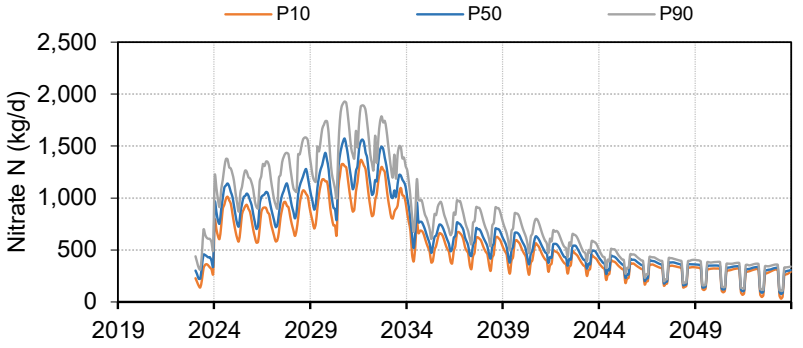
(b) Selenium Load Reduction



(c) Nitrate Influent Concentration



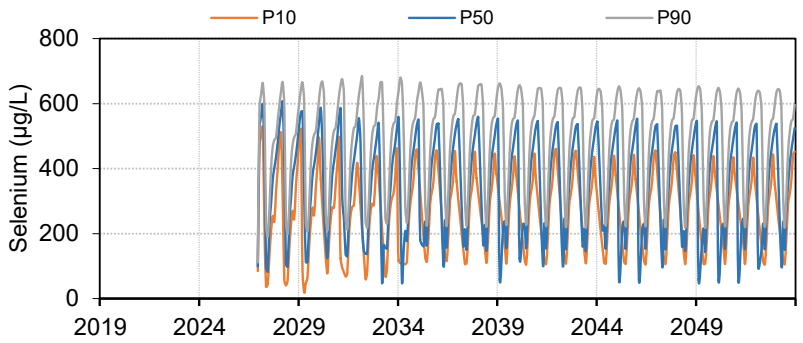
(d) Nitrate Load Reduction



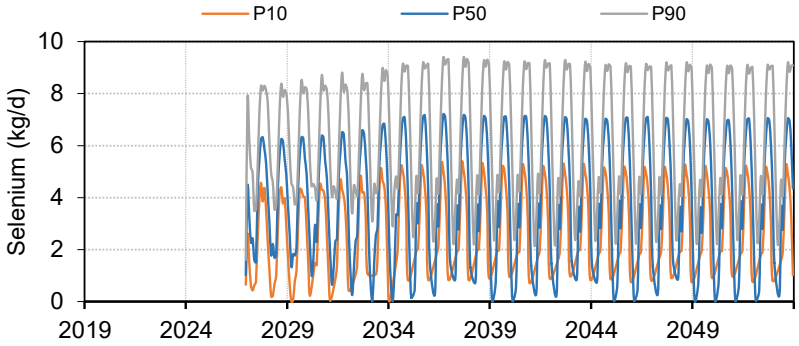
Notes: Influent concentrations decrease in 2024 because additional sources (i.e., Clode Creek, Liverpool Ponds / Swift Pit, and Post Ponds are treatment at the FRO-N 1 SRF.
Load reductions decrease in 2034 due to temporary water storage in Swift Pit.

Figure A-2: Monthly Influent Concentrations and Load Reductions for Selenium and Nitrate at the Fording River Operations North 2 Saturated Rock Fill

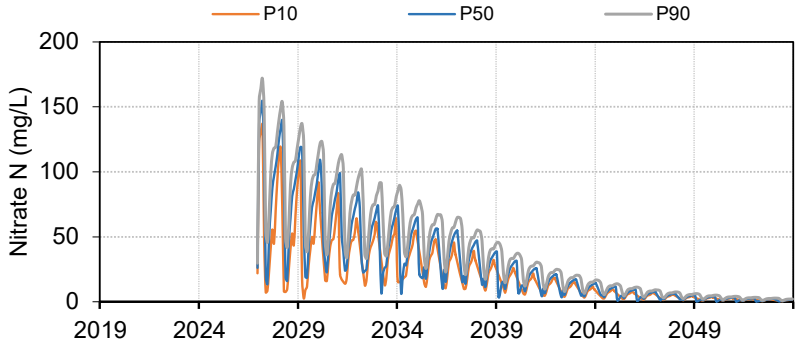
(a) Selenium Influent Concentration



(b) Selenium Load Reduction



(c) Nitrate Influent Concentration



(d) Nitrate Load Reduction

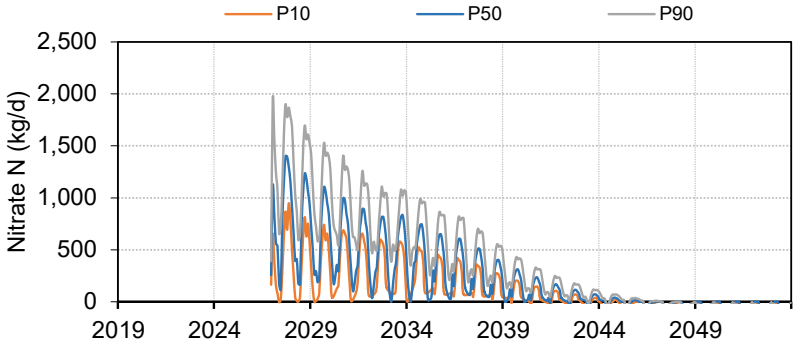
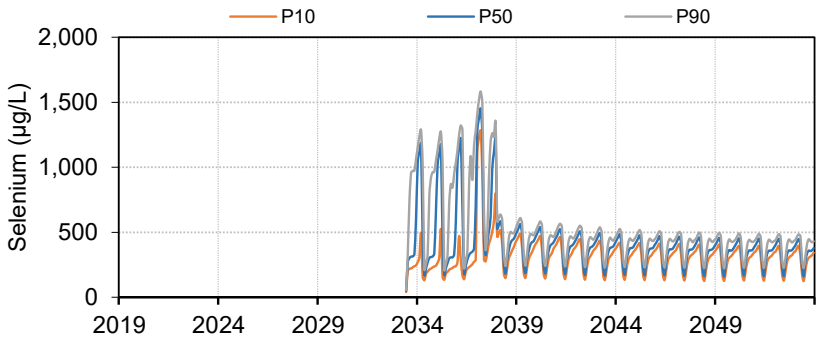
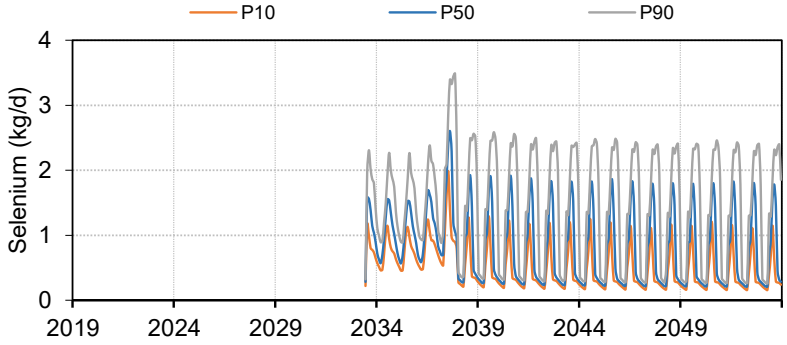


Figure A-3: Monthly Influent Concentrations and Load Reductions for Selenium and Nitrate at the Eagle 6 Saturated Rock Fill

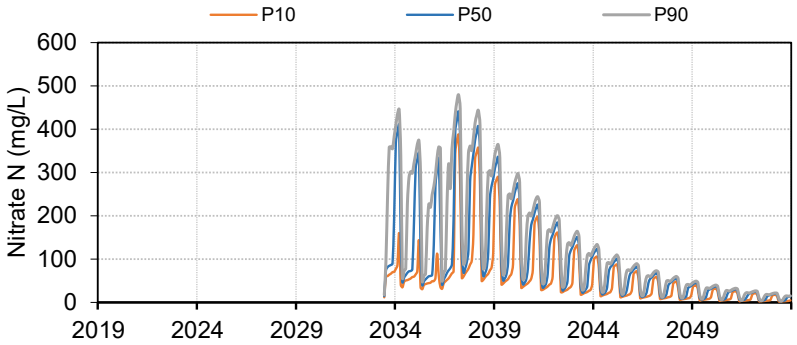
(a) Selenium Influent Concentration



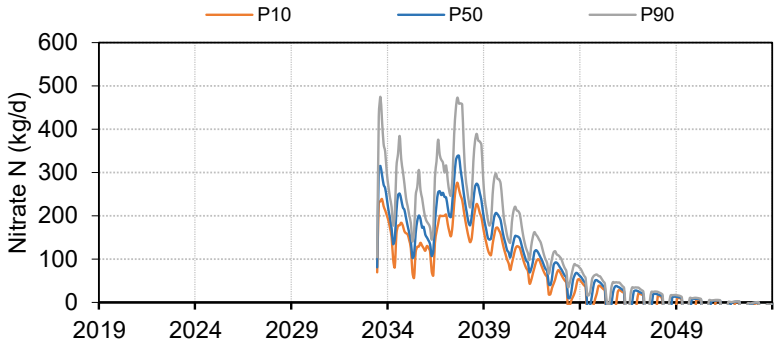
(b) Selenium Load Reduction



(c) Nitrate Influent Concentration



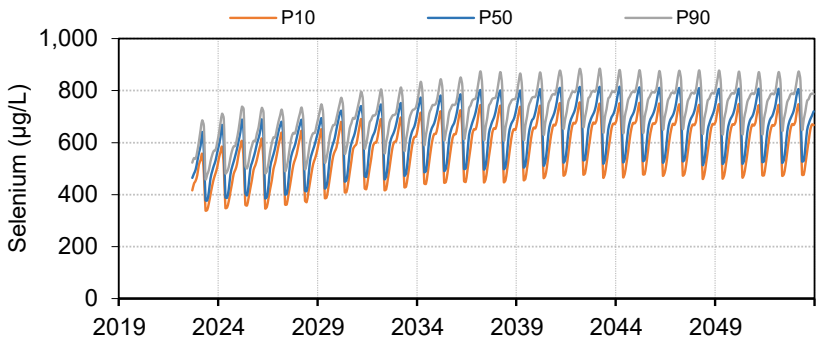
(d) Nitrate Load Reduction



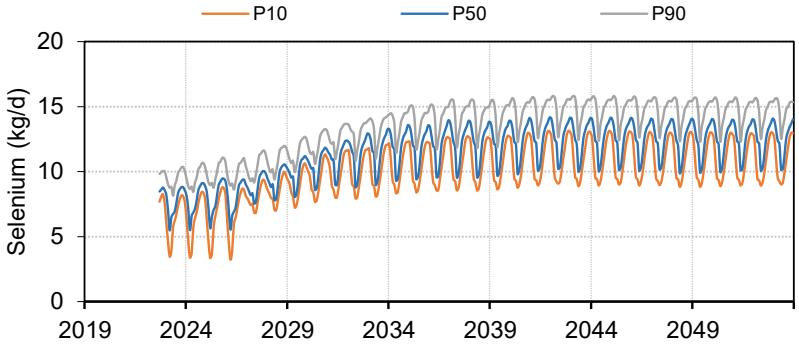
Notes: Influent concentrations decrease in 2037 because mining in Eagle 6 Pit North is complete and the pit is allowed to fill with water.

Figure A-4: Monthly Influent Concentrations and Load Reductions for Selenium and Nitrate at the Fording River Operations Active Water Treatment Facility South

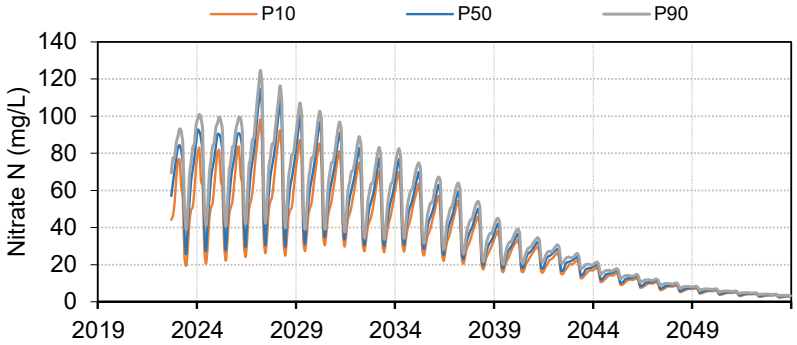
(a) Selenium Influent Concentration



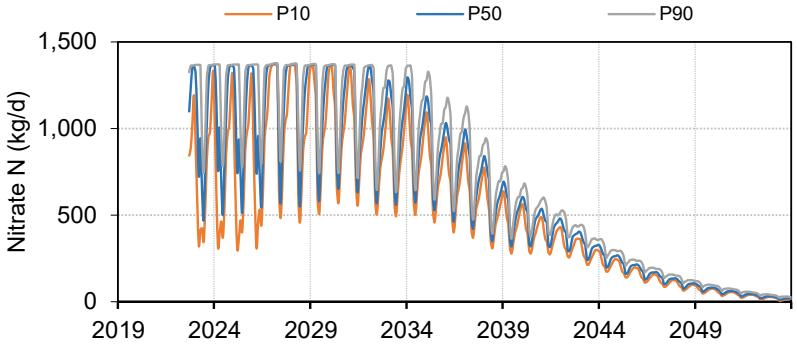
(b) Selenium Load Reduction



(c) Nitrate Influent Concentration



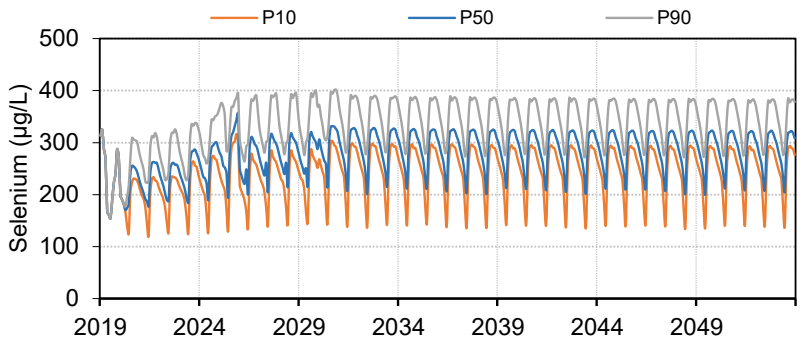
(d) Nitrate Load Reduction



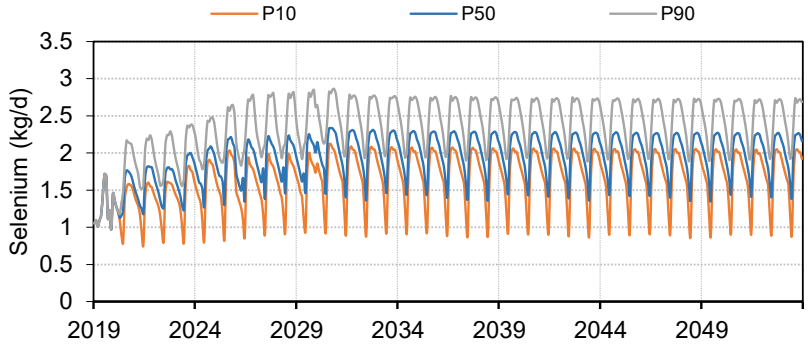
Notes: Influent concentrations and load reductions increase in 2027 due to collection and treatment of Kilmarnock Creek groundwater.

Figure A-5: Monthly Influent Concentrations and Load Reductions for Selenium and Nitrate at the West Line Creek Active Water Treatment Facility

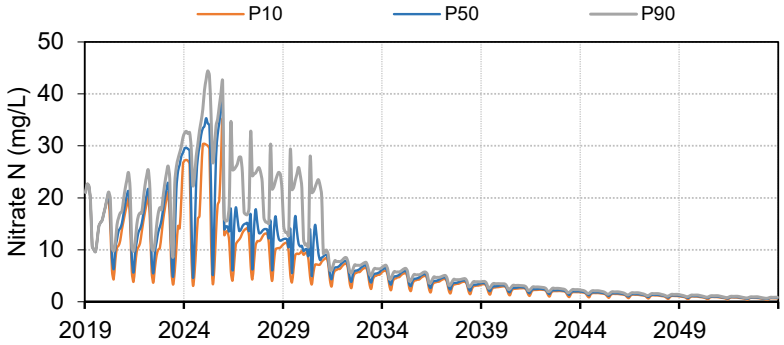
(a) Selenium Influent Concentration



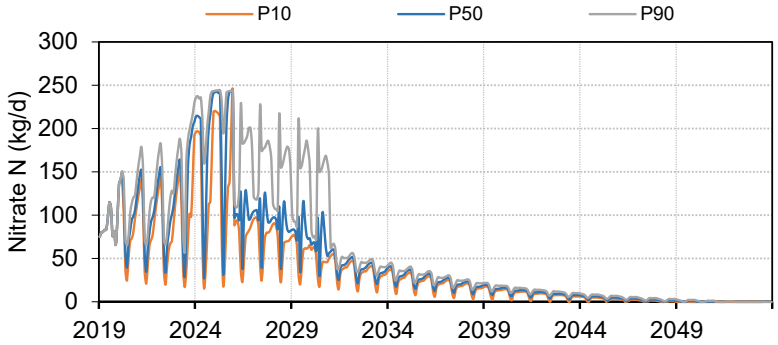
(b) Selenium Load Reduction



(c) Nitrate Influent Concentration



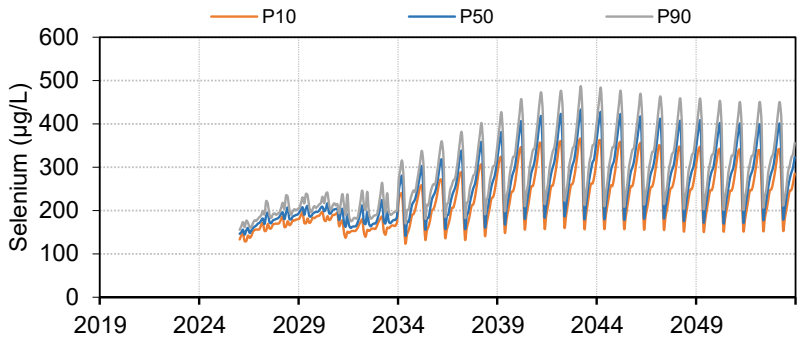
(d) Nitrate Load Reduction



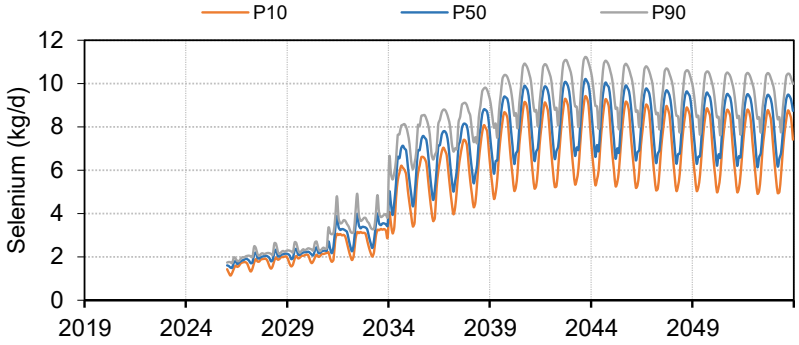
Notes: Influent nitrate concentrations and load reductions decrease in 2026 when the NLC SRF is fully effective. Influent nitrate concentrations and load reductions decrease in 2030 due to collection and treatment of West Line Creek groundwater.

Figure A-6: Monthly Influent Concentrations and Load Reductions for Selenium and Nitrate at the North Line Creek Saturated Rock Fill

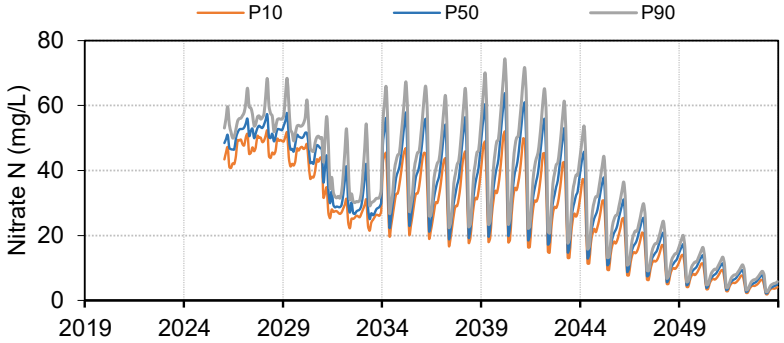
(a) Selenium Influent Concentration



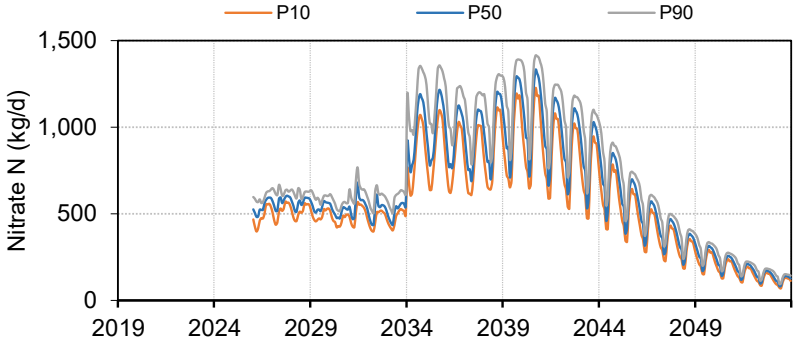
(b) Selenium Load Reduction



(c) Nitrate Influent Concentration



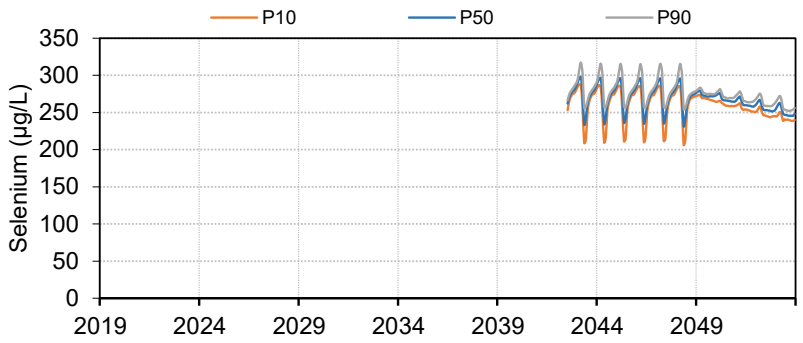
(d) Nitrate Load Reduction



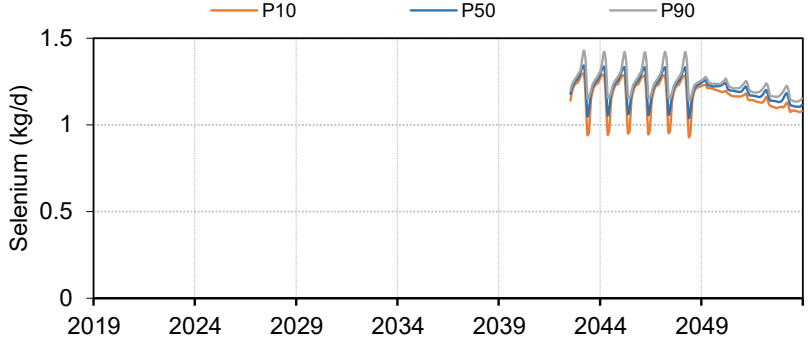
Notes: Influent selenium concentrations and load reductions increase in 2031 and 2034 when Phases II and III of the NLC SRF are fully effective. Influent nitrate concentrations and load reductions generally follow the same pattern but are also influence by the declining trend in nitrate in the numerical model.

Figure A-7: Monthly Influent Concentrations and Load Reductions for Selenium and Nitrate at the Cougar South Pit Saturated Rock Fill

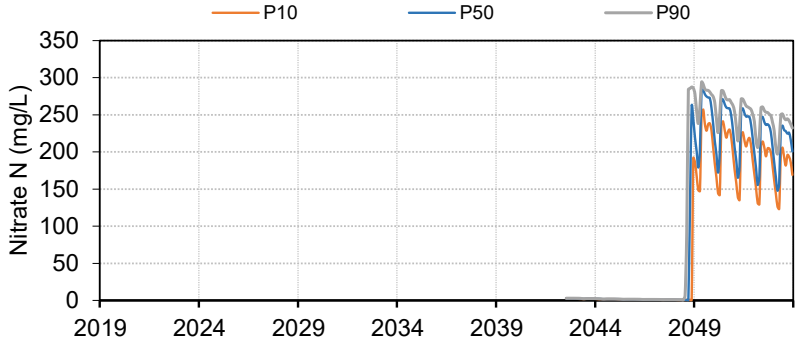
(a) Selenium Influent Concentration



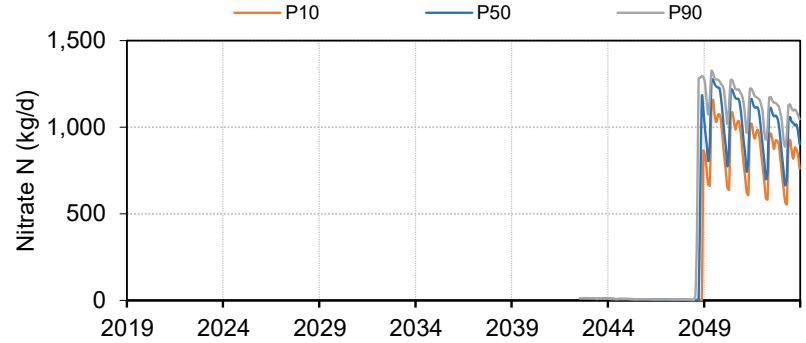
(b) Selenium Load Reduction



(c) Nitrate Influent Concentration



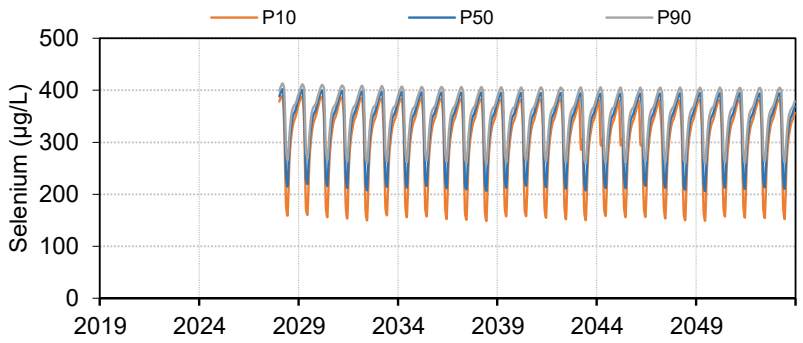
(d) Nitrate Load Reduction



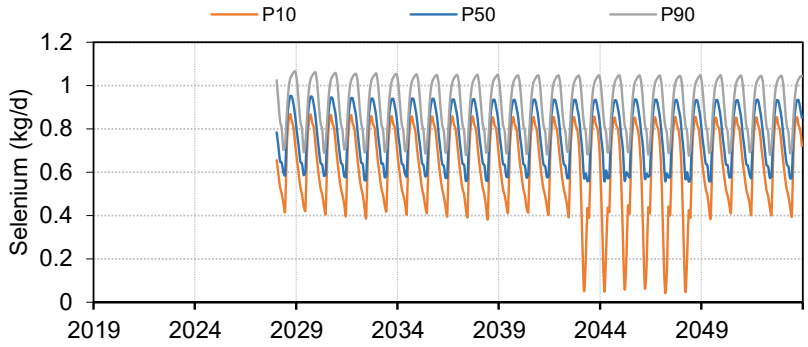
Notes: The seasonality in influent selenium concentrations and load reductions decreases in 2050 because the Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.
Influent nitrate concentrations and load reduction increase in 2050 because the Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

Figure A-8: Monthly Influent Concentrations and Load Reductions for Selenium and Nitrate at Greenhills Creek

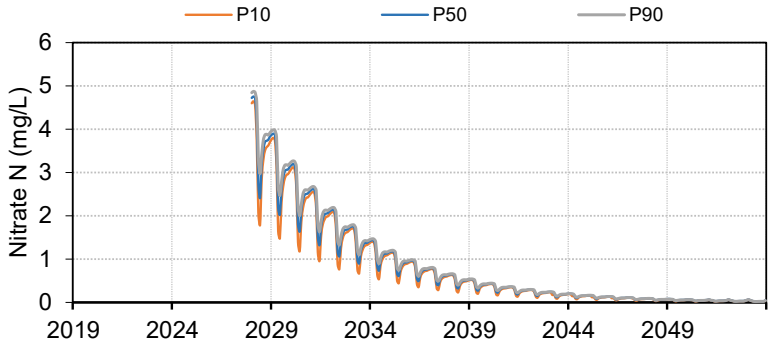
(a) Selenium Influent Concentration



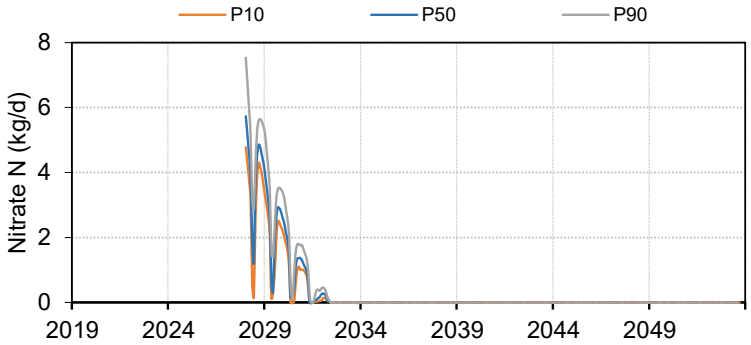
(b) Selenium Load Reduction



(c) Nitrate Influent Concentration



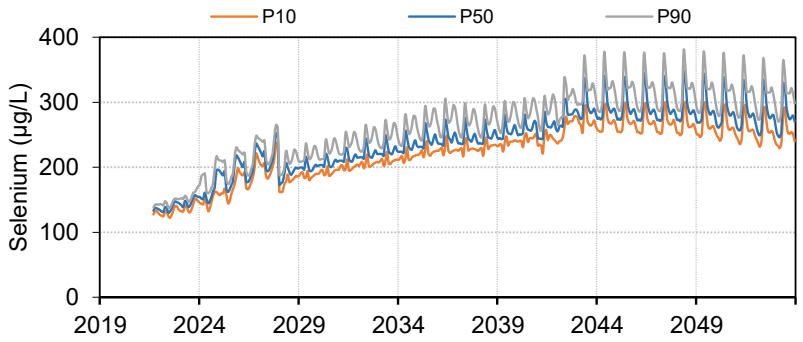
(d) Nitrate Load Reduction



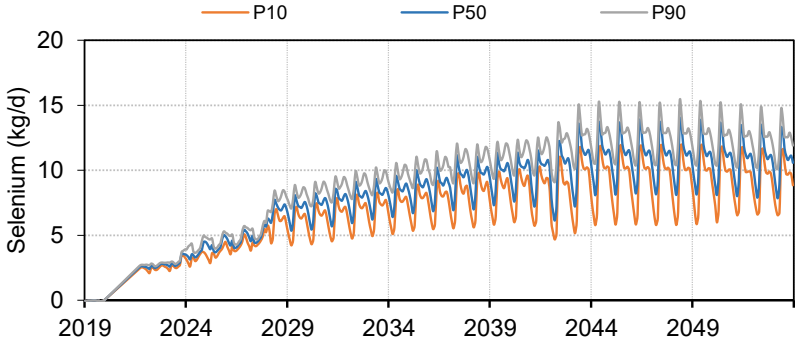
Notes: Selenium load reduction (P_{10}) decreases in 2043 because water from upper Greenhills Creek is treated at the Cougar South Pit SRF. Selenium load reduction (P_{10}) increases in 2049 because the Cougar Pit Phase 6 at Greenhills Operations is modelled to spill and water from Cougar Pit Phase 6 is prioritized for treated at the Cougar South Pit SRF before water from upper Greenhills Creek.

Figure A-9: Monthly Influent Concentrations and Load Reductions for Selenium and Nitrate at the EVO Saturated Rock Fill

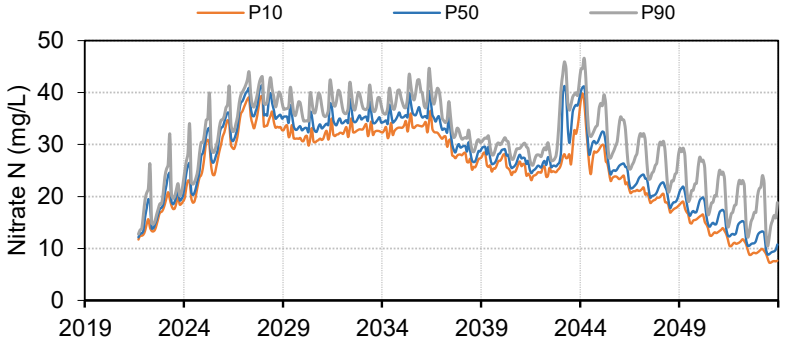
(a) Selenium Influent Concentration



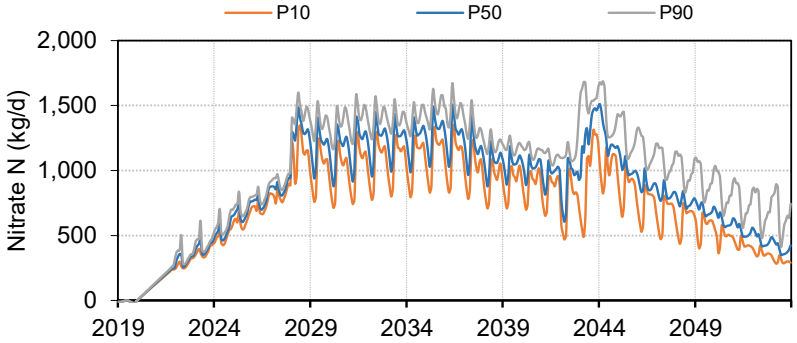
(b) Selenium Load Reduction



(c) Nitrate Influent Concentration



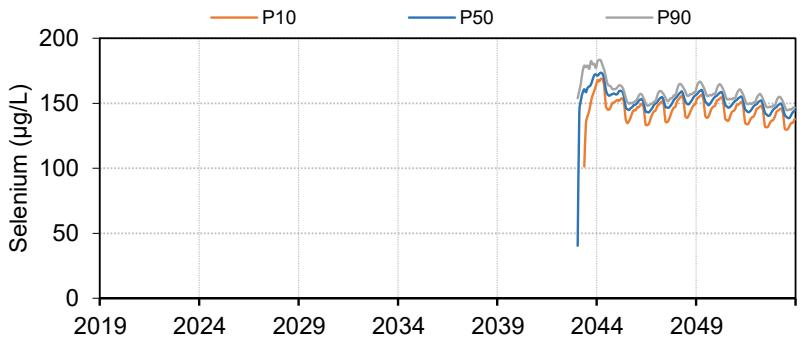
(d) Nitrate Load Reduction



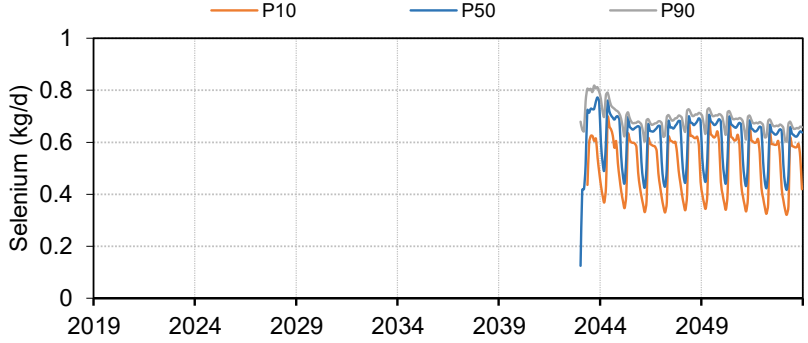
Notes: Influent concentrations decrease and load reductions increase in 2028 when Phase III of the EVO SRF is fully effective. Influent concentrations and load reductions increase in 2043 because the Baldy Ridge Pit at Elkview Operations is modelled to spill.

Figure A-10: Monthly Influent Concentrations and Load Reductions for Selenium and Nitrate at the Baldy Ridge Pit Saturated Rock Fill

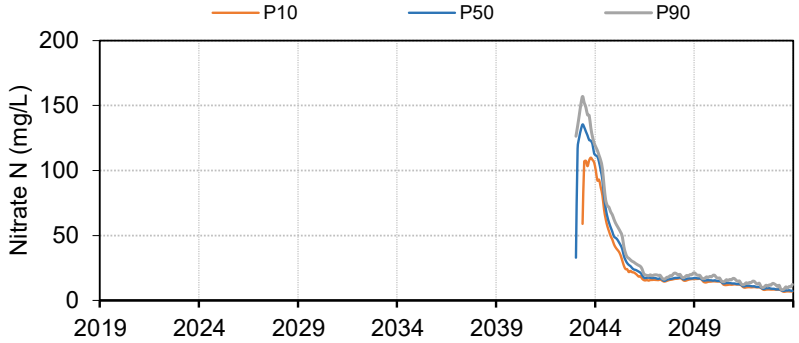
(a) Selenium Influent Concentration



(b) Selenium Load Reduction



(c) Nitrate Influent Concentration



(d) Nitrate Load Reduction

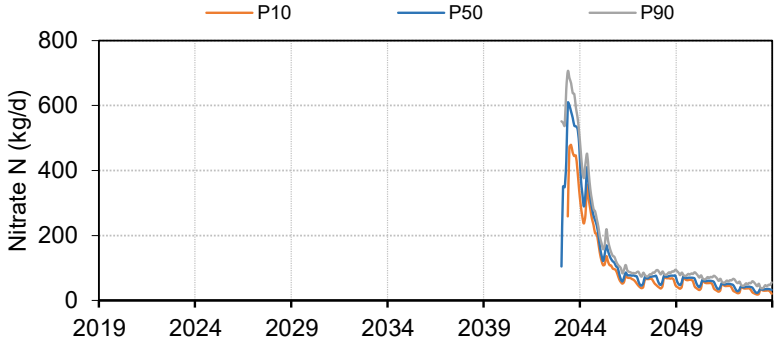
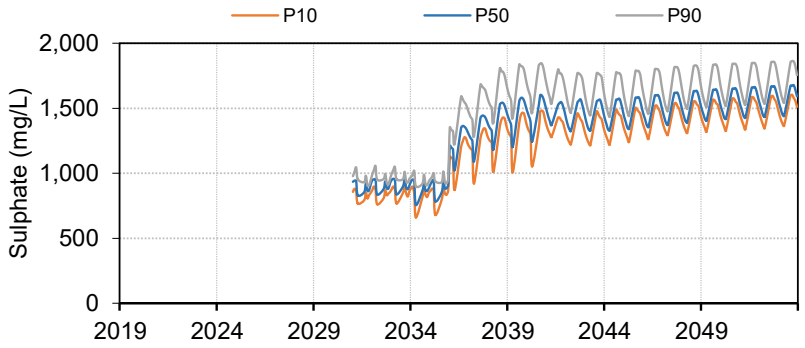
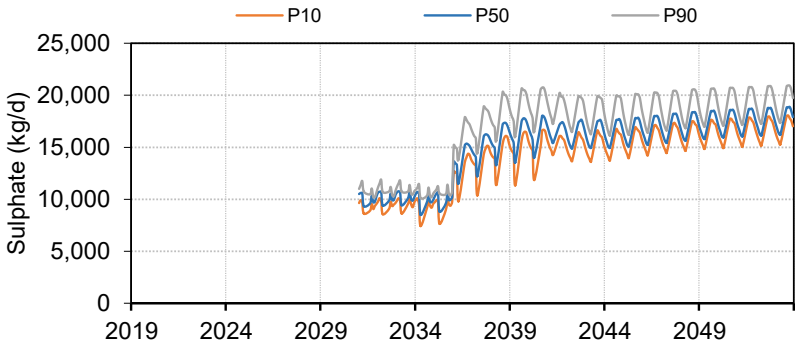


Figure A-11: Monthly Influent Concentrations and Load Reductions for Sulphate at Fording River Operations North

(a) Sulphate Influent Concentration



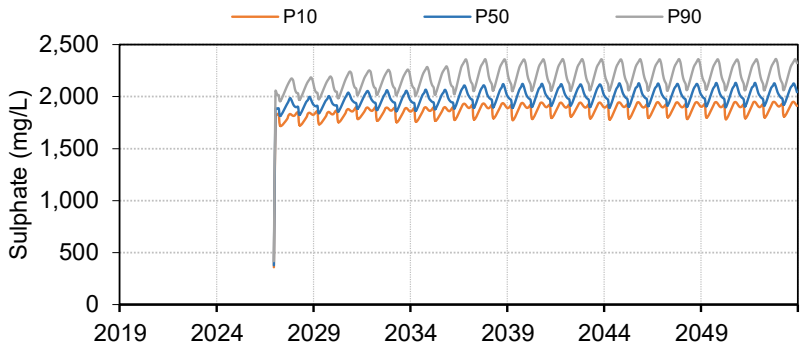
(b) Sulphate Load Reduction



Notes: Influent concentrations and load reductions increase in 2035 due to temporary water storage in Swift Pit and in 2041 because mining in Swift Pit is complete and the pit is allowed to fill with water.

Figure A-12: Monthly Influent Concentrations and Load Reductions for Sulphate at the Fording River Operations Active Water Treatment Facility South

(a) Sulphate Influent Concentration



(b) Sulphate Load Reduction

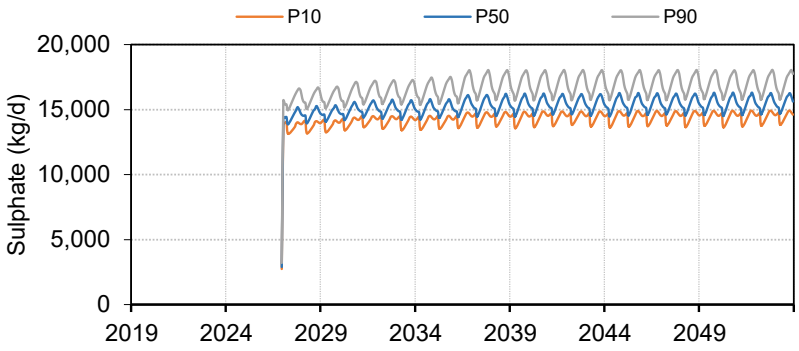
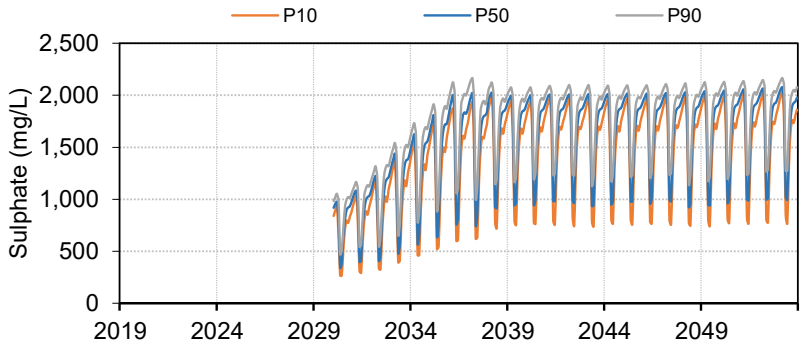
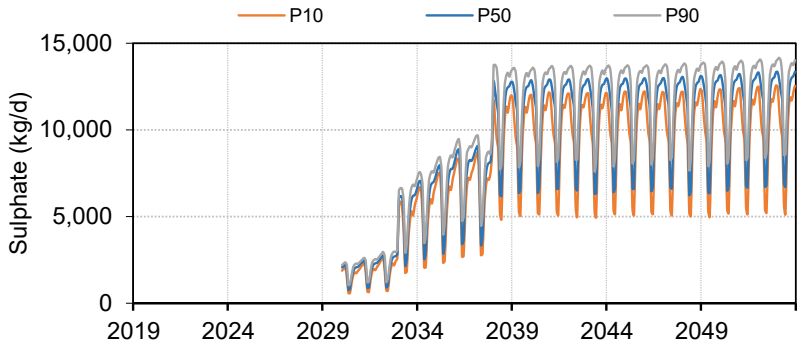


Figure A-13: Monthly Influent Concentrations and Load Reductions for Sulphate at Line Creek Operations - Dry Creek

(a) Sulphate Influent Concentration



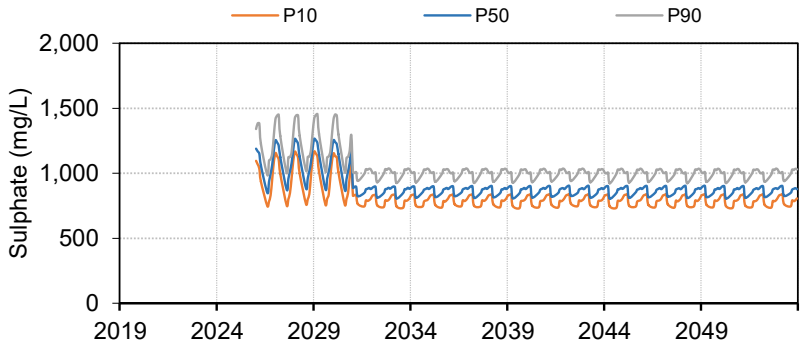
(b) Sulphate Load Reduction



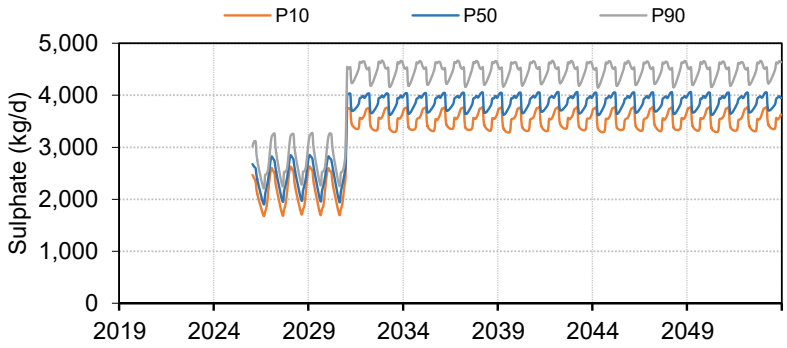
Note: Load reduction increases in 2033 and 2038 when Phases II and III of treatment are fully effective.

Figure A-14: Monthly Influent Concentrations and Load Reductions for Sulphate at the West Line Creek Active Water Treatment Facility

(a) Sulphate Influent Concentration



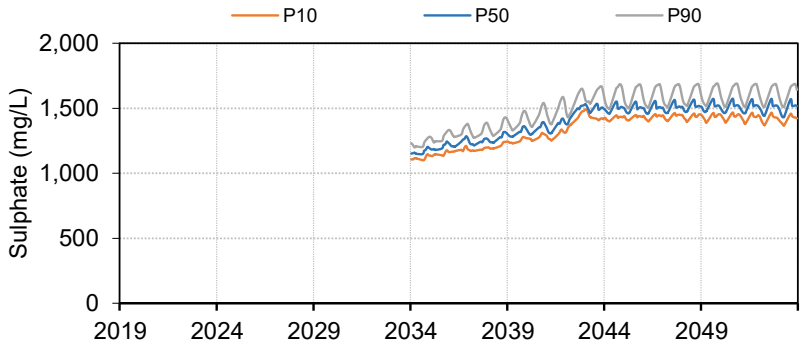
(b) Sulphate Load Reduction



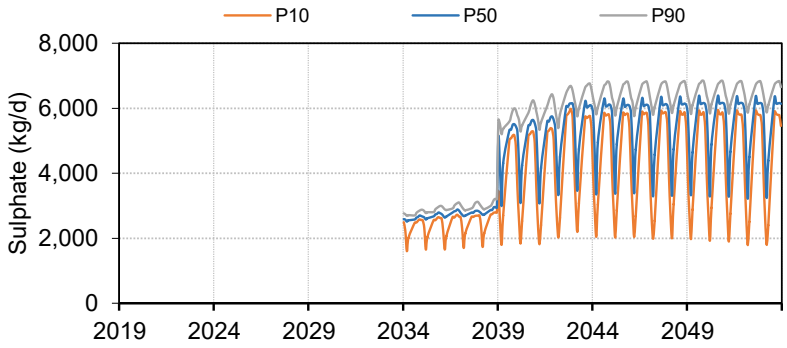
Note: Influent concentration decreases and load reduction increases in 2031 when Phase II of sulphate treatment at the West Line Creek active water treatment facility is fully effective.

Figure A-15: Monthly Influent Concentrations and Load Reductions of Sulphate at Elkview Operations - Dry Creek

(a) Sulphate Influent Concentration



(b) Sulphate Load Reduction



Note: Influent concentration and load reduction increase in 2039 when Phase II of sulphate treatment is fully effective.

Appendix B

Hydrographs of Treated Flows

Figures

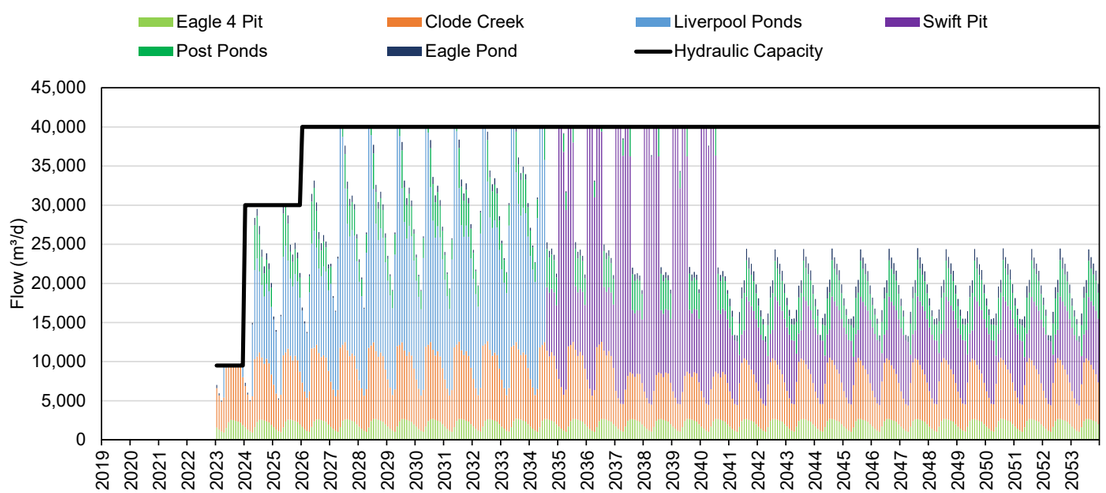
Monthly hydrographs of treated flows at each Saturated Rock Fill (SRF) and Active Water Treatment Facility (AWTF) for the 2022 Implementation Plan Adjustment (IPA) are shown in Figures B-1 to B-12. The projections are presented as stacked column plots. For reference, the hydrographs are plotted along with the treatment capacities identified in the 2022 IPA.

The x-axis runs from the start of 2019 to the end of 2053. The start date corresponds to the end of the calibration period for the 2020 RWQM. The end date (2053) corresponds to the modelled time period at which all permitted waste rock has been deposited and the lag associated with that rock has passed (i.e., all waste rock is contributing nitrate, selenium, and sulphate load).

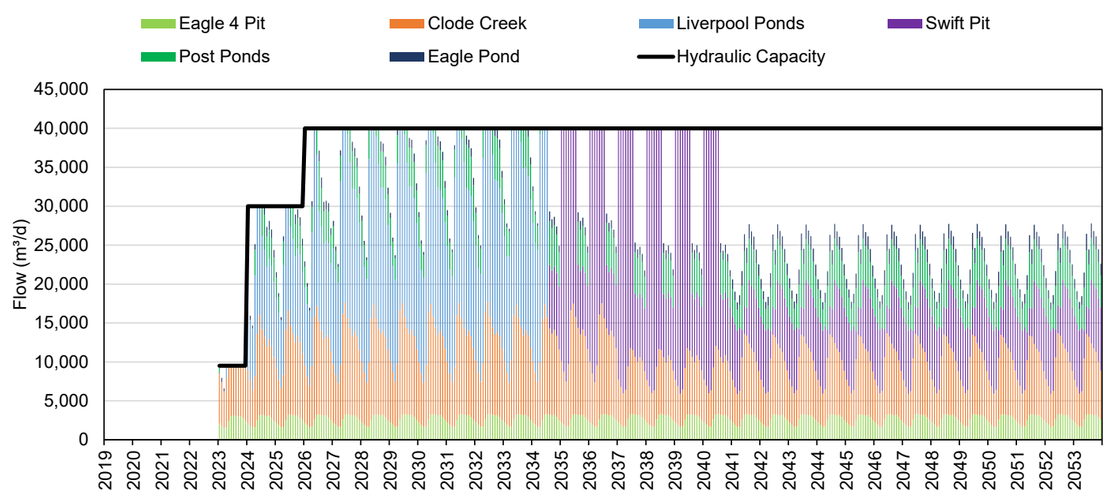
Projected 10^{th} percentile (P_{10}), 50^{th} percentile (P_{50}), and 90^{th} percentile (P_{90}) monthly average flows are presented for each SRF and AWTF. The hydrographs account for clean water diversions, as well as surface water availabilities and intake efficiencies in the water management system.

Figure B-1: Monthly Hydrographs of Treated Flows at the Fording River Operations North 1 Saturated Rock Fill - Selenium and Nitrate Treatment

(a) P_{10}



(b) P_{50}



(c) P_{90}

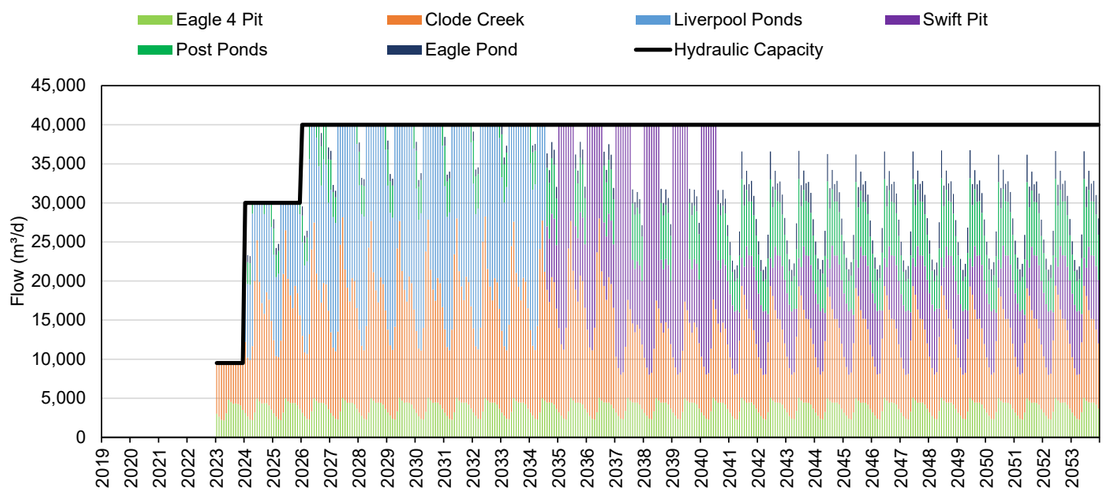
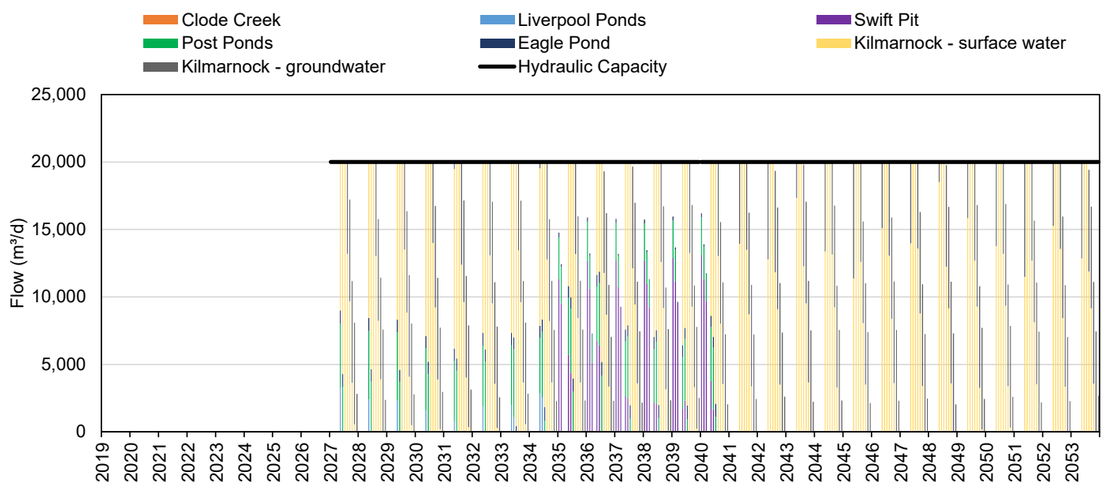
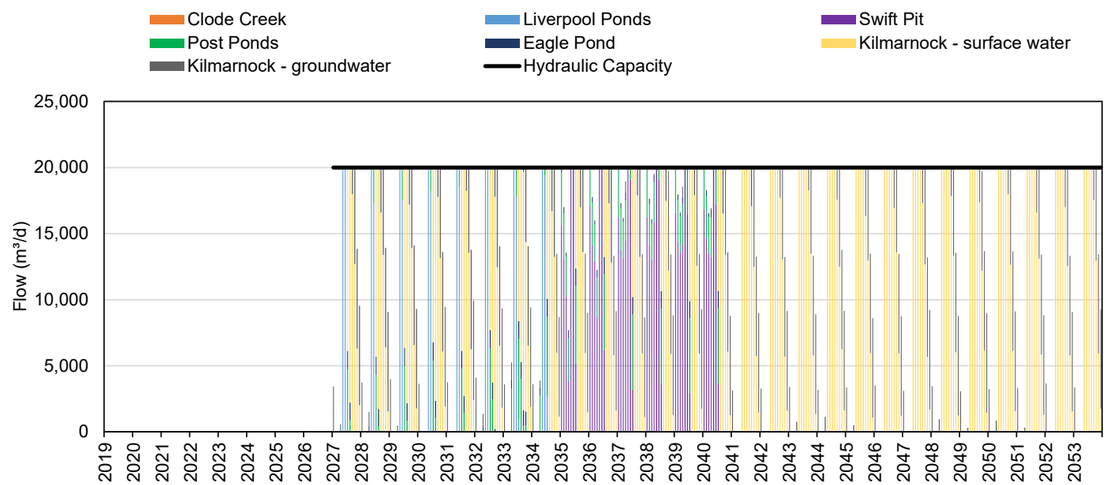


Figure B-2: Monthly Hydrographs of Treated Flows at the Fording River Operations North 2 Saturated Rock Fill - Selenium and Nitrate Treatment

(a) P_{10}



(b) P_{50}



(c) P_{90}

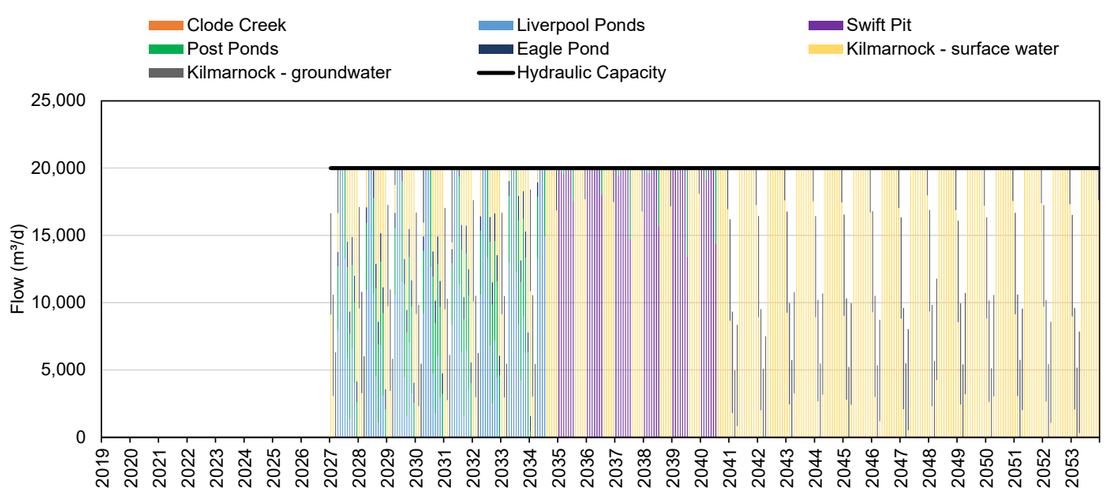


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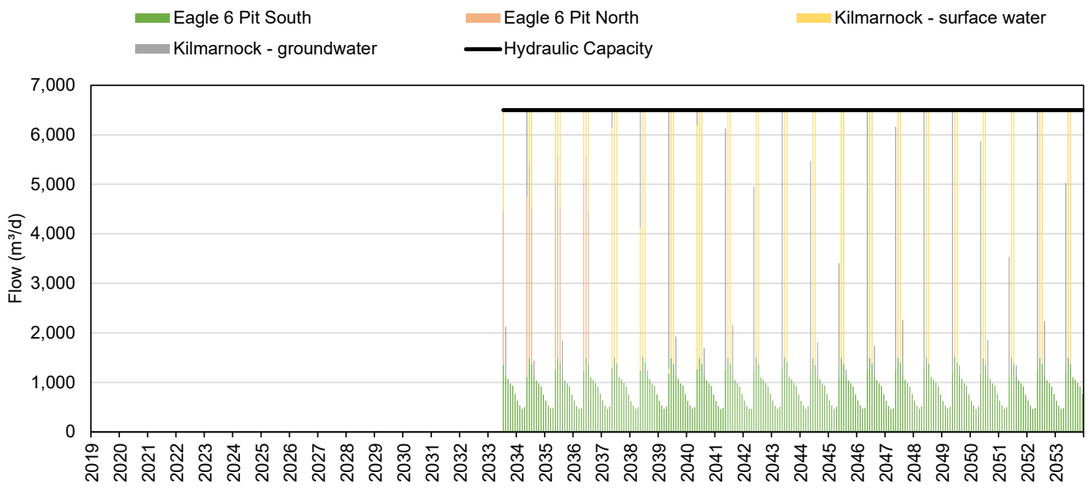
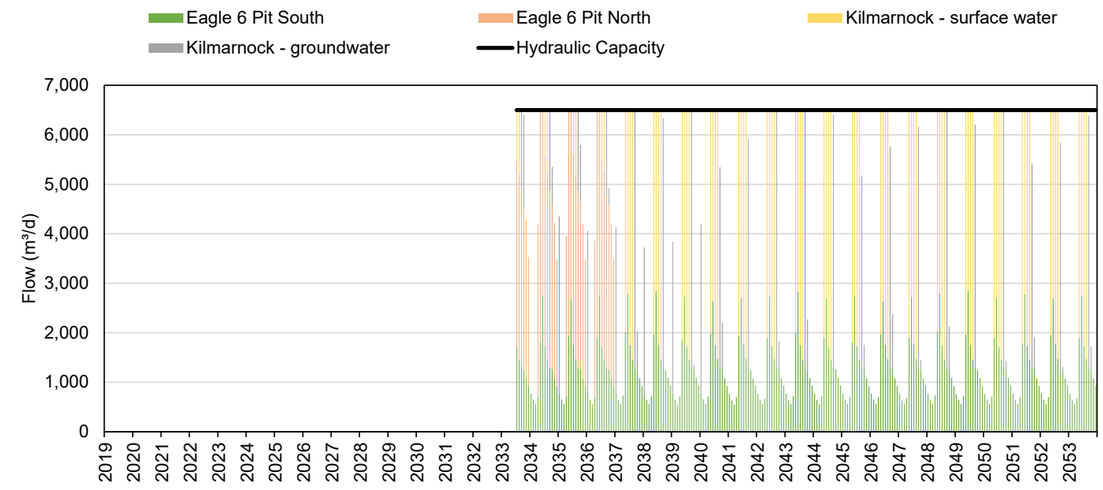
Figure B-3: Monthly Hydrographs of Treated Flows at the Eagle 6 Saturated Rock Fill - Selenium and Nitrate Treatment

(a) P_{10}



(b) P_{50}



(c) P_{90}

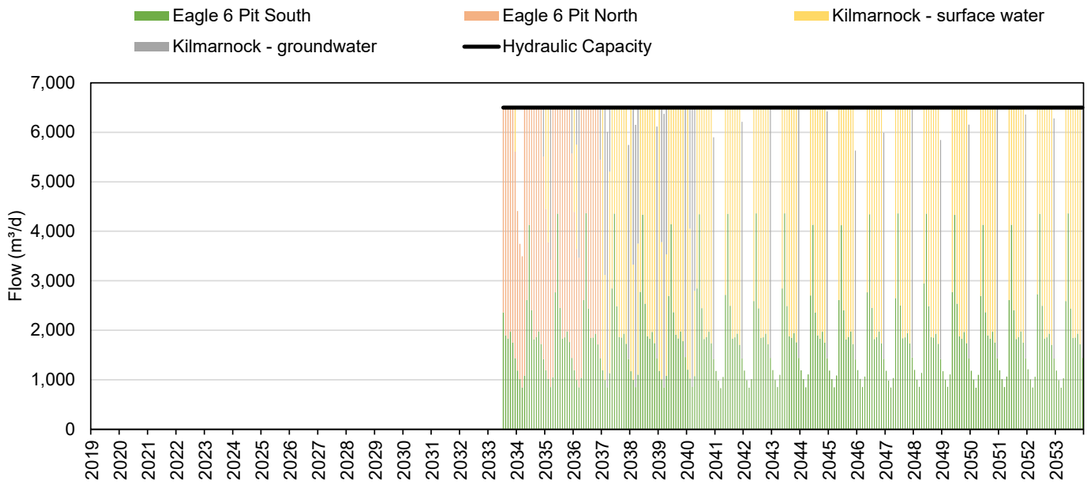
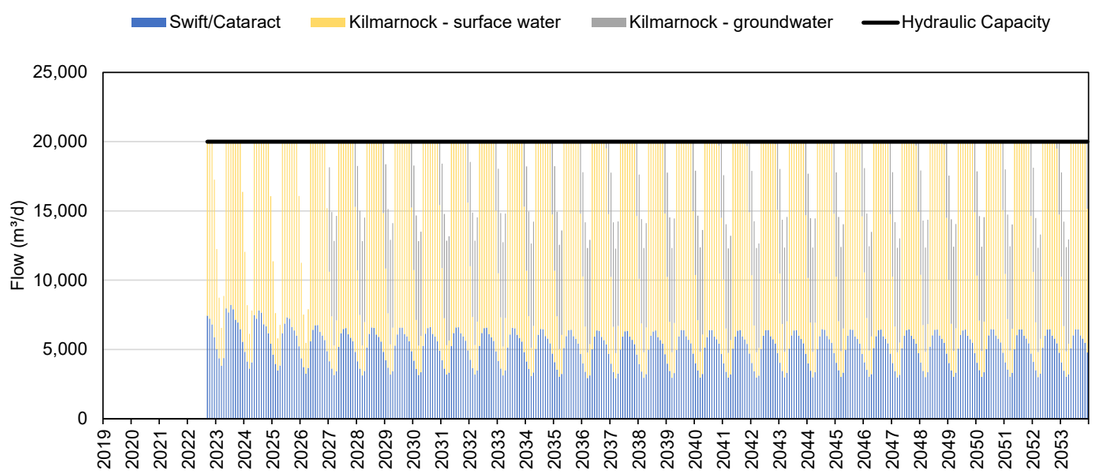
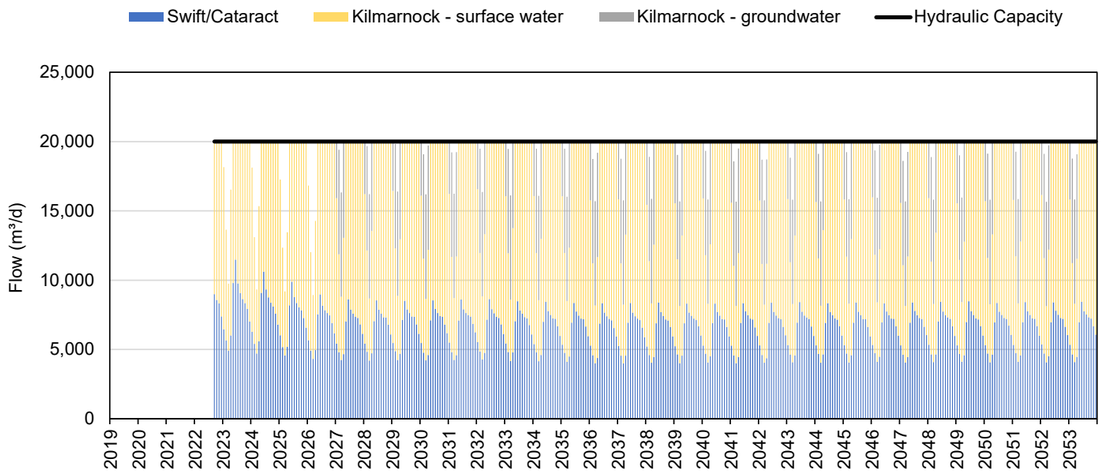


Figure B-4: Monthly Hydrographs of Treated Flows at the Fording River Operations Active Water Treatment Facility South - Selenium and Nitrate Treatment

(a) P_{10}



(b) P_{50}



(c) P_{90}

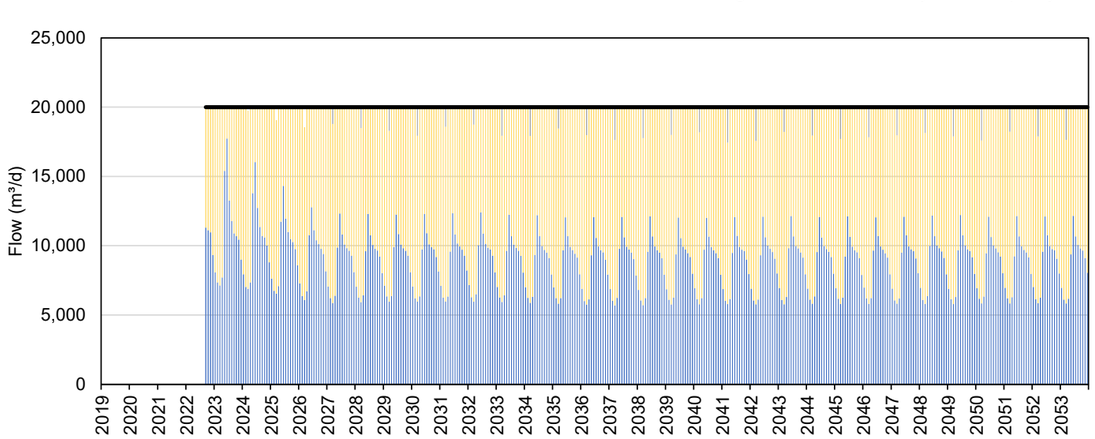
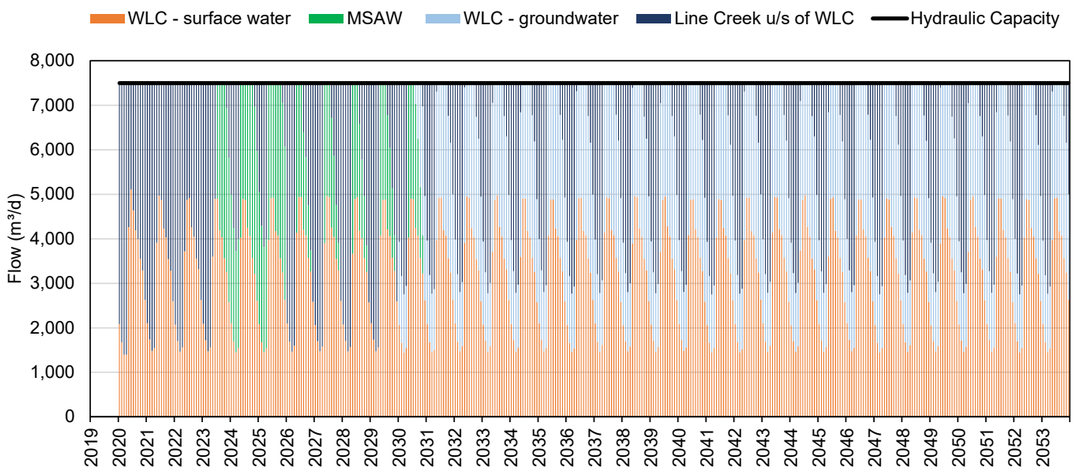
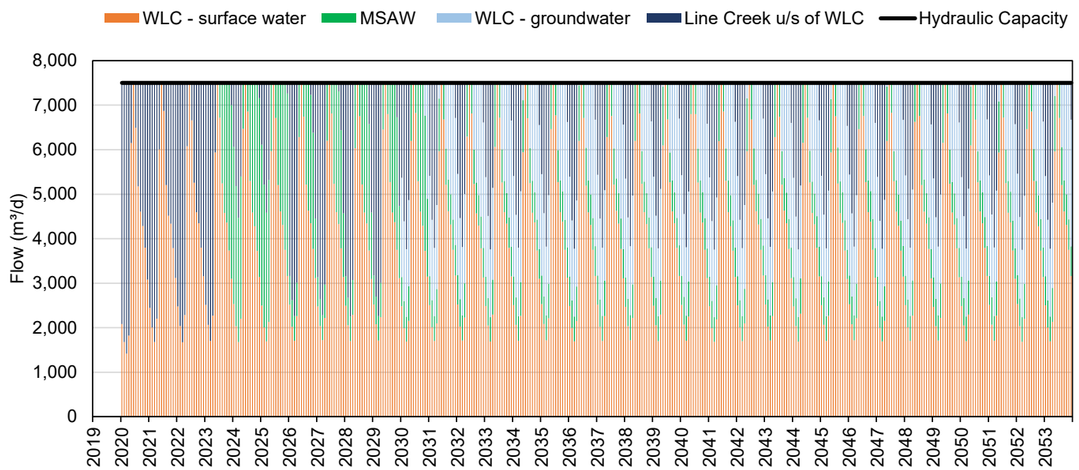


Figure B-5: Monthly Hydrographs of Treated Flows at the West Line Creek Active Water Treatment Facility - Selenium and Nitrate Treatment

(a) P_{10}



(b) P_{50}



(c) P_{90}

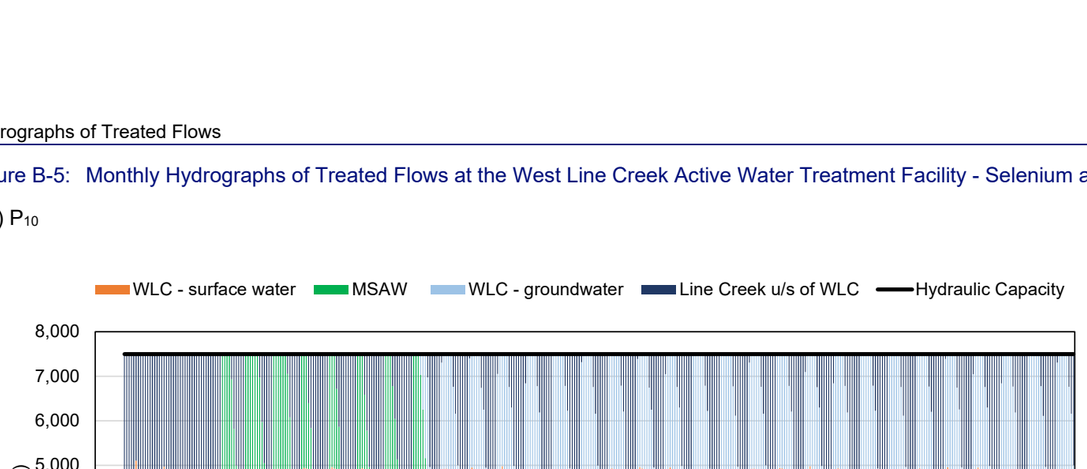
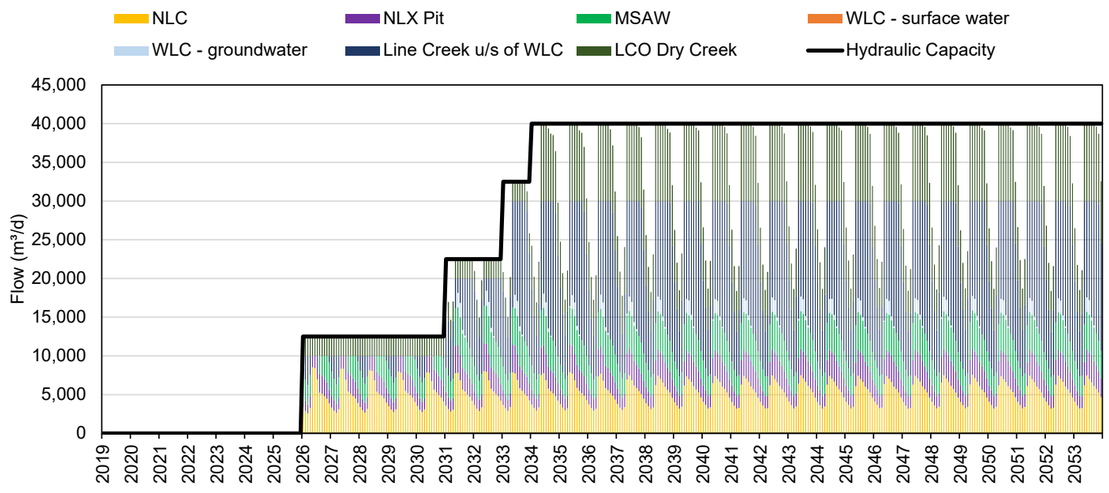
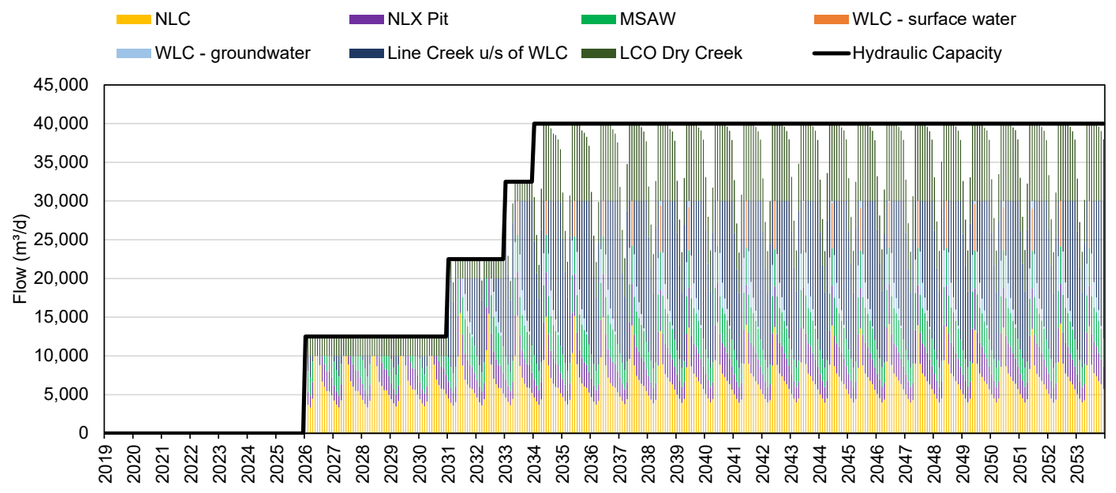


Figure B-6: Monthly Hydrographs of Treated Flows at the North Line Creek Saturated Rock Fill - Selenium and Nitrate Treatment

(a) P_{10}



(b) P_{50}



(c) P_{90}

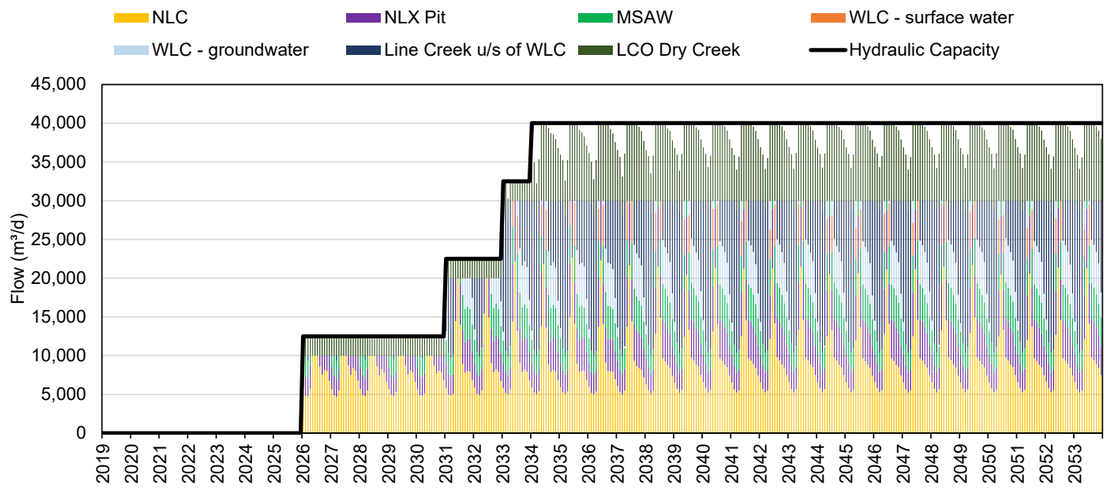
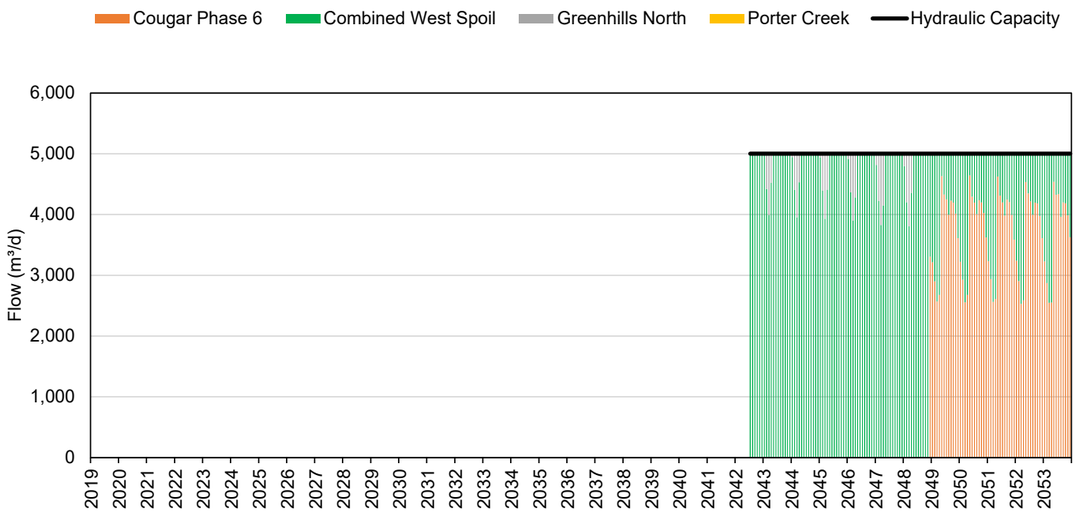
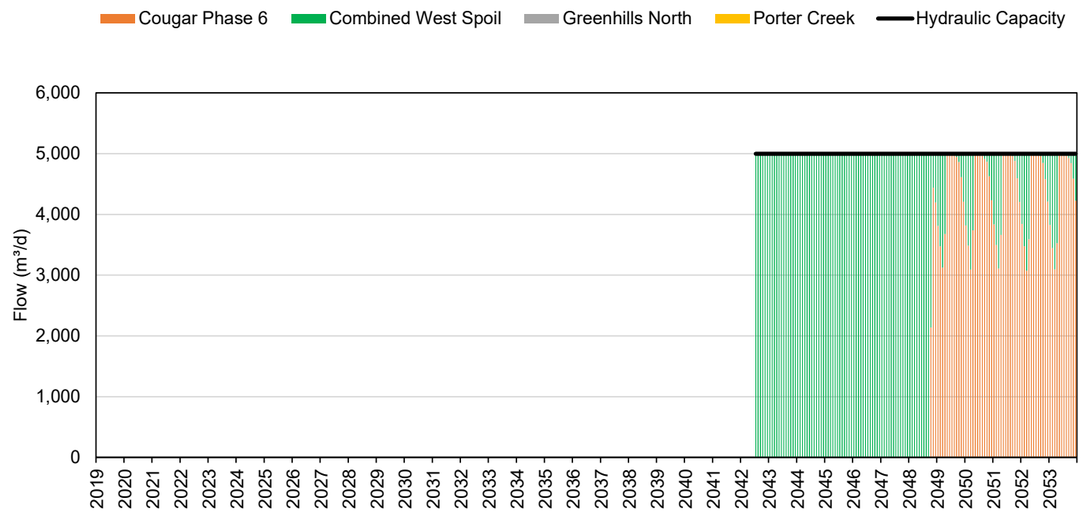


Figure B-7: Monthly Hydrographs of Treated Flows at the Cougar South Pit Saturated Rock Fill - Selenium and Nitrate Treatment

(a) P_{10}



(b) P_{50}



(c) P_{90}

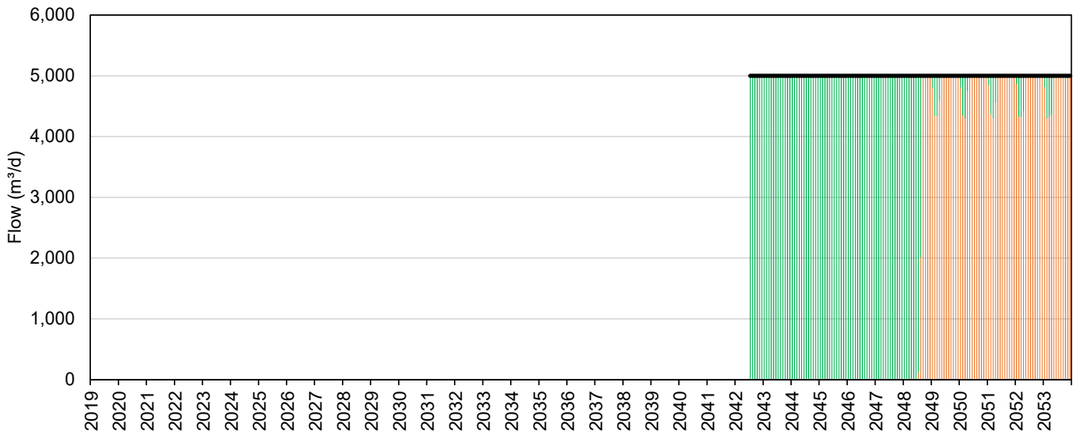
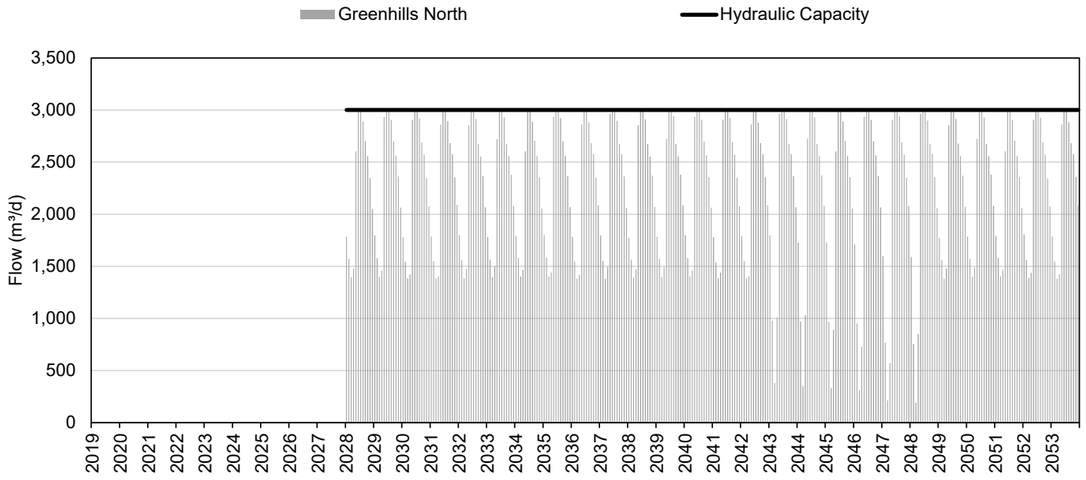
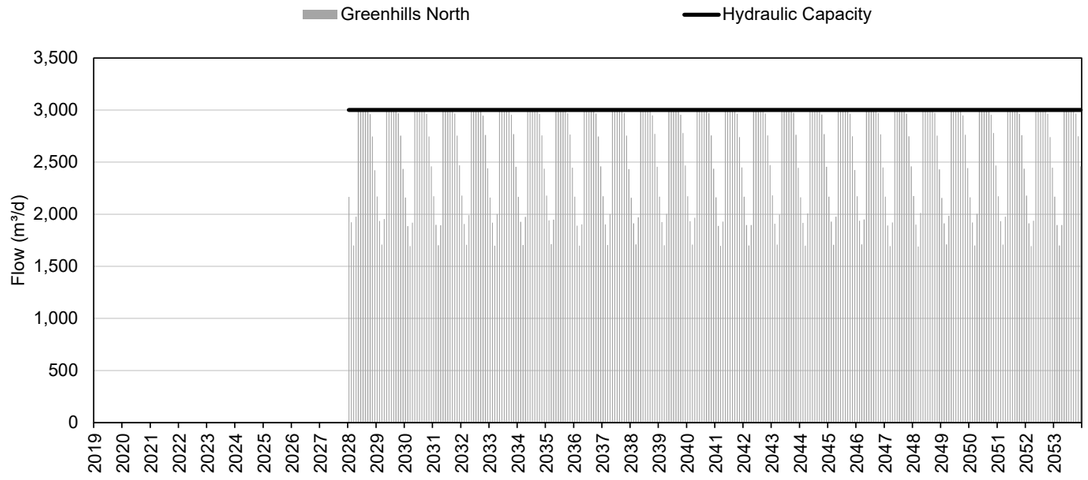


Figure B-8: Monthly Hydrographs of Treated Flows at Greenhills Creek - Selenium and Nitrate Treatment

(a) P_{10}



(b) P_{50}



(c) P_{90}

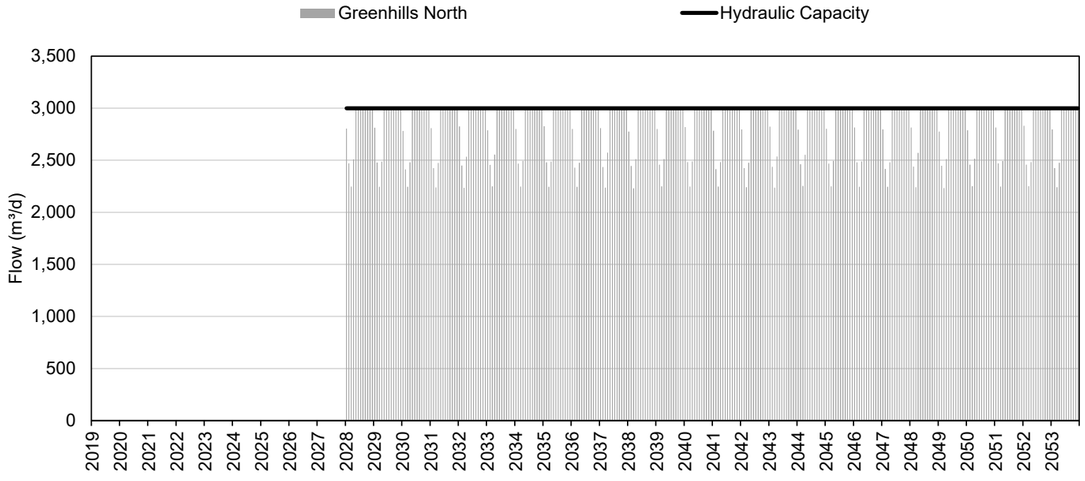
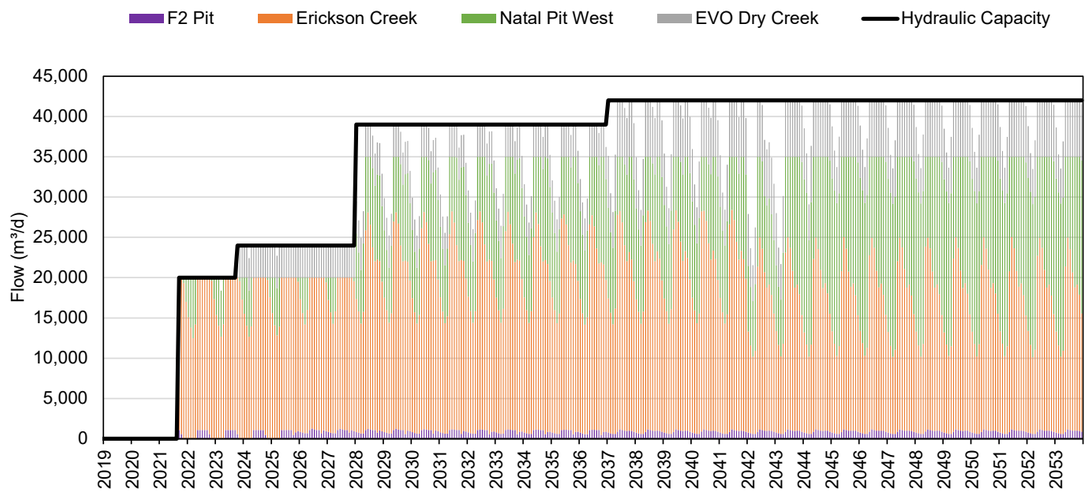
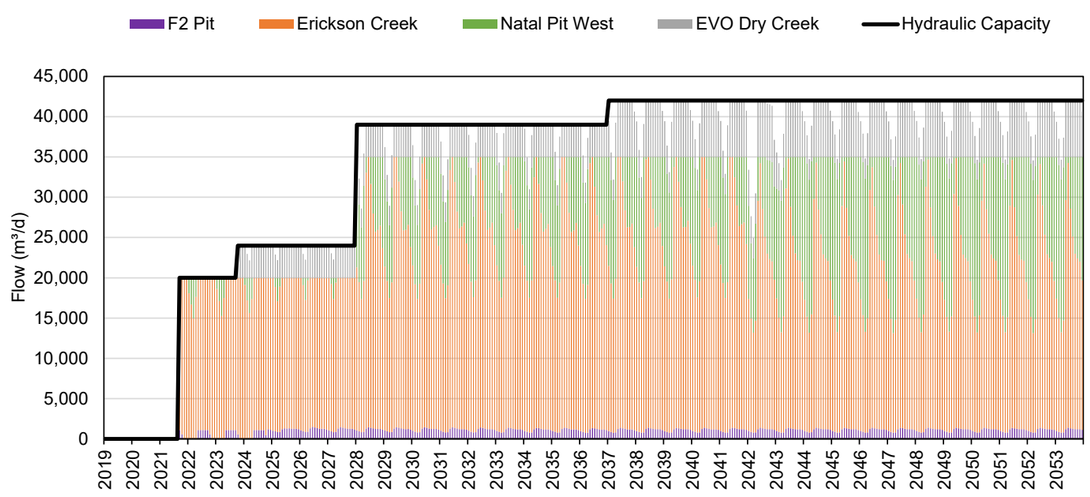


Figure B-9: Monthly Hydrographs of Treated Flows at the EVO Saturated Rock Fill - Selenium and Nitrate Treatment

(a) P_{10}



(b) P_{50}



(c) P_{90}

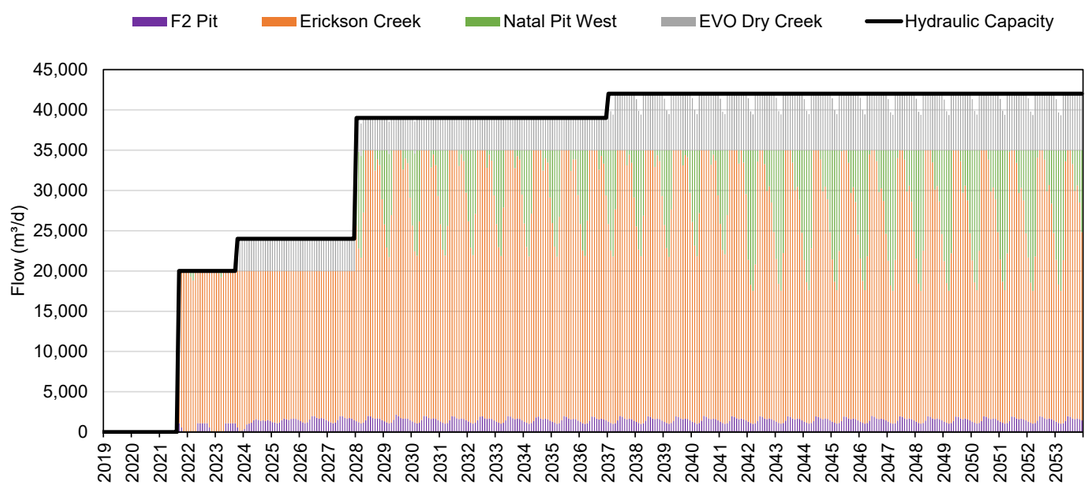
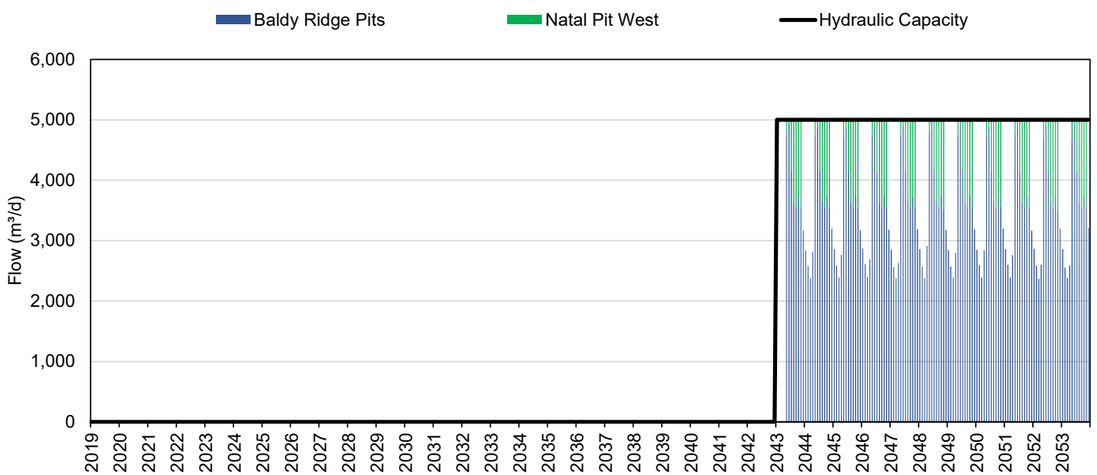
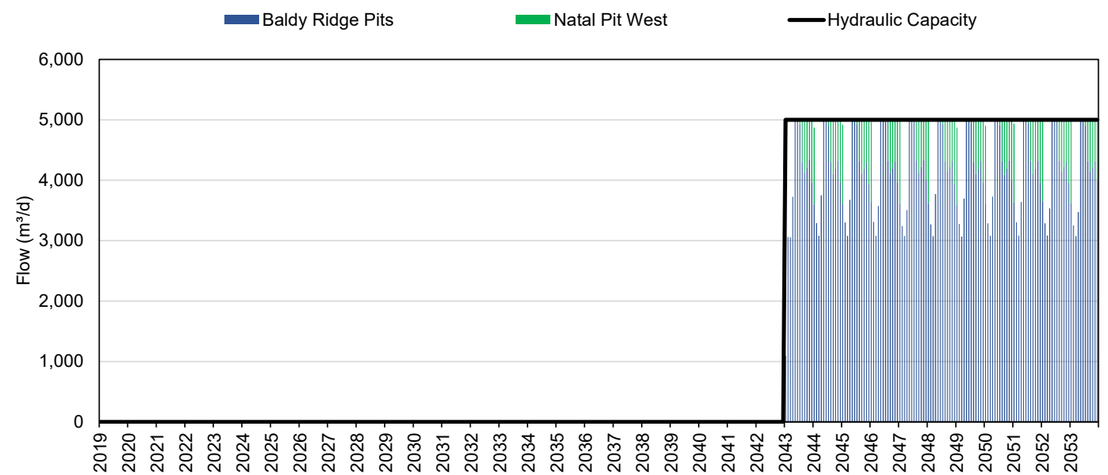


Figure B-10: Monthly Hydrographs of Treated Flows at the Baldy Ridge Pit Saturated Rock Fill - Selenium and Nitrate Treatment

(a) P_{10}



(b) P_{50}



(c) P_{90}

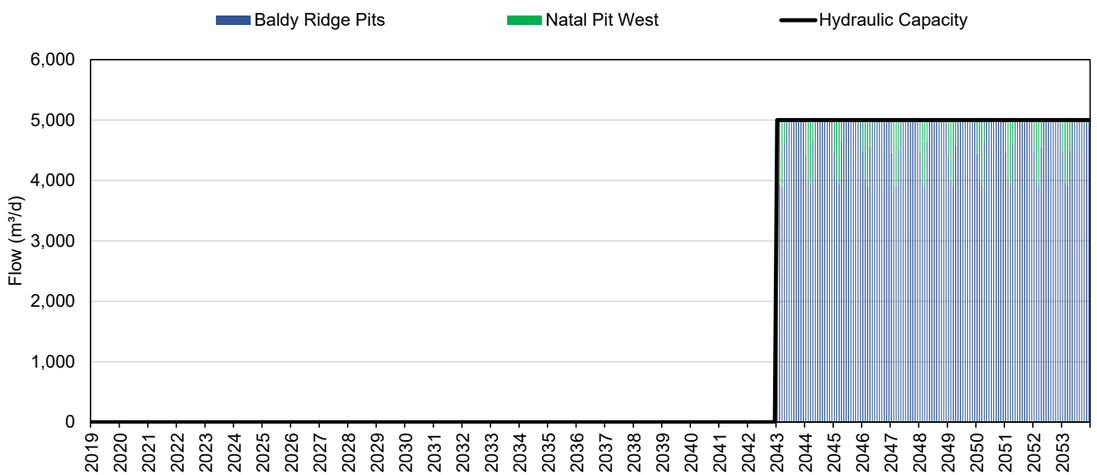
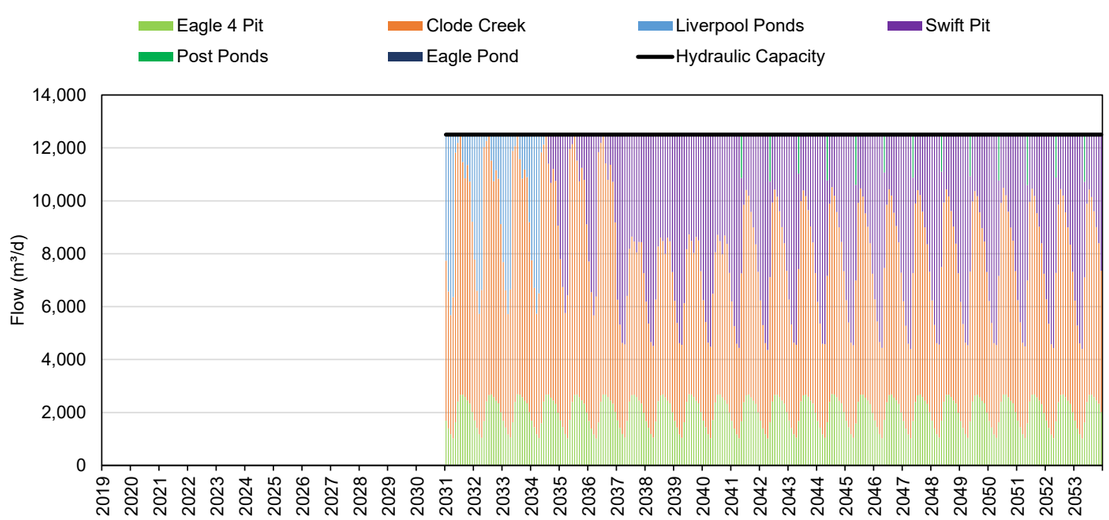
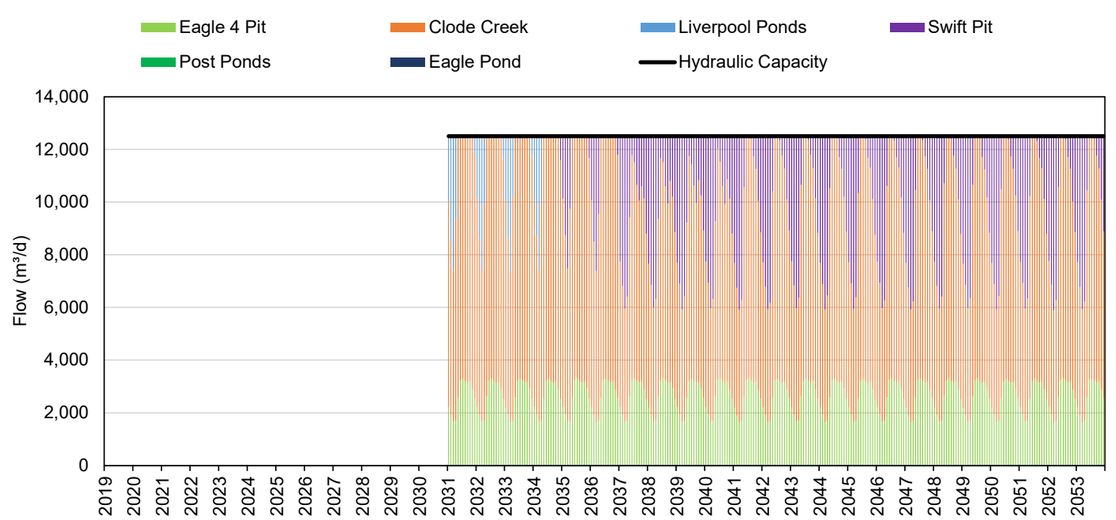


Figure B-11: Monthly Hydrographs of Treated Flows at Fording River Operations North - Sulphate Treatment

(a) P_{10}



(b) P_{50}



(c) P_{90}

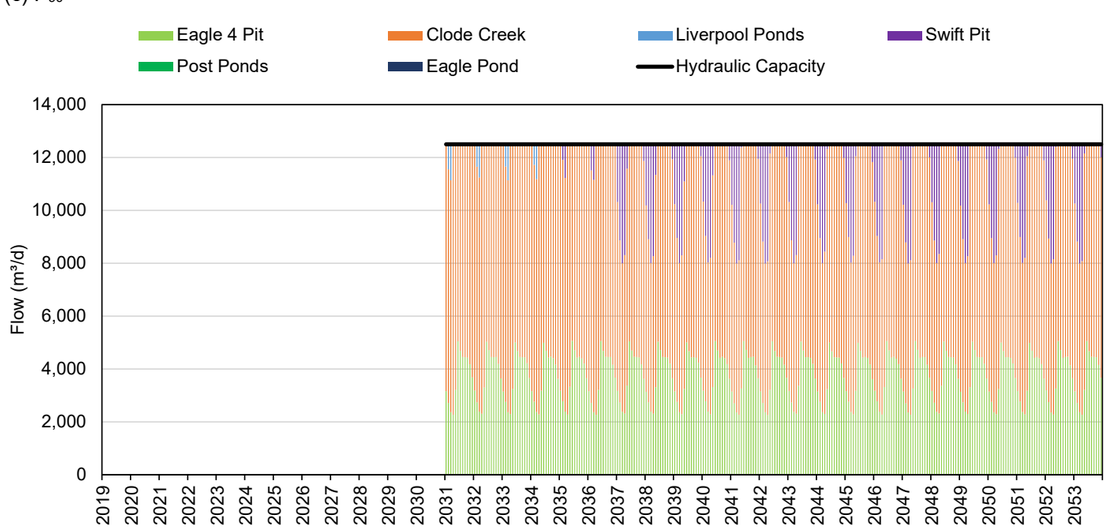
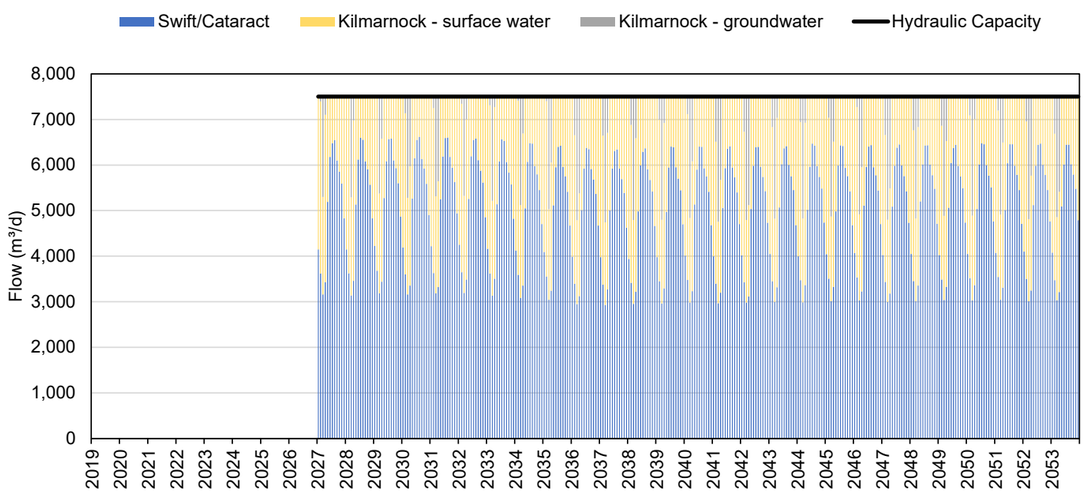
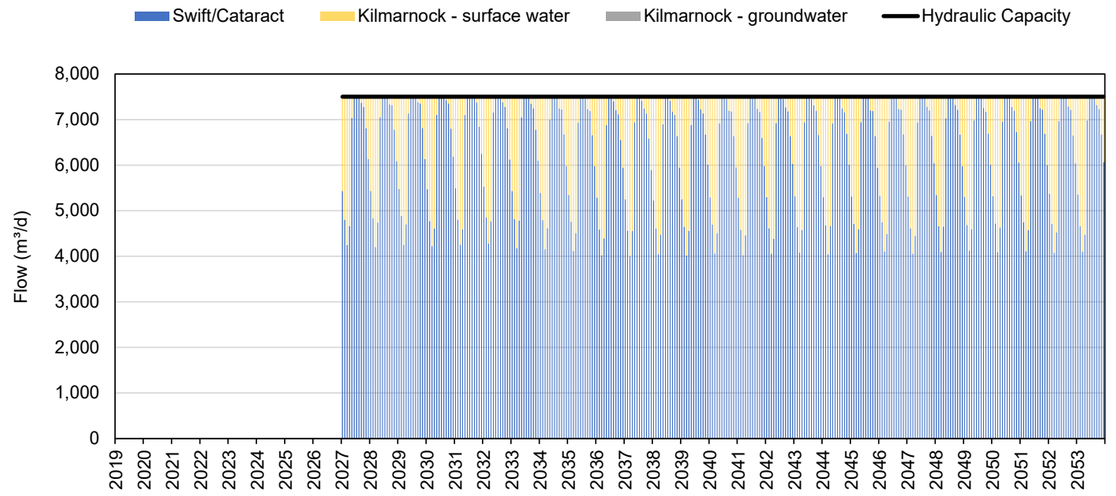


Figure B-12: Monthly Hydrographs of Treated Flows at the Fording River Operations South Active Water Treatment Facility - Sulphate Treatment

(a) P_{10}



(b) P_{50}



(c) P_{90}

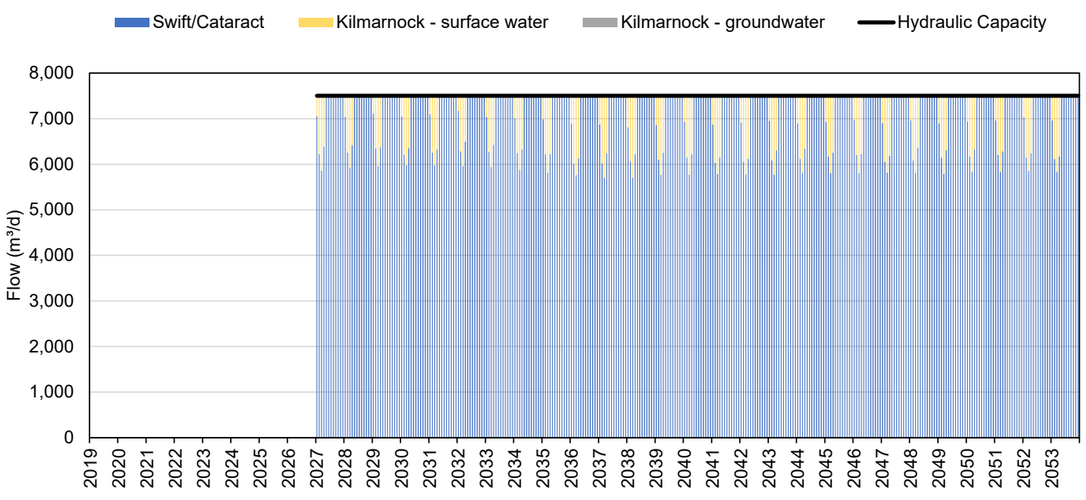
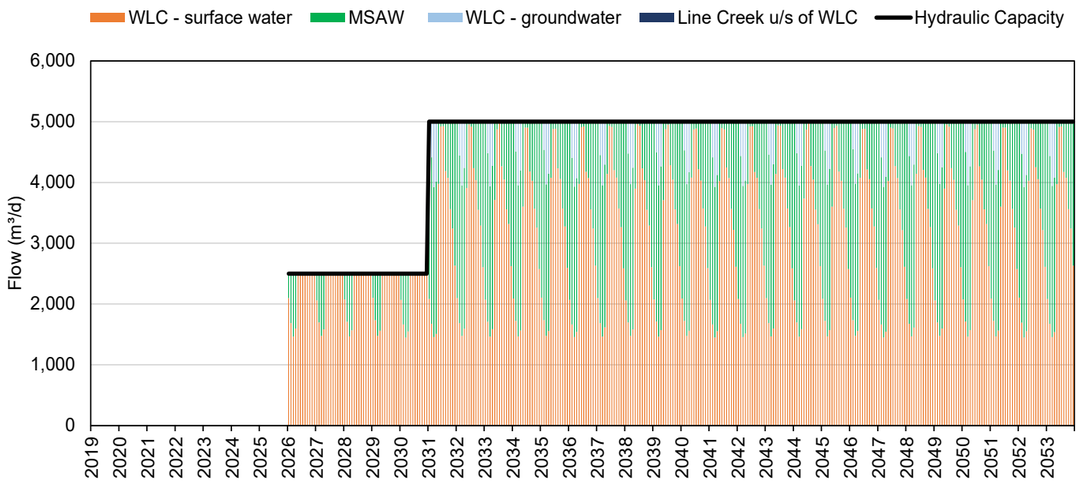
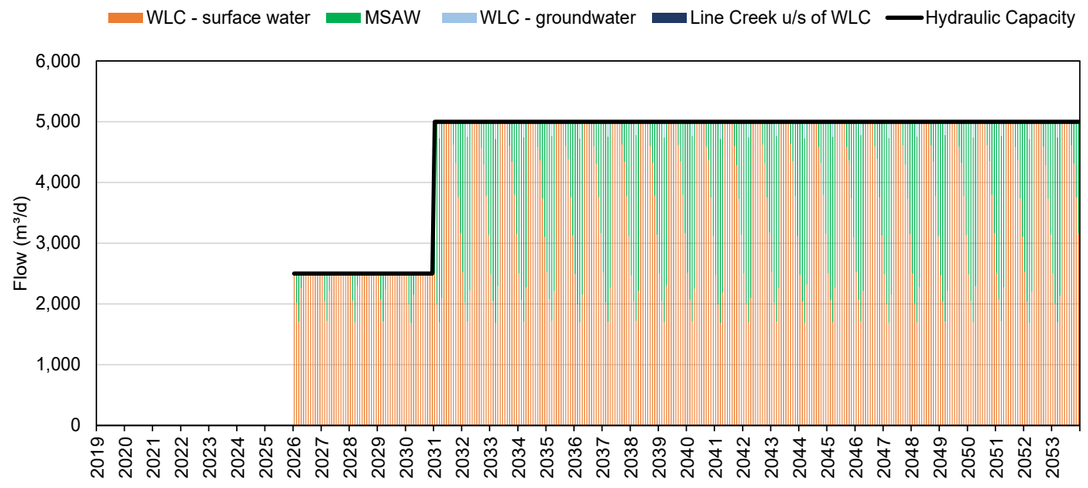


Figure B-13: Monthly Hydrographs of Treated Flows at the West Line Creek Active Water Treatment Facility - Sulphate Treatment

(a) P_{10}



(b) P_{50}



(c) P_{90}

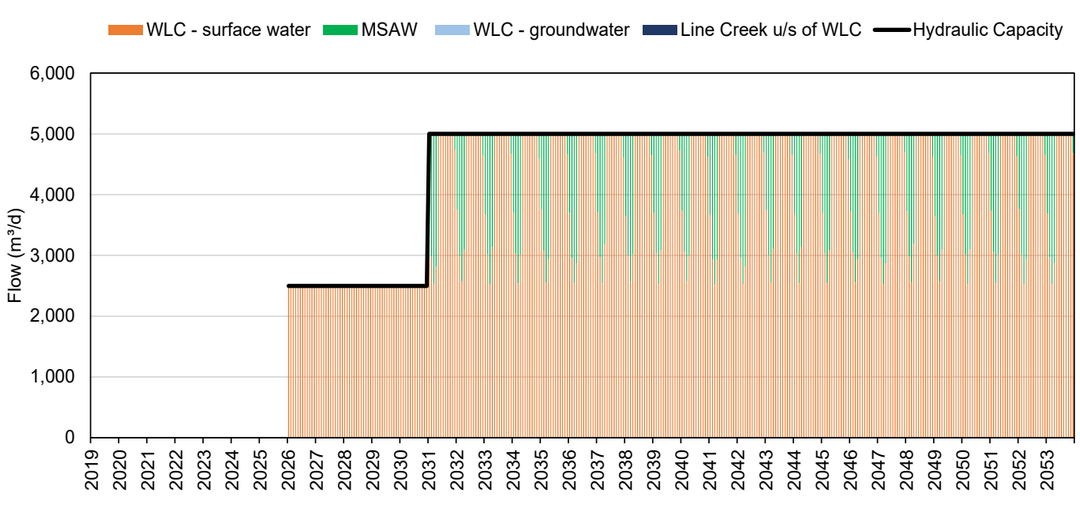
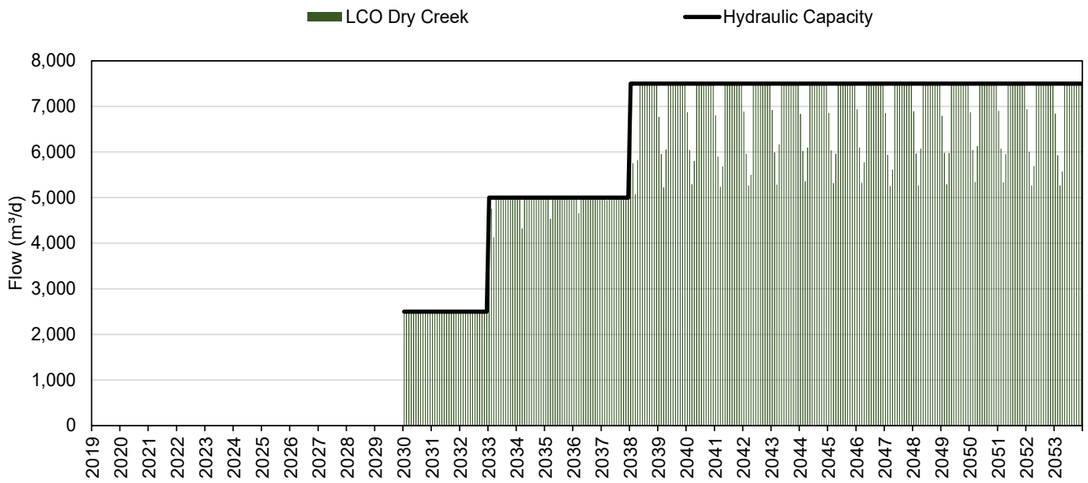
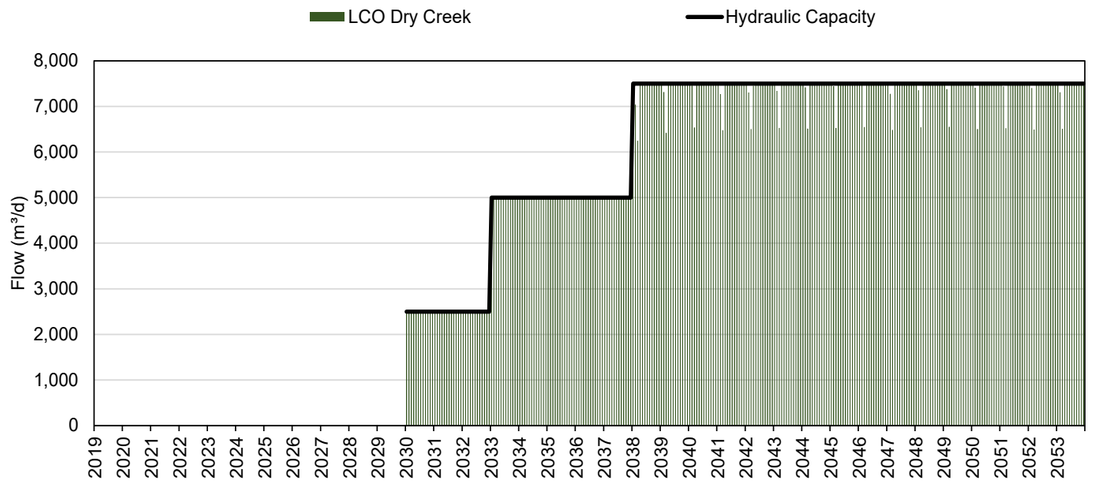


Figure B-14: Monthly Hydrographs of Treated Flows at Line Creek Operations Dry Creek - Sulphate Treatment

(a) P_{10}



(b) P_{50}



(c) P_{90}

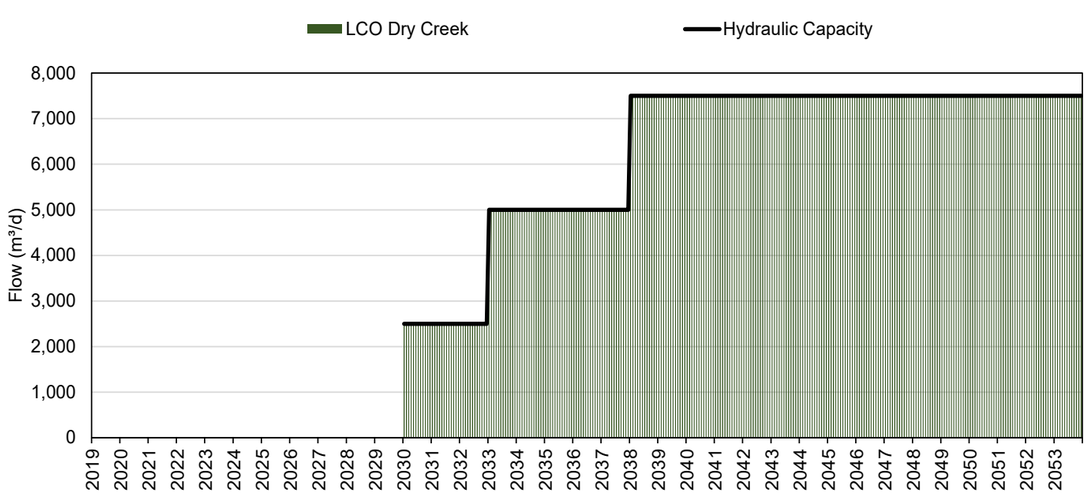
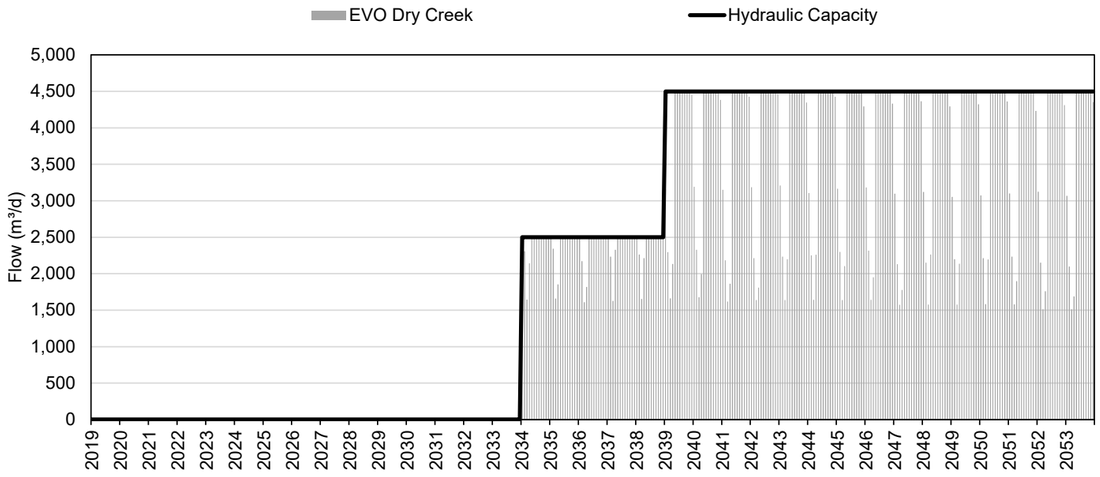
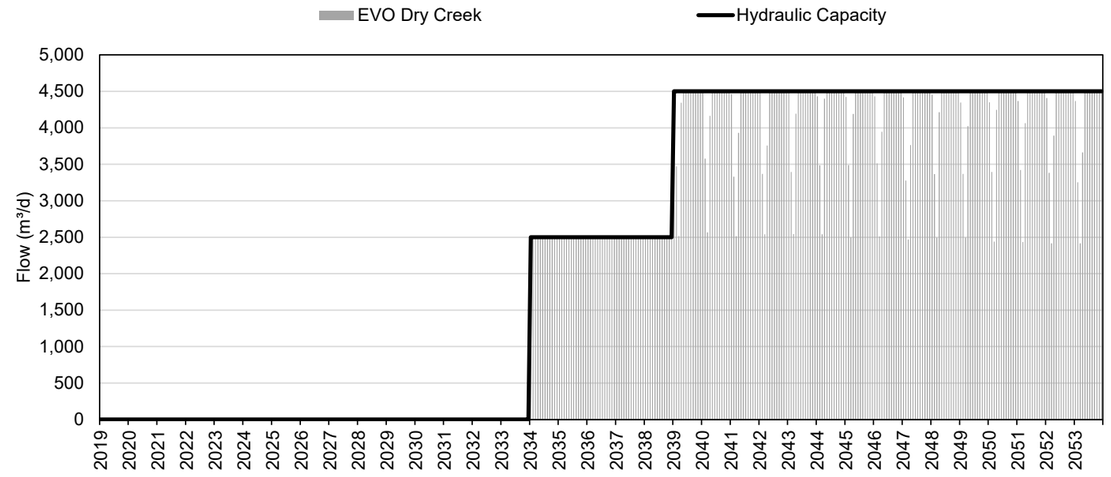


Figure B-15: Monthly Hydrographs of Treated Flows at Elkview Operations Dry Creek - Sulphate Treatment

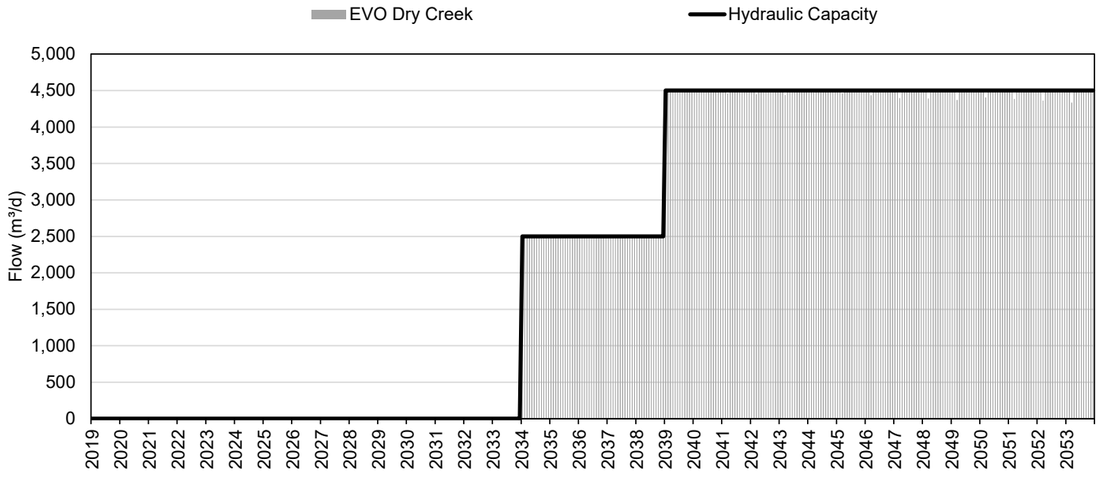
(a) P_{10}



(b) P_{50}



(c) P_{90}



Appendix C

Projected Concentrations of Nitrate, Selenium, and Sulphate with Changes to Water Availability

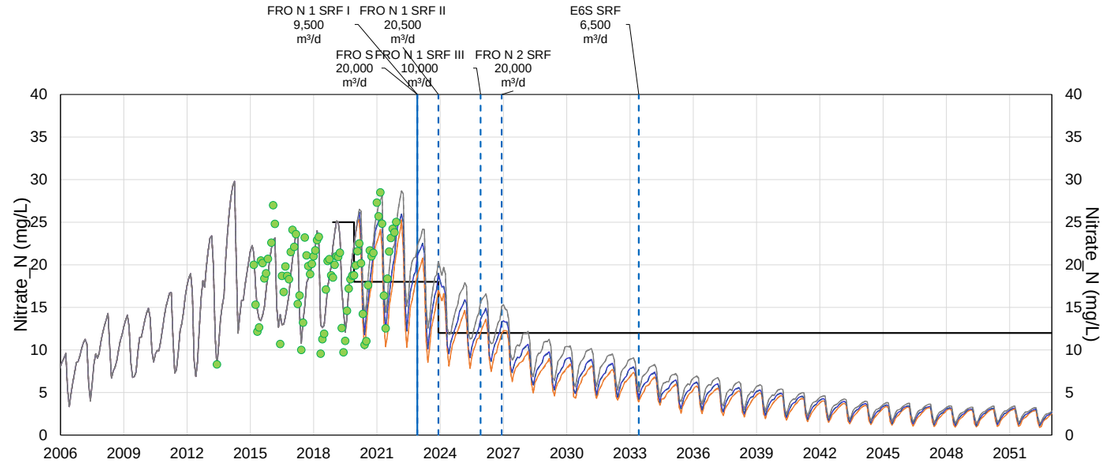
Figures

Projected concentrations of nitrate, selenium, and sulphate at the nearest downstream compliance points, with and without changes to water availability are shown in Figures C-1 to C-8. The format of the figures is as follows:

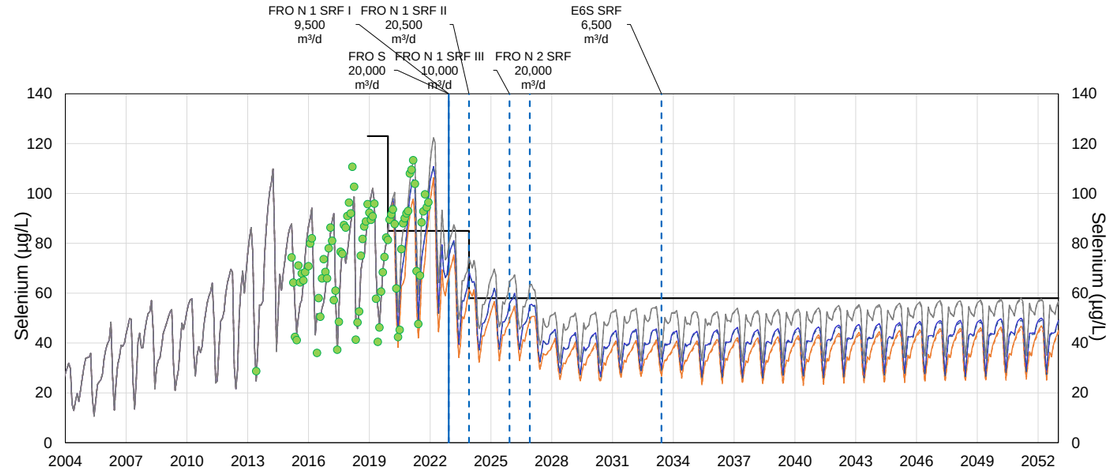
- The x-axis runs from the start of 2004 (for selenium and sulphate) or 2006 (for nitrate) to the end of 2053. The start date corresponds to the start of the calibration period for the 2020 RWQM. The end date (2053) corresponds to the modelled time period at which all permitted waste rock has been deposited and the lag associated with that rock has passed (i.e., all waste rock is contributing nitrate, selenium, and sulphate load).
- Projected 10th percentile (P_{10}), 50th percentile (P_{50}), and 90th percentile (P_{90}) monthly average concentrations, without changes to water availabilities are shown as solid orange, blue and grey lines, respectively.
- Projected P_{10}, P_{50}, and P_{90} monthly average concentrations, with changes to water availabilities are shown as dashed orange, blue and grey lines, respectively.
- Measured monthly average concentrations are shown as green points.
- Modelled information shown prior to 2020 was developed based on calibrated flows. Those shown thereafter were developed using multiple climate realizations, as described in the 2020 update (Teck 2021).
- Compliance limits are shown as a solid black line, and Site Performance Objectives (SPOs) are shown as a solid green line.
- The fully effective dates for the Saturated Rock Fills (SRFs) and active water treatment facilities (AWTFs) are shown as a vertical blue line.

Figure C-1: Projected Concentrations of Nitrate, Selenium, and Sulphate at the FRO Compliance Point (FR_FRABCH; E223753) with Kilmarnock Creek Groundwater Water Availability Increased from 75% to 80%

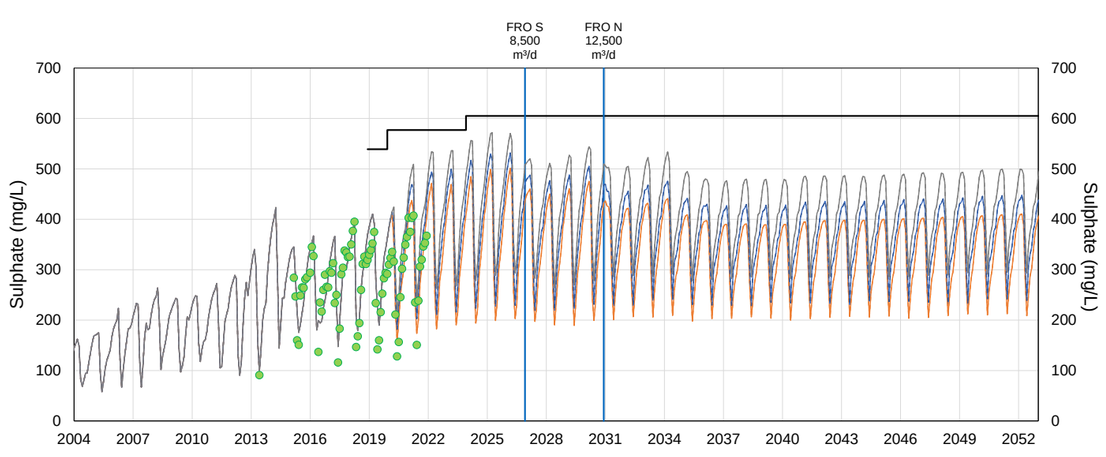
(a) Nitrate



(b) Selenium



(c) Sulphate



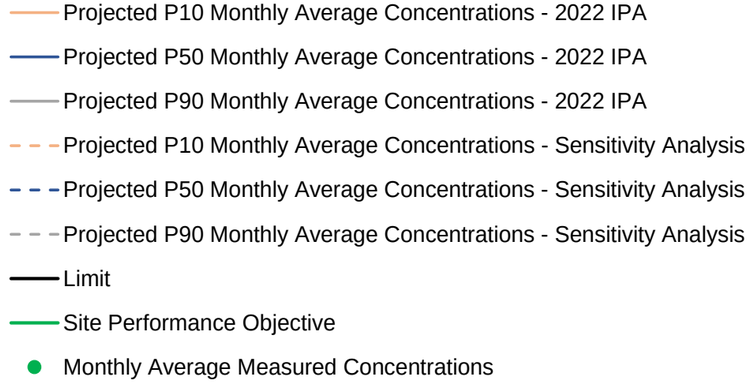
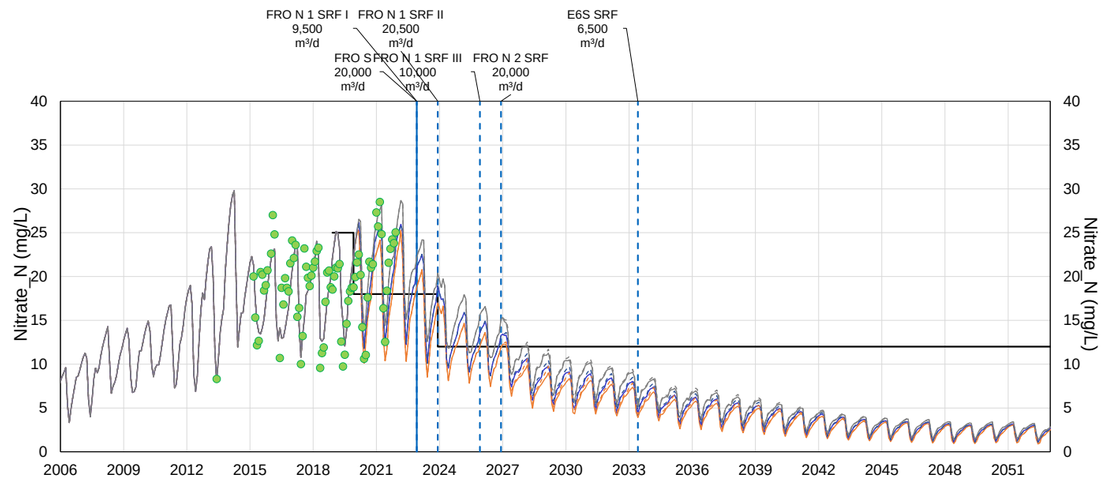
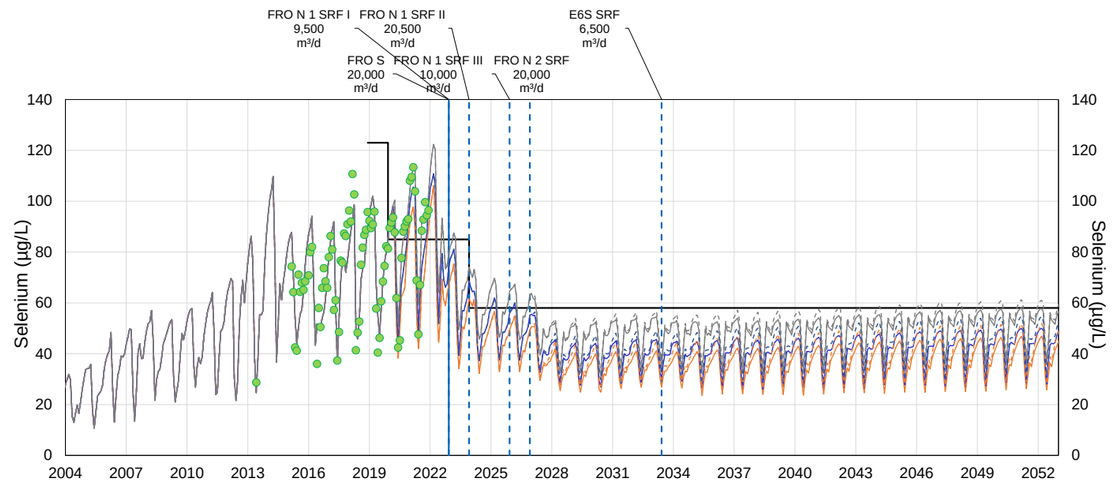


Figure C-2: Projected Concentrations of Nitrate, Selenium, and Sulphate at the FRO Compliance Point (FR_FRABCH; E223753) with Kilmarnock Creek Groundwater Water Availability Decreased from 75% to 50%

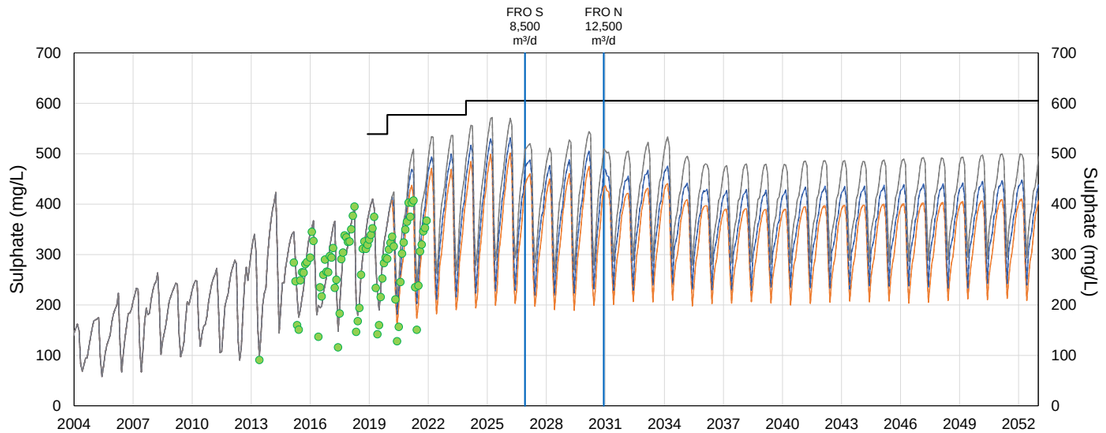
(a) Nitrate



(b) Selenium



(c) Sulphate



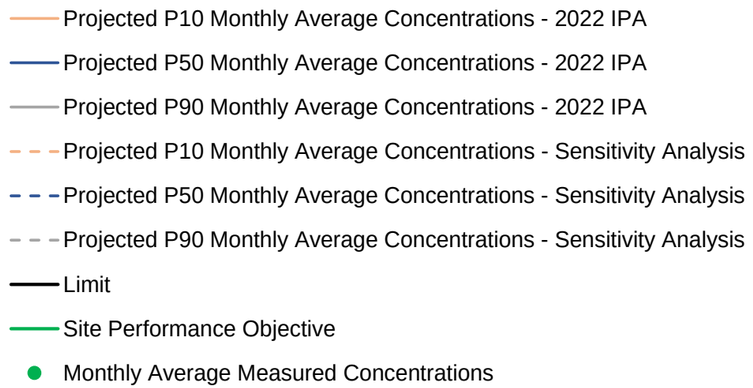
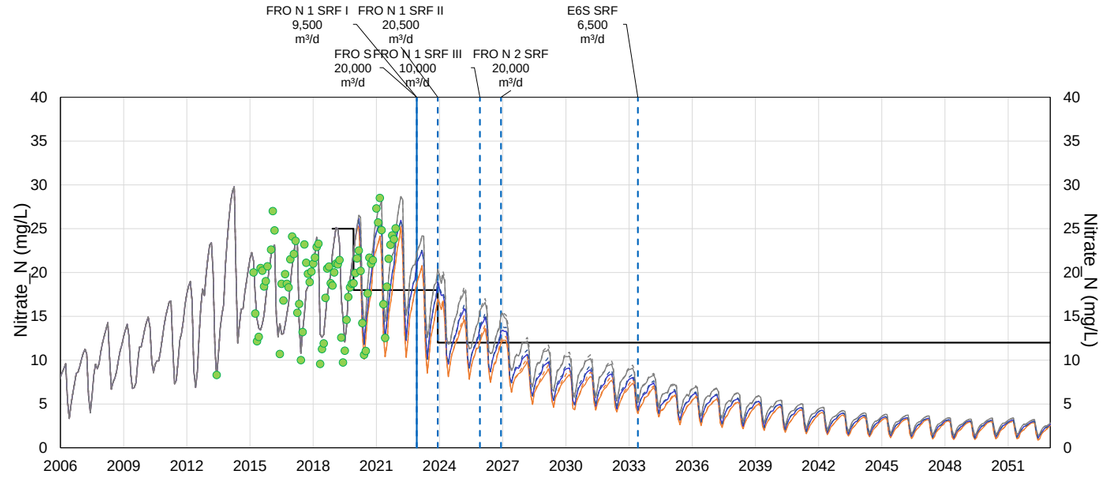
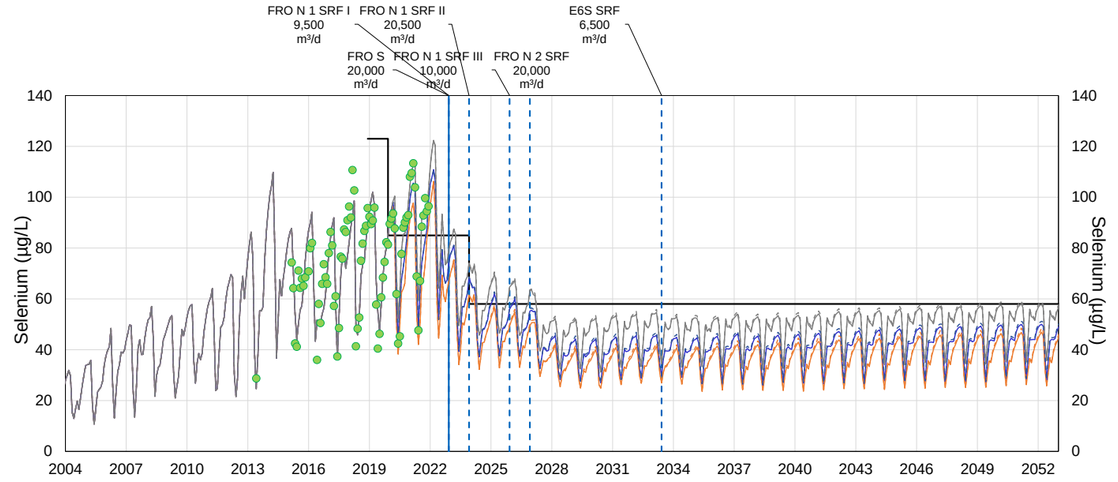


Figure C-3: Projected Concentrations of Nitrate, Selenium, and Sulphate at the FRO Compliance Point (FR_FRABCH; E223753) with Clode Creek Water Availability Decreased from 85% to 75%

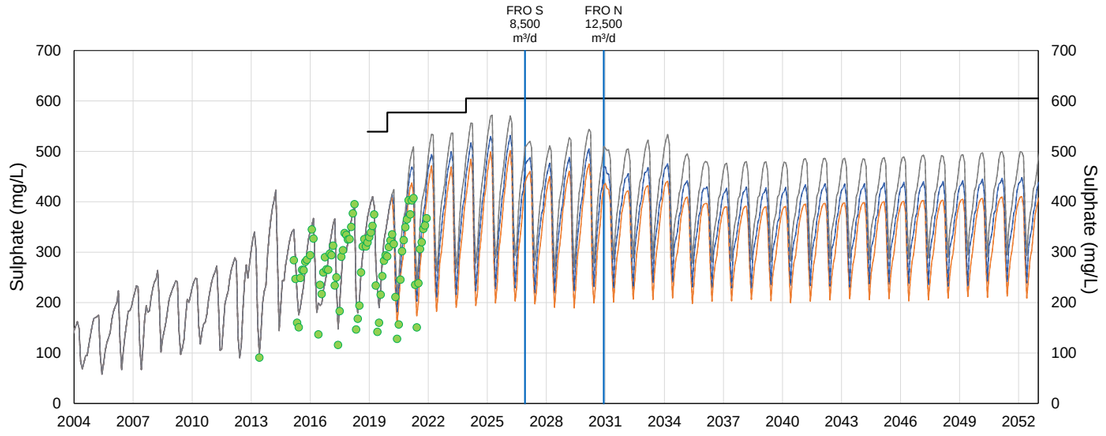
(a) Nitrate



(b) Selenium



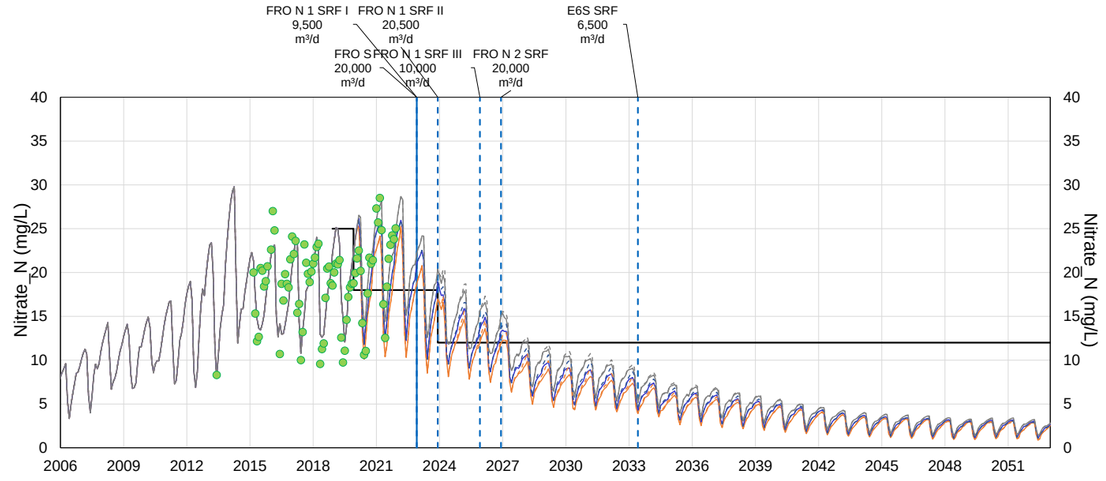
(c) Sulphate



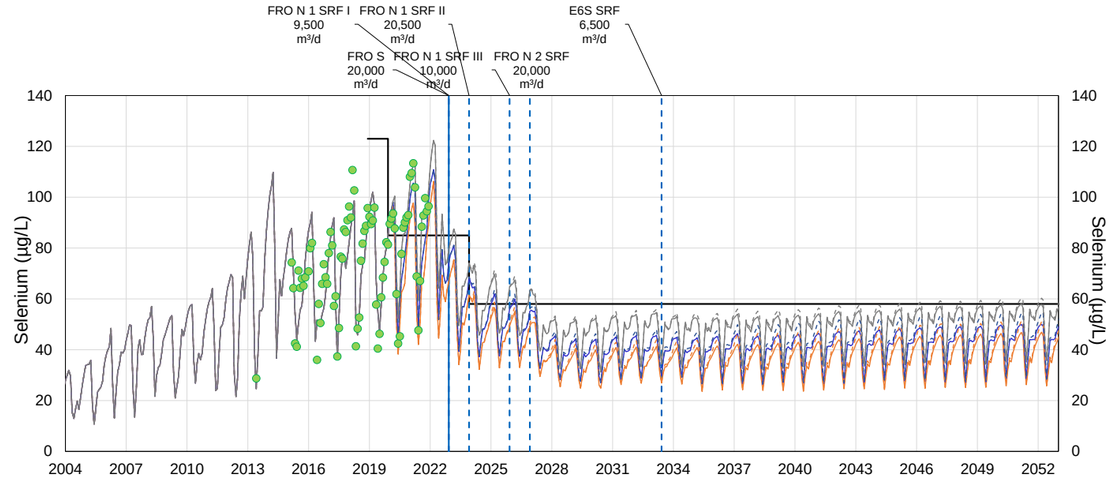
- Projected P10 Monthly Average Concentrations - 2022 IPA
- Projected P50 Monthly Average Concentrations - 2022 IPA
- Projected P90 Monthly Average Concentrations - 2022 IPA
- Projected P10 Monthly Average Concentrations - Sensitivity Analysis
- Projected P50 Monthly Average Concentrations - Sensitivity Analysis
- Projected P90 Monthly Average Concentrations - Sensitivity Analysis
- Limit
- Site Performance Objective
- Monthly Average Measured Concentrations

Figure C-4: Projected Concentrations of Nitrate, Selenium, and Sulphate at the FRO Compliance Point (FR_FRABCH; E223753) with Clode Creek Water Availability Decreased from 85% to 60%

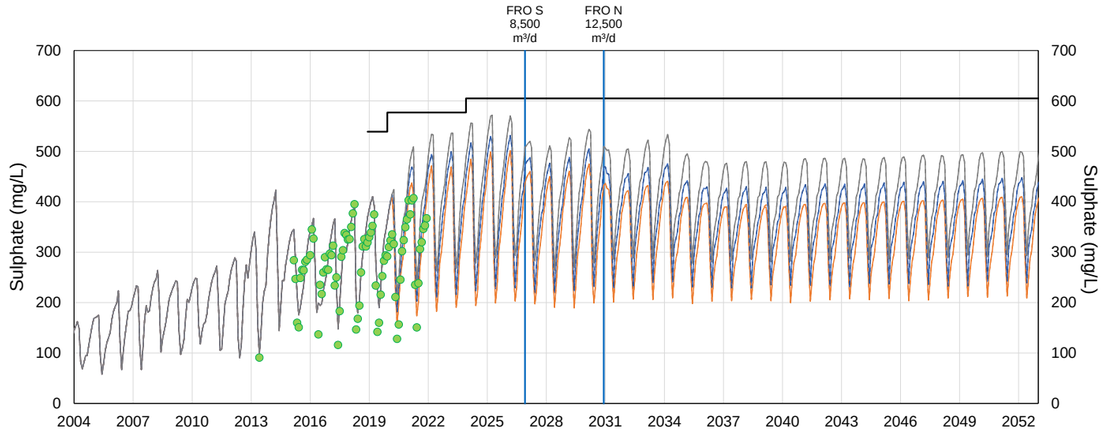
(a) Nitrate



(b) Selenium



(c) Sulphate



Projected P10 Monthly Average Concentrations - 2022 IPA

Projected P50 Monthly Average Concentrations - 2022 IPA

Projected P90 Monthly Average Concentrations - 2022 IPA

Projected P10 Monthly Average Concentrations - Sensitivity Analysis

Projected P50 Monthly Average Concentrations - Sensitivity Analysis

Projected P90 Monthly Average Concentrations - Sensitivity Analysis

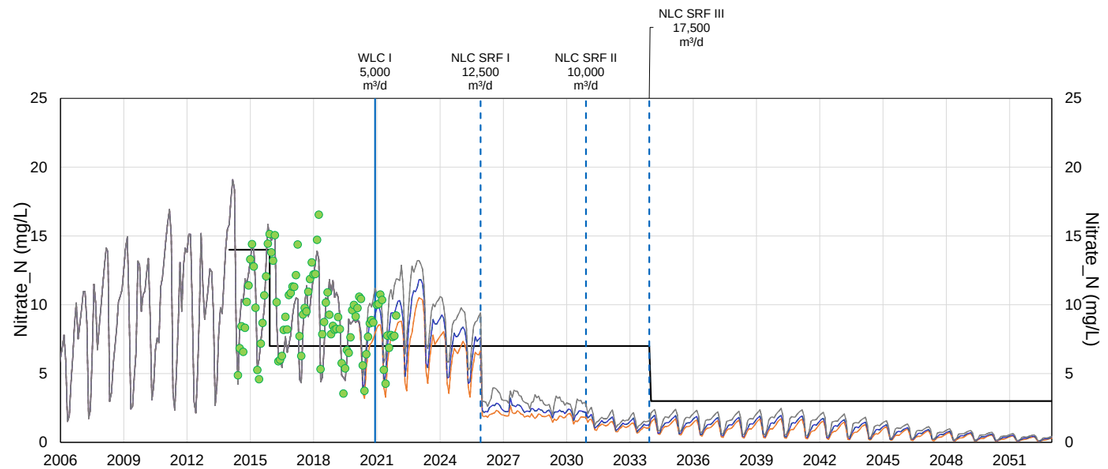
Limit

Site Performance Objective

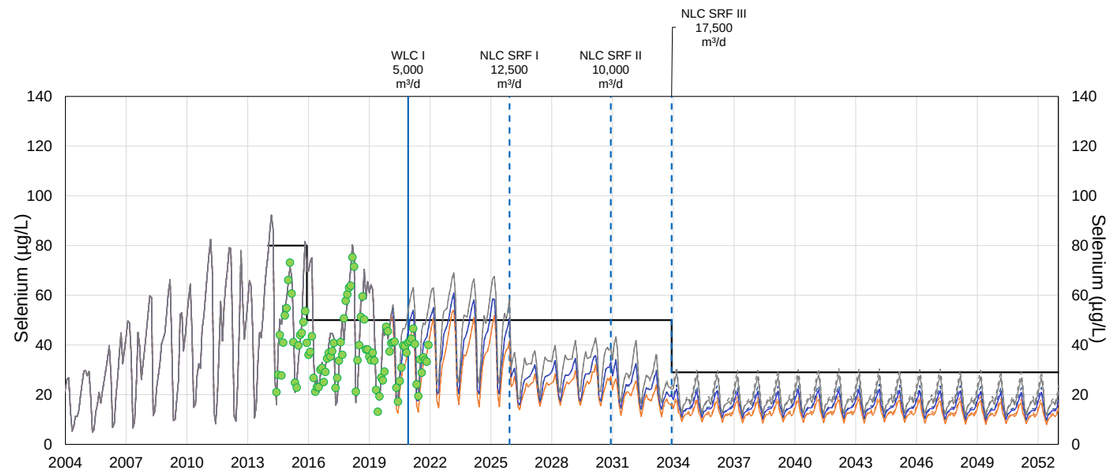
Monthly Average Measured Concentrations

Figure C-5: Projected Concentrations of Nitrate, Selenium, and Sulphate at the LCO Compliance Point (LC_LCDSSLCC; E297110) with West Line Creek Groundwater Water Availability Decreased from 60% to 50%

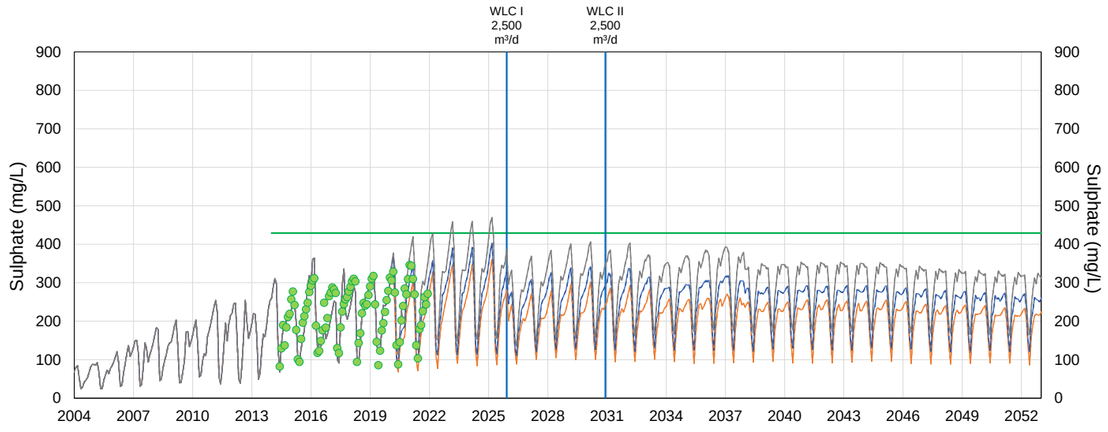
(a) Nitrate



(b) Selenium



(c) Sulphate



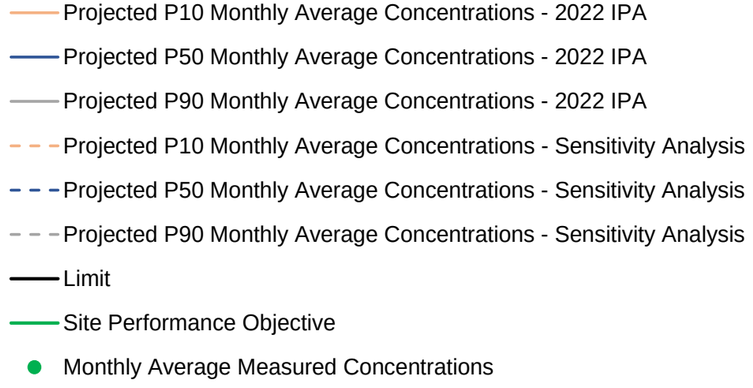
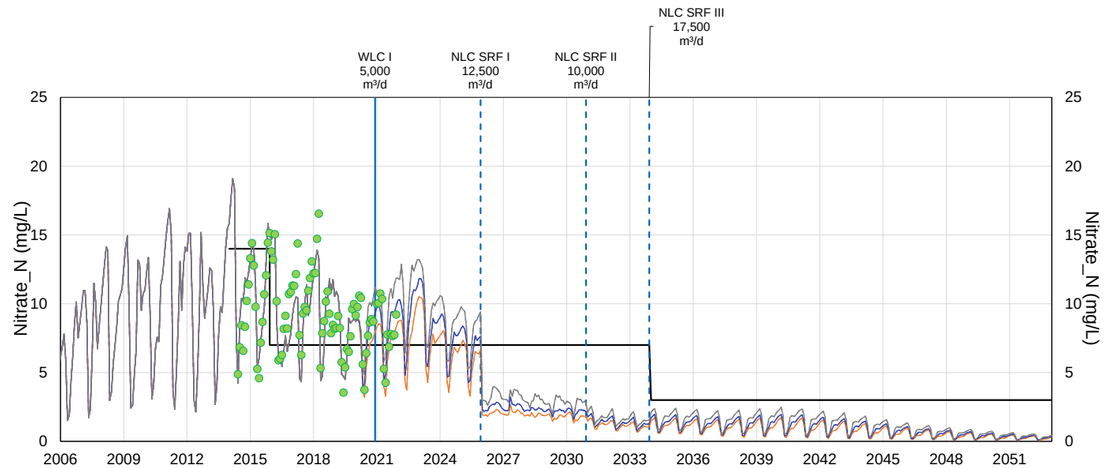
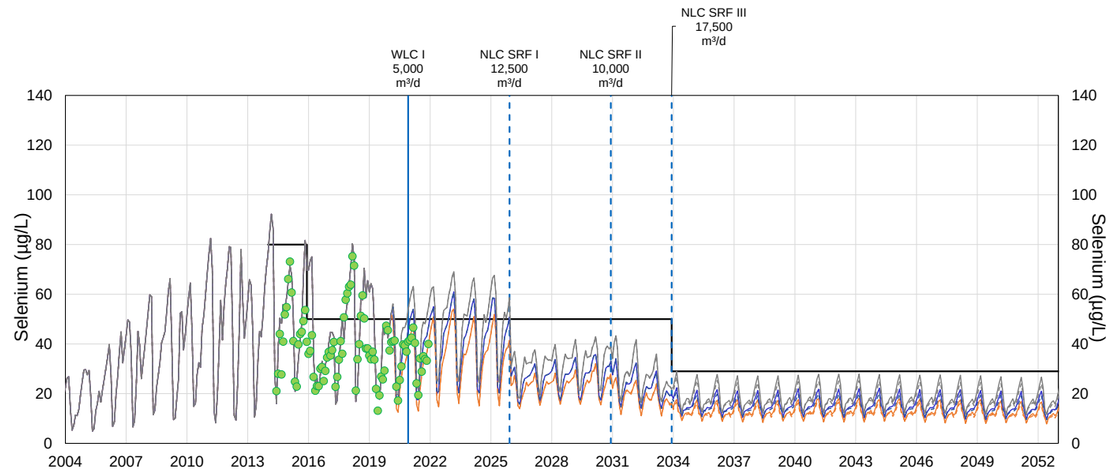


Figure C-6: Projected Concentrations of Nitrate, Selenium, and Sulphate at the LCO Compliance Point (LC_LCDSSLCC; E297110) with West Line Creek Groundwater Water Availability Increased from 60% to 70%

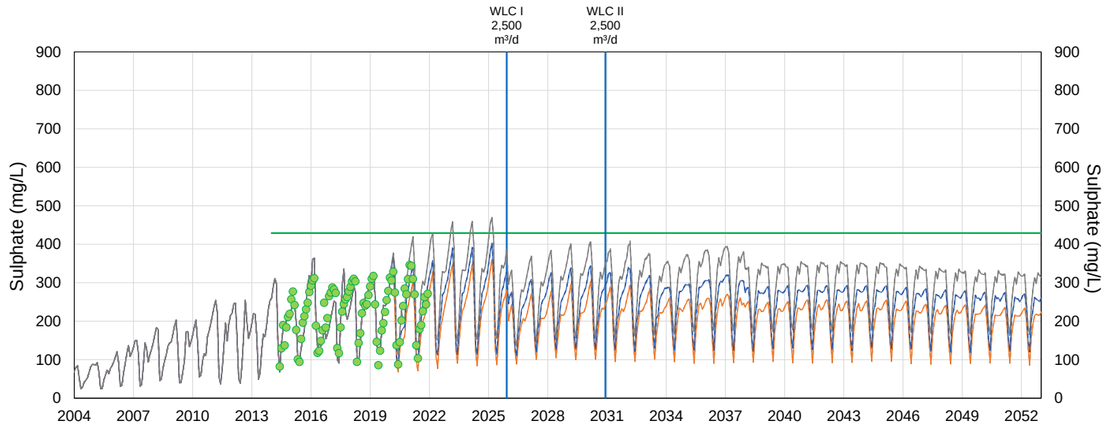
(a) Nitrate



(b) Selenium



(c) Sulphate



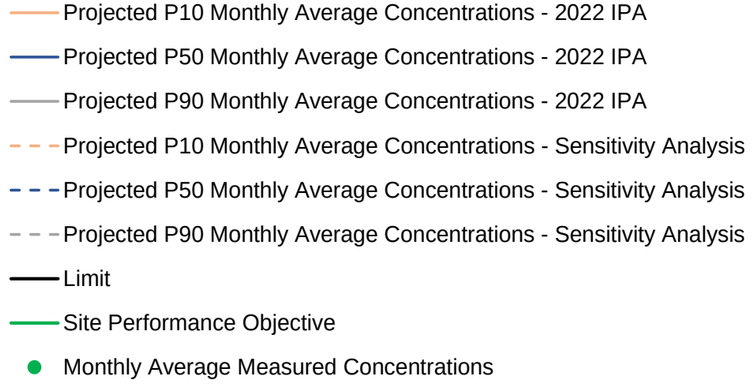
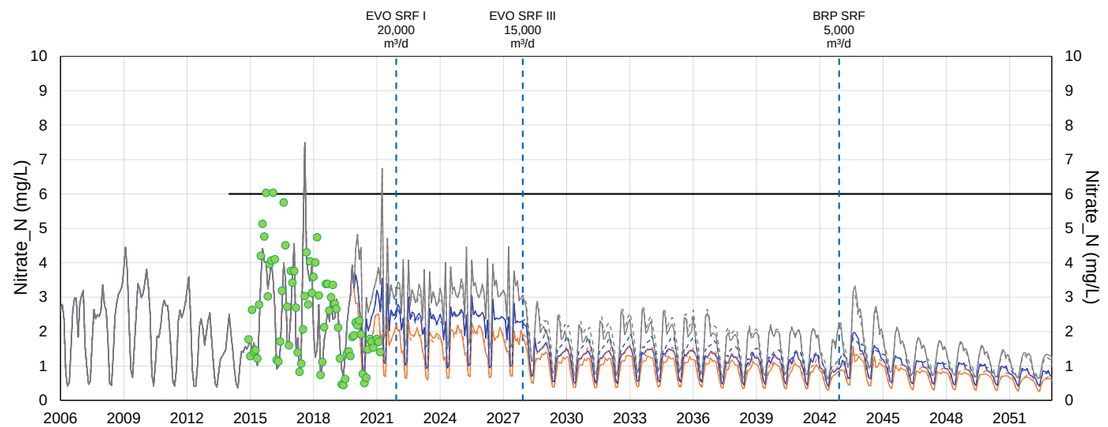
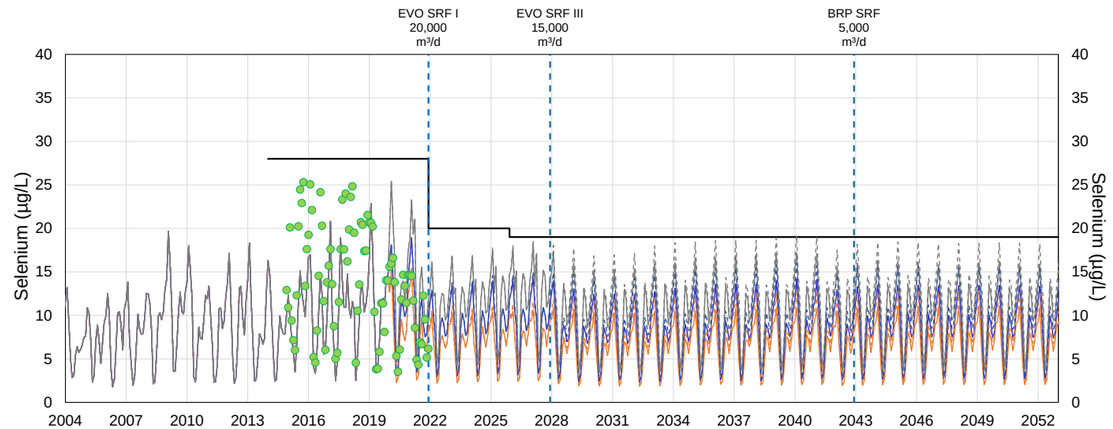


Figure C-7: Projected Concentrations of Nitrate, Selenium, and Sulphate at the EVO Michel Creek Compliance Point (EV_MC2; E300091) with Erickson Creek Water Availability Decreased from 95% to 85%

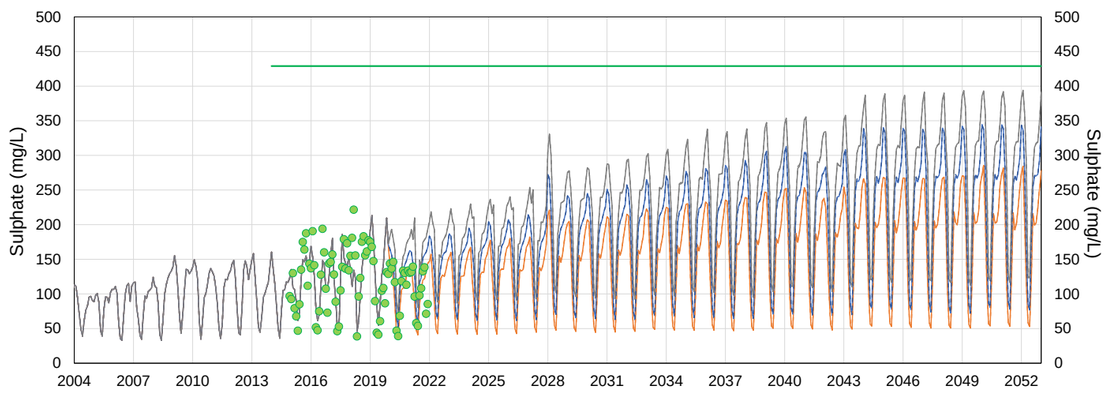
(a) Nitrate



(b) Selenium



(c) Sulphate



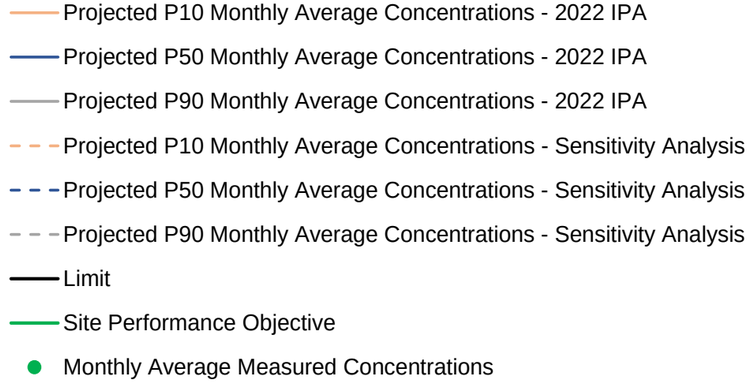
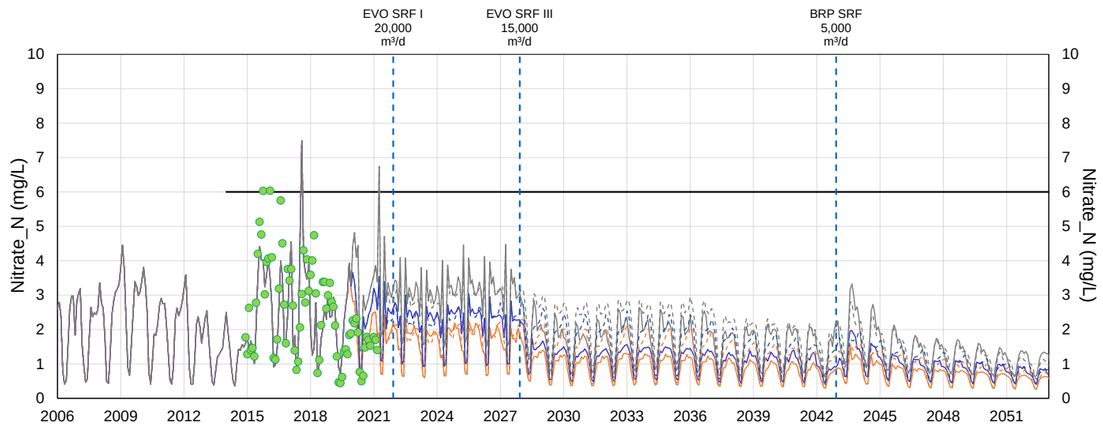
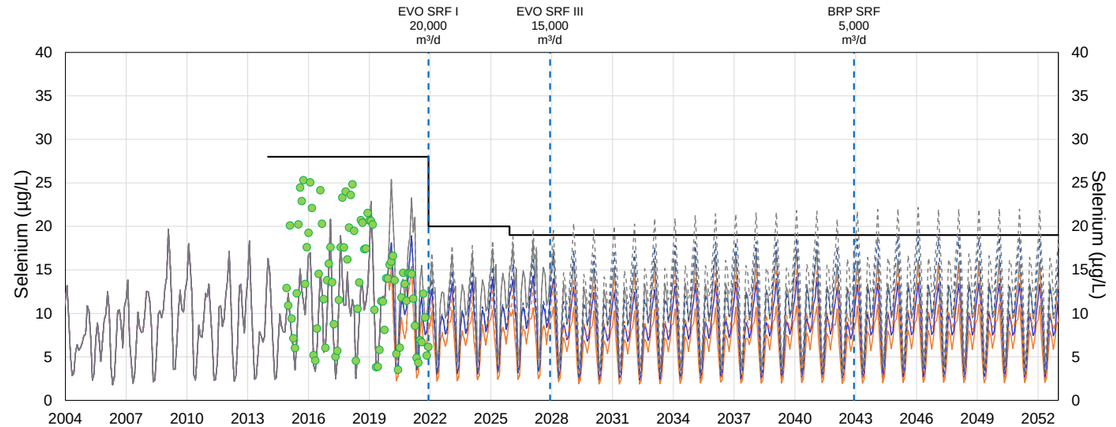


Figure C-8: Projected Concentrations of Nitrate, Selenium, and Sulphate at the EVO Michel Creek Compliance Point (EV_MC2; E300091) with Erickson Creek Water Availability Decreased from 95% to 70%

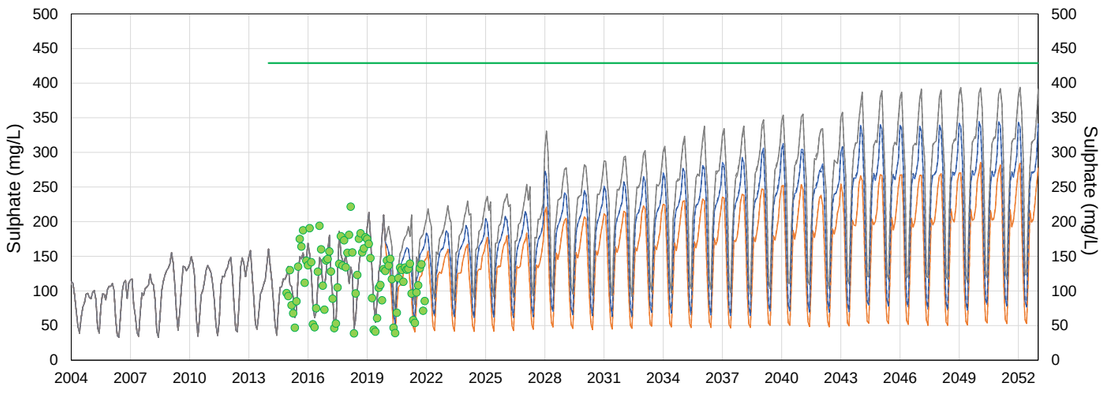
(a) Nitrate

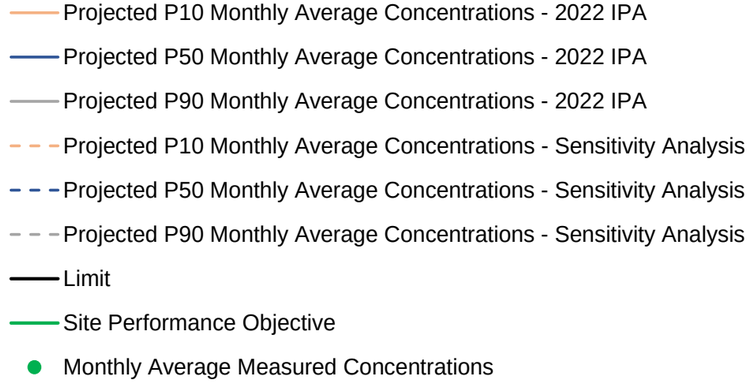


(b) Selenium



(c) Sulphate





Appendix D

Projected Concentrations of Nitrate with Changes to Nitrate Content

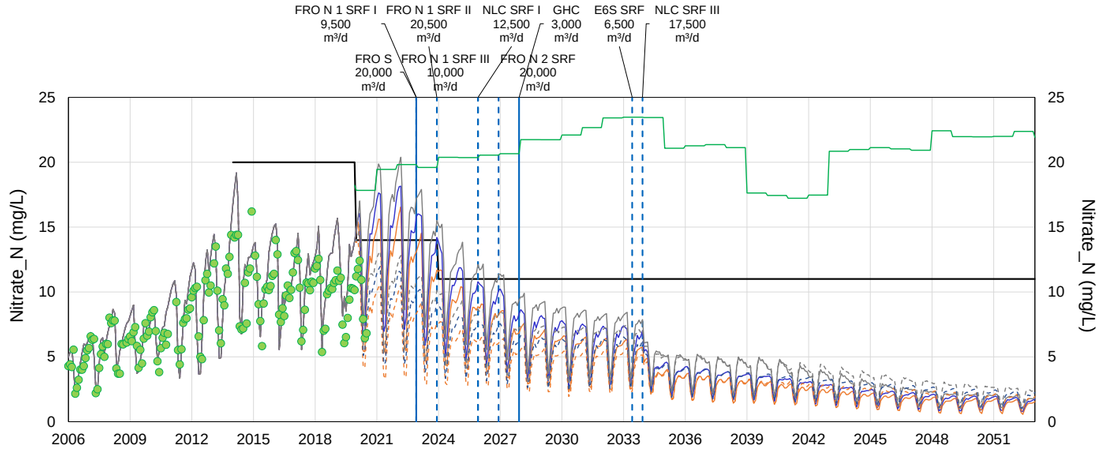
Figures

Projected concentrations of nitrate at Order Stations and compliance points in the Fording River watershed, with and without changes to nitrate content in waste rock spoils are shown in Figures D-1 and D-2. The format of the figures is as follows:

- The x-axis runs from the start of 2006 to the end of 2053. The start date corresponds to the start of the calibration period for nitrate in the 2020 RWQM. The end date (2053) corresponds to the modelled time period at which all permitted waste rock has been deposited and the lag associated with that rock has passed (i.e., all waste rock is contributing nitrate load).
- Projected 10^{th} percentile (P_{10}), 50^{th} percentile (P_{50}), and 90^{th} percentile (P_{90}) monthly average concentrations, without changes to nitrate content in waste rock spoils are shown as solid orange, blue and grey lines, respectively.
- Projected P_{10}, P_{50}, and P_{90} monthly average concentrations, with changes to nitrate content in waste rock spoils are shown as dashed orange, blue and grey lines, respectively.
- Measured monthly average concentrations are shown as green points.
- Modelled information shown prior to 2020 was developed based on calibrated flows. Those shown thereafter were developed using multiple climate realizations, as described in the 2020 update (Teck 2021).
- Compliance limits are shown as a solid black line, and Site Performance Objectives (SPOs) are shown as a solid green line.
- The fully effective dates for the Saturated Rock Fills (SRFs) and active water treatment facilities (AWTFs) are shown as a vertical blue line.

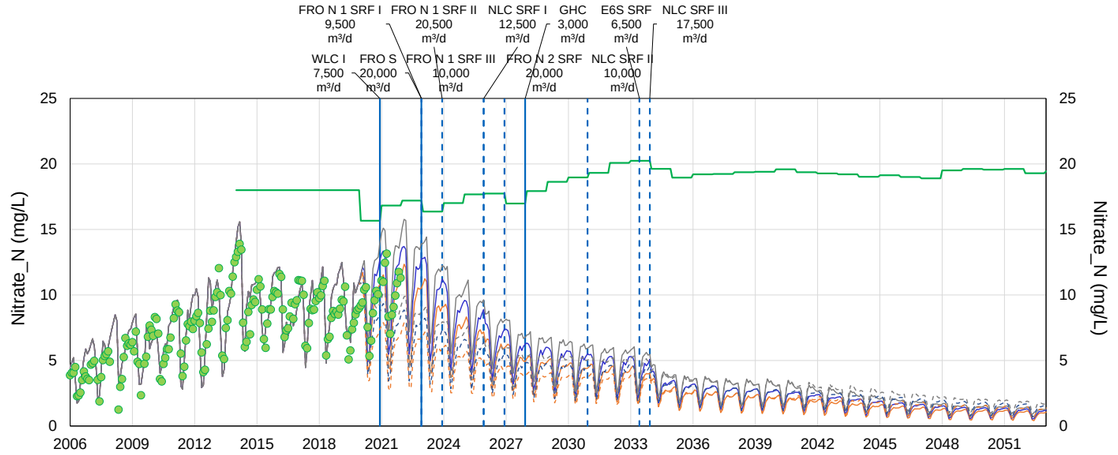
Figure D-1: Projected Concentrations of Nitrate at Order Stations in the Fording River, with and without Changes to Nitrate Content in Waste Rock Spoils

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)



Note: This location is also the GHO Fording River Compliance Point. Site Performance Objective is hardness dependent from 2023 onward and is calculated using the following formula: N (in mg-N/L) = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$.; it varies with time to reflect projected hardness concentrations in the month when maximum monthly nitrate concentrations are projected to occur.

(b) Fording River downstream of Line Creek (LC_LC5; 0200028)

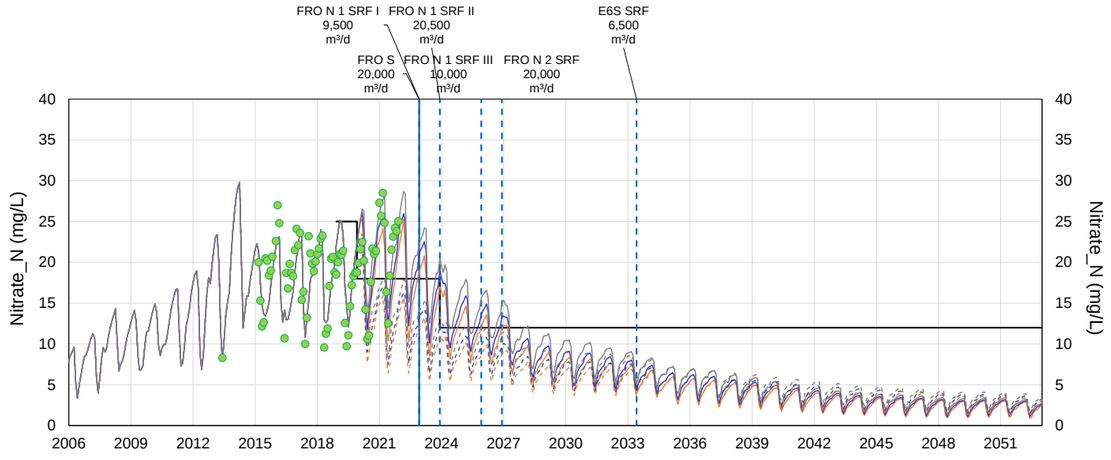


Note: Site Performance Objective is hardness dependent from 2019 onward and is calculated using the following formula: N (in mg-N/L) = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$.; it varies with time to reflect projected hardness concentrations in the month when maximum monthly nitrate concentrations are projected to occur.

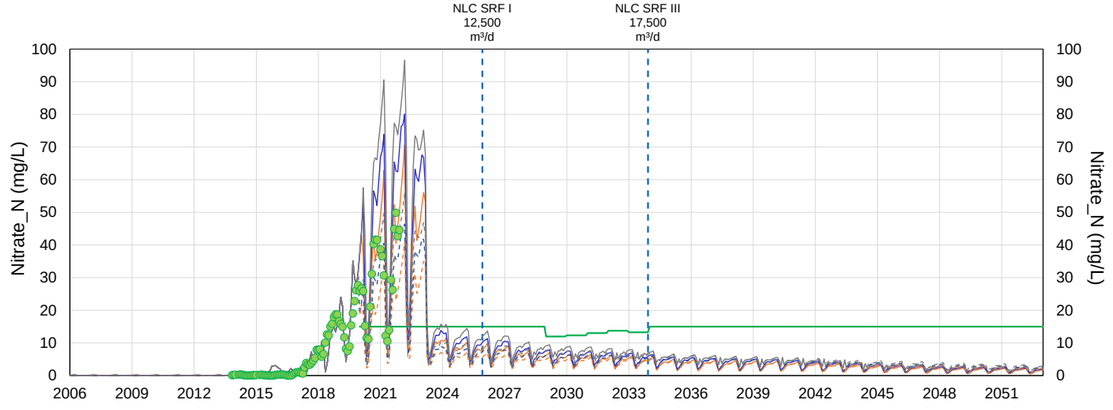
- Projected P10 Monthly Average Concentrations - 2022 IPA
- Projected P50 Monthly Average Concentrations - 2022 IPA
- Projected P90 Monthly Average Concentrations - 2022 IPA
- Projected P10 Monthly Average Concentrations - Sensitivity Analysis
- Projected P50 Monthly Average Concentrations - Sensitivity Analysis
- Projected P90 Monthly Average Concentrations - Sensitivity Analysis
- Limit
- Site Performance Objective
- Monthly Average Measured Concentrations

Figure D-2: Projected Concentrations of Nitrate at Compliance Points in the Fording River and in LCO Dry Creek, with and without Changes to Nitrate Content in Waste Rock Spoils

(a) FRO Compliance Point (FR_FRABCH; E223753)

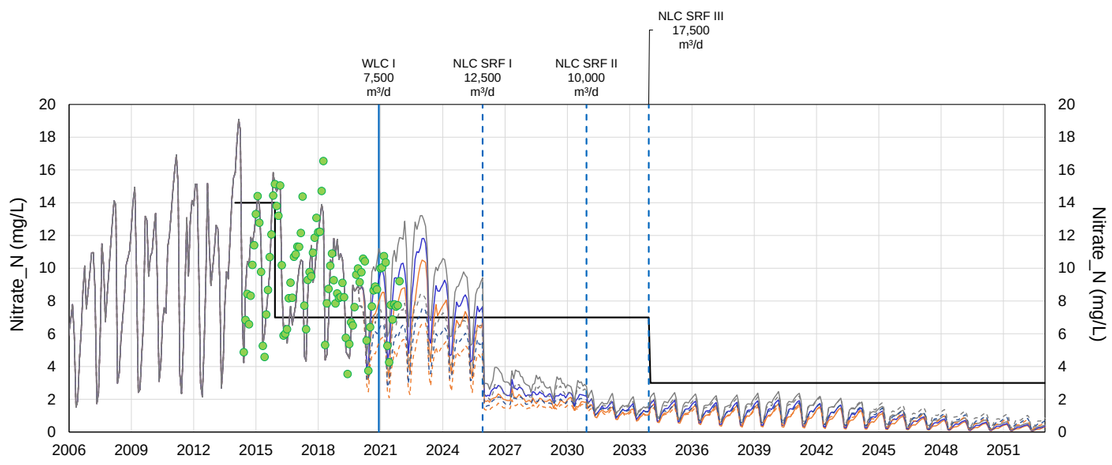


(c) LCO Dry Creek downstream of the Sedimentation Ponds (LC_DCDS; E295210)



Note: Projected concentrations decrease in 2023 due to conveyance and supplementation.

(c) LCO Compliance Point (LC_LCDSSLCC; E297110)



Appendix E

Projected Concentrations of Selenium and Sulphate with Changes to Selenium and Sulphate Release Rates

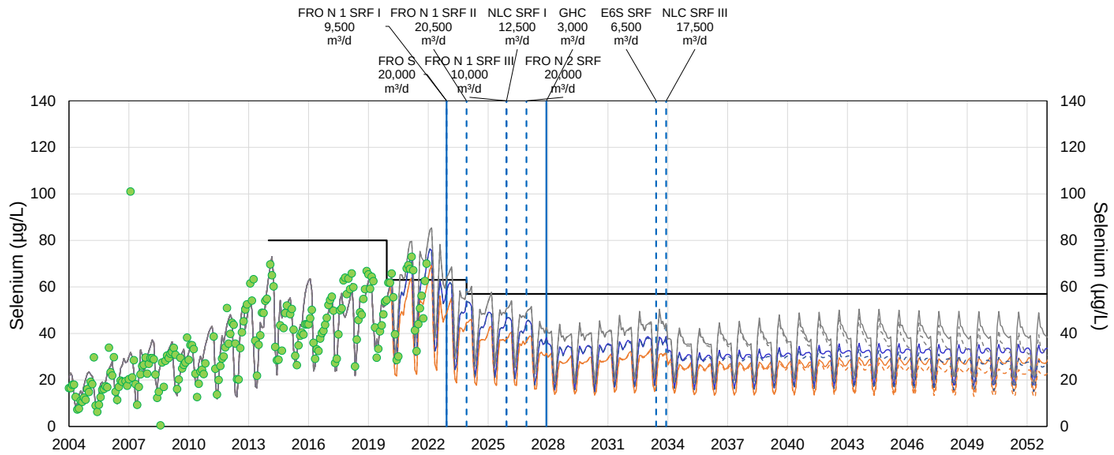
Figures

Projected concentrations of selenium and sulphate at Order Stations and compliance points, with and without application of first order decay to selenium and sulphate release rates are shown in Figures E-1 to E-4. The format of the figures is as follows:

- The x-axis runs from the start of 2004 to the end of 2053. The start date corresponds to the start of the calibration period for selenium and sulphate in the 2020 RWQM. The end date (2053) corresponds to the modelled time period at which all permitted waste rock has been deposited and the lag associated with that rock has passed (i.e., all waste rock is contributing selenium and sulphate load).
- Projected 10th percentile (P_{10}), 50th percentile (P_{50}), and 90th percentile (P_{90}) monthly average concentrations, without application of first order decay to selenium and sulphate release rates are shown as solid orange, blue and grey lines, respectively.
- Projected P_{10}, P_{50}, and P_{90} monthly average concentrations, without application of first order decay to selenium and sulphate release rates are shown as dashed orange, blue and grey lines, respectively.
- Measured monthly average concentrations are shown as green points.
- Modelled information shown prior to 2020 was developed based on calibrated flows. Those shown thereafter were developed using multiple climate realizations, as described in the 2020 update (Teck 2021).
- Compliance limits are shown as a solid black line, and Site Performance Objectives (SPOs) are shown as a solid green line.
- The fully effective dates for the Saturated Rock Fills (SRFs) and active water treatment facilities (AWTFs) are shown as a vertical blue line.

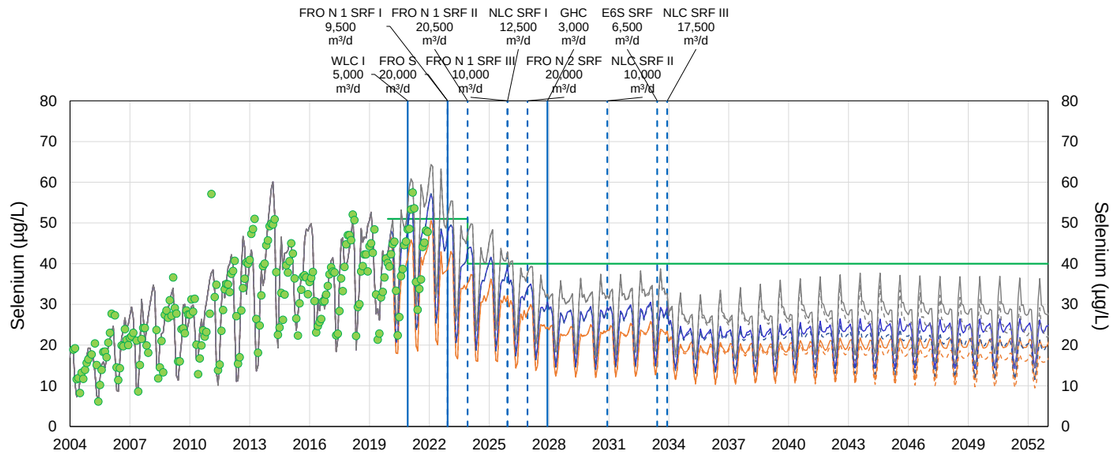
Figure E-1: Projected Selenium Concentrations at Order Stations with and without Changes to Release Rates

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)

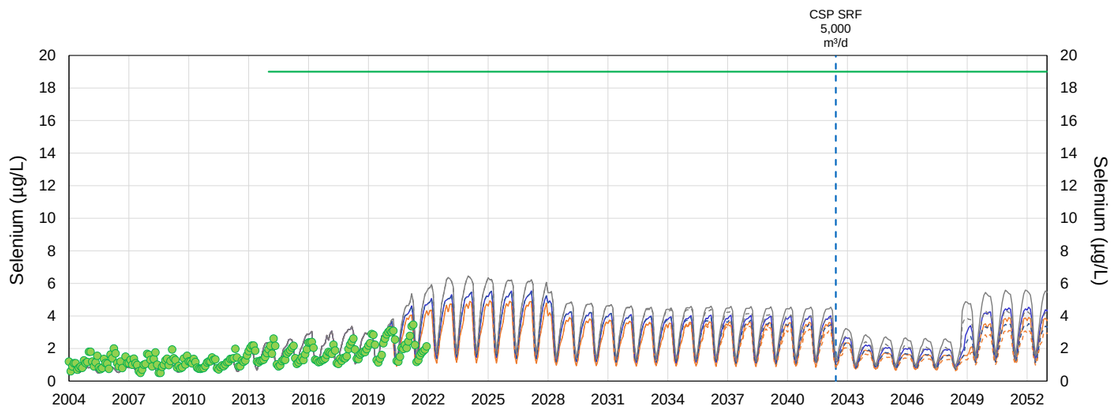


Note: This location is also the GHO Fording River Compliance Point.

(b) Fording River downstream of Line Creek (LC_LC5; 0200028)

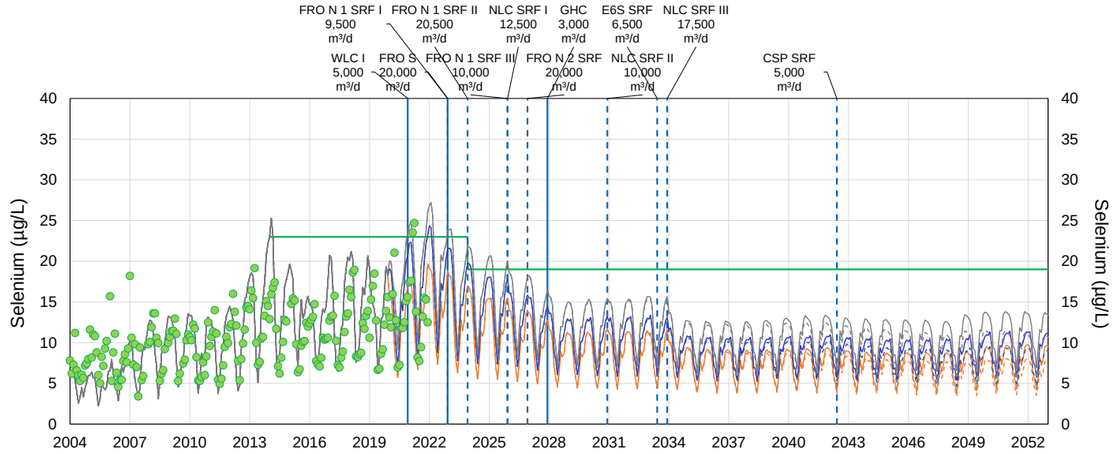


(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)

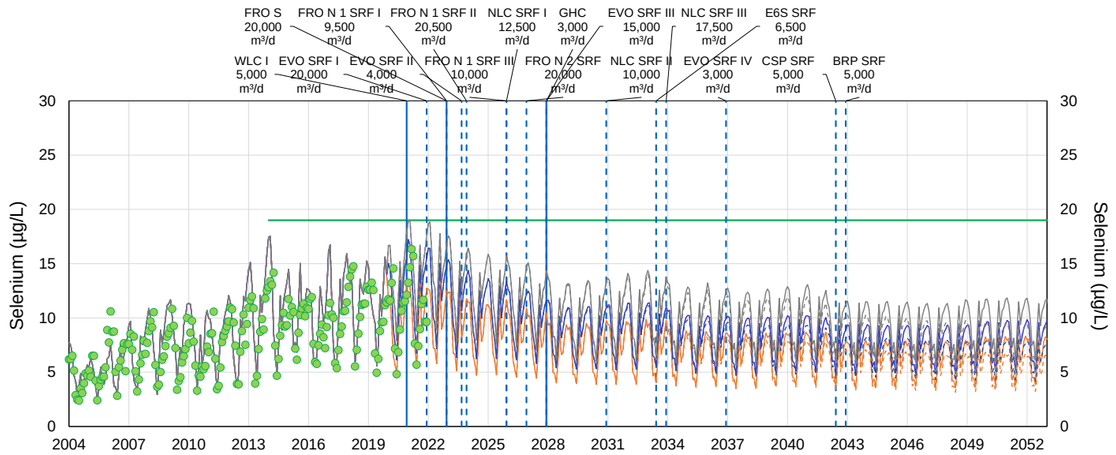


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

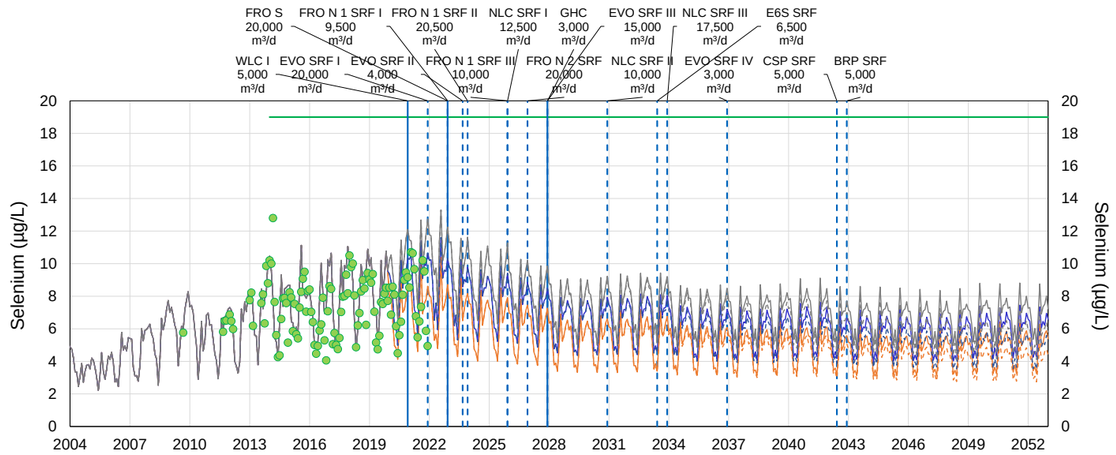
(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)



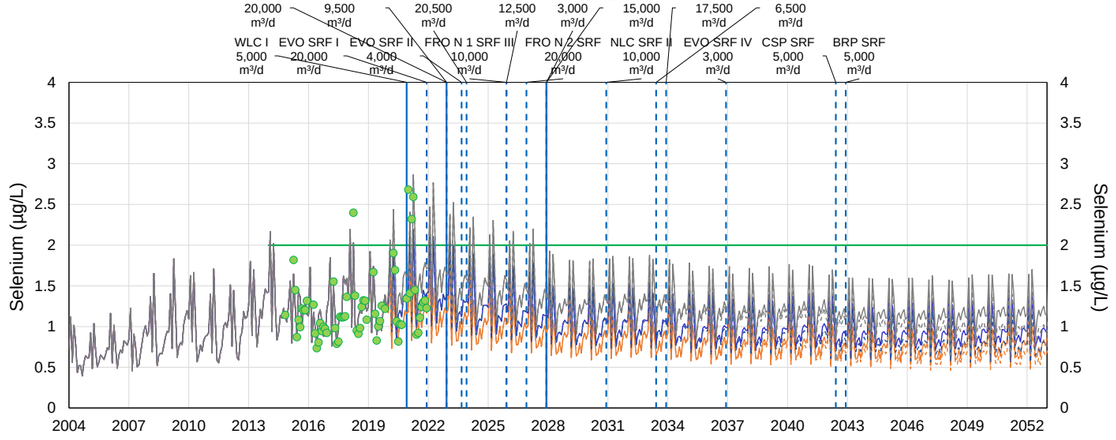
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



(g) Koocanusa Reservoir (RG_DSELK; E300230)



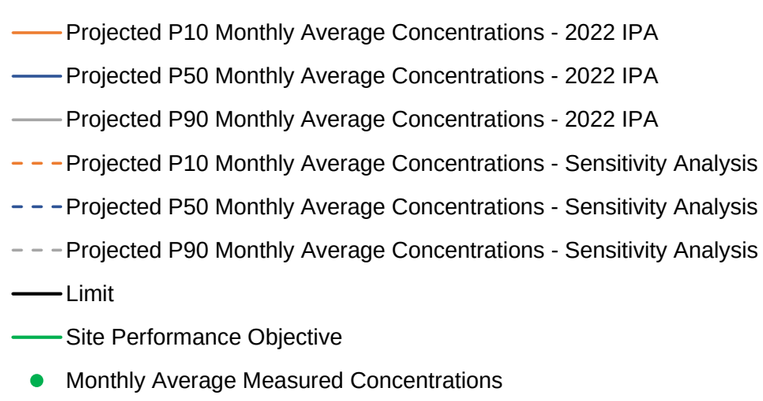
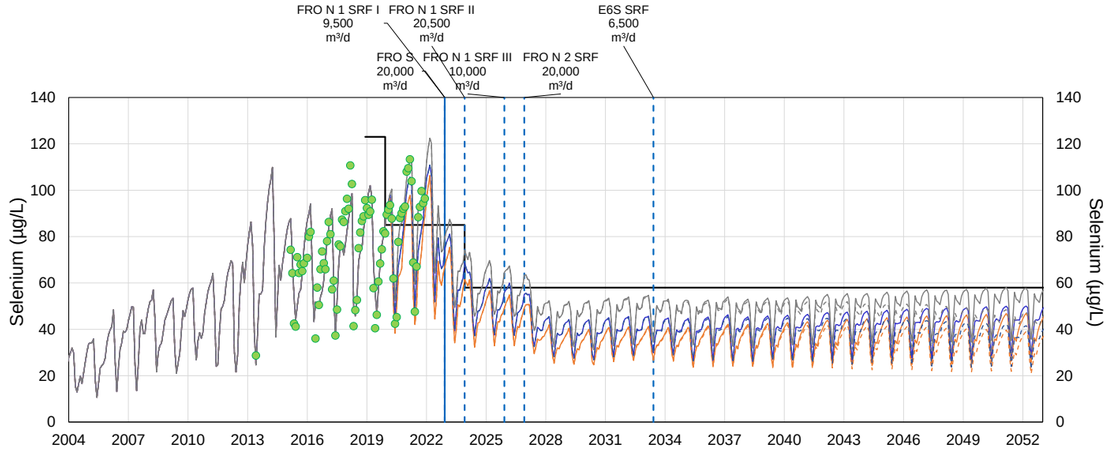
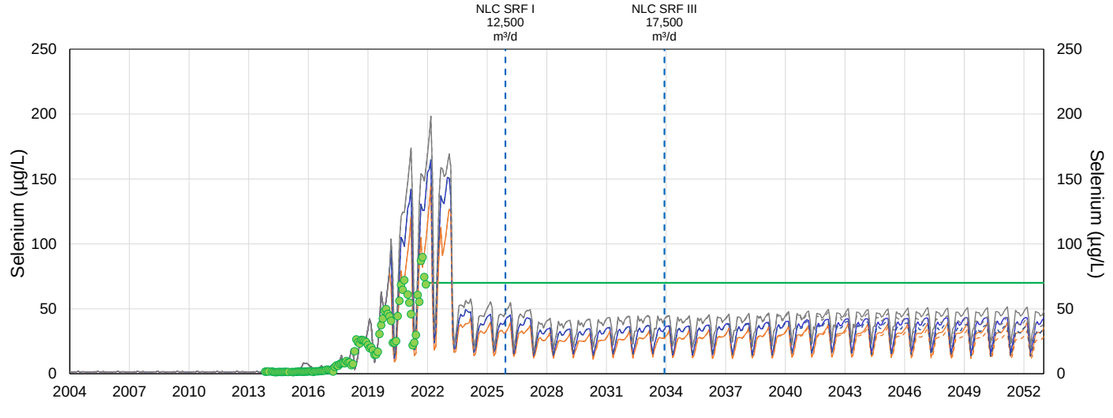


Figure E-2: Projected Selenium Concentrations at Compliance Points and in LCO Dry Creek with and without Changes to Release Rates

(a) FRO Compliance Point (FR_FRABCH; E223753)

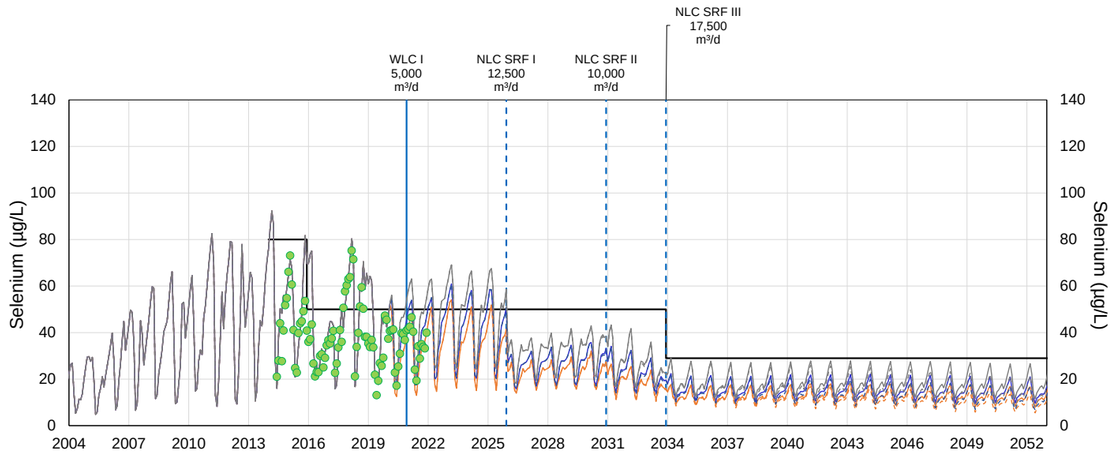


(b) Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)

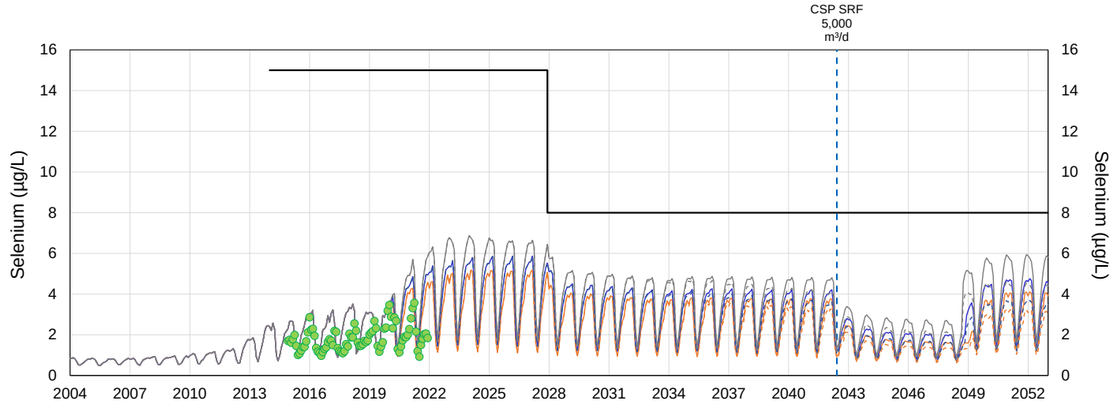


Note: Projected concentrations decrease in 2023 due to conveyance and supplementation.

(c) LCO Compliance Point (LC_LCDSSLCC; E297110)

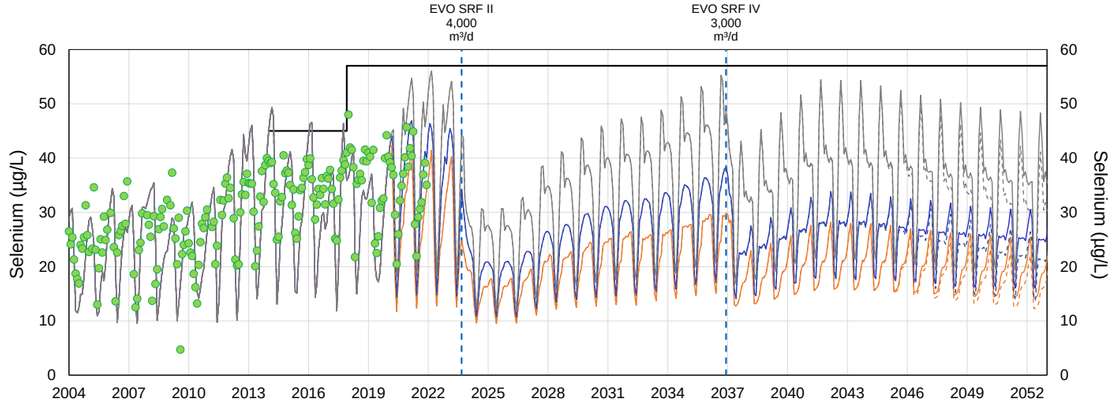


(d) GHO Elk River Compliance Point (GH_ERC; E300090)

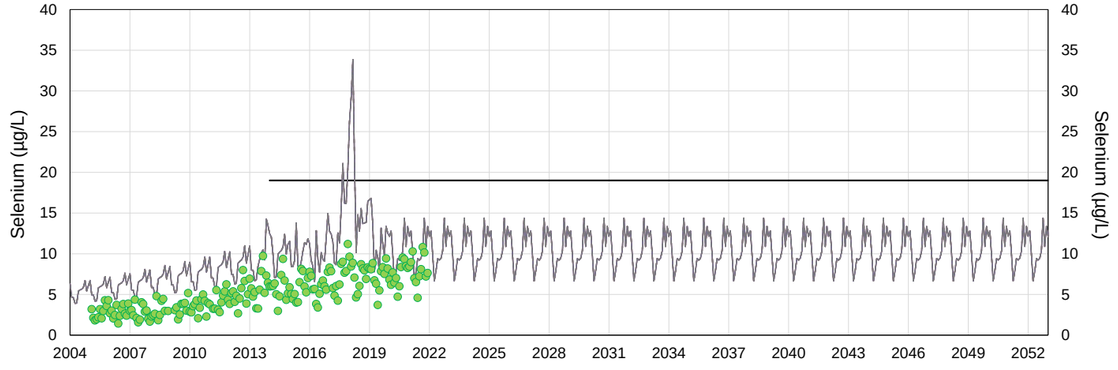


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) EVO Harmer Compliance Point (EV_HC1; E102682)



(f) CMO Compliance Point (CM_MC2; E258937)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

(g) EVO Michel Creek Compliance Point (EV_MC2; E300091)

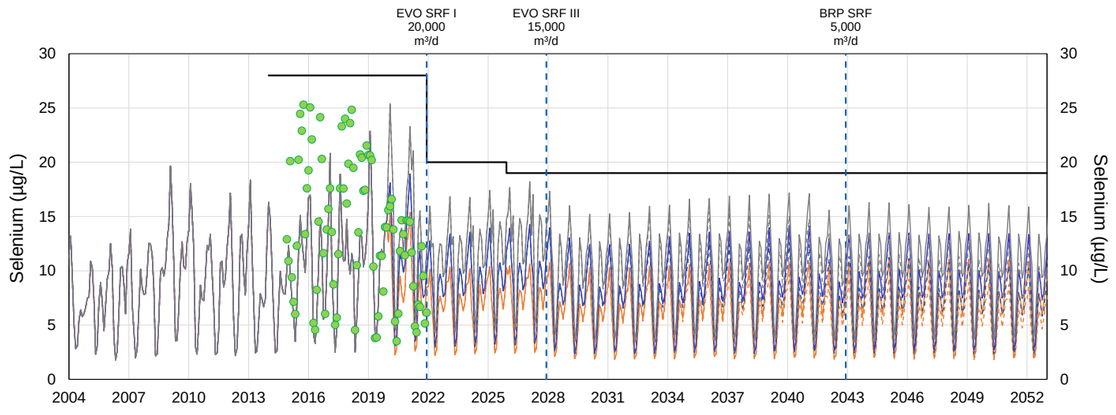
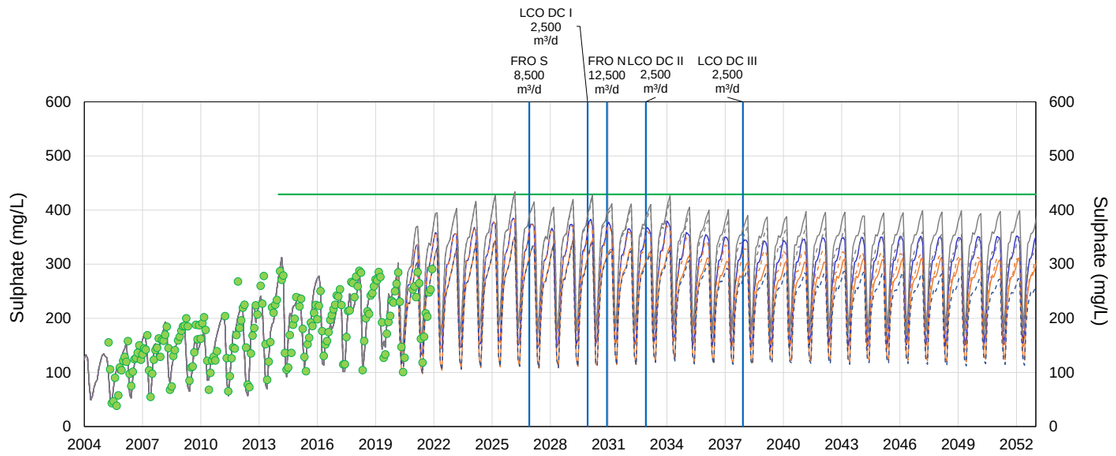


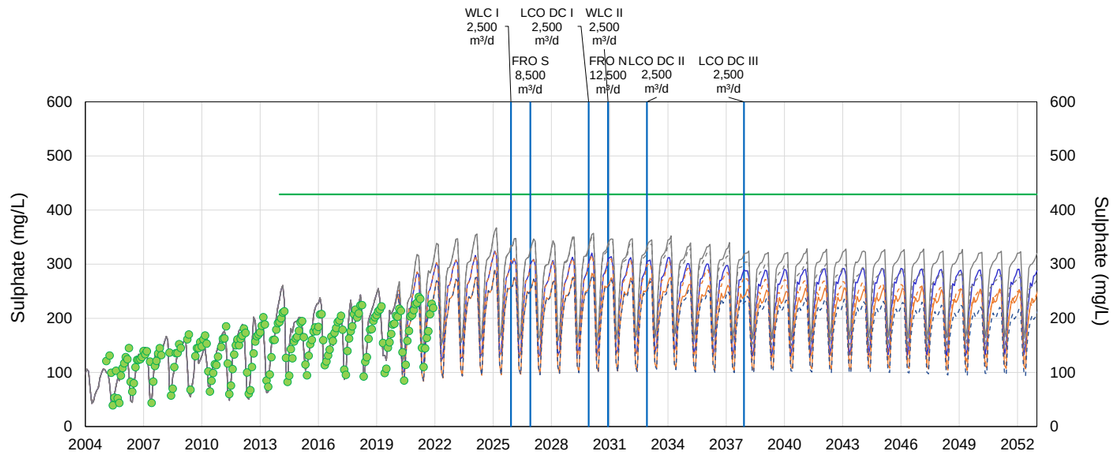
Figure E-3: Projected Sulphate Concentrations at Order Stations with and without Changes to Release Rates

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)

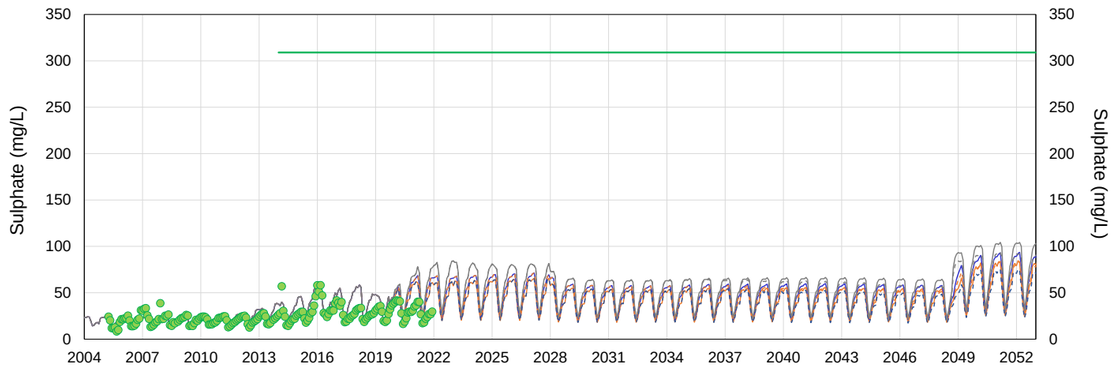


Note: This location is also the GHO Fording River Compliance Point.

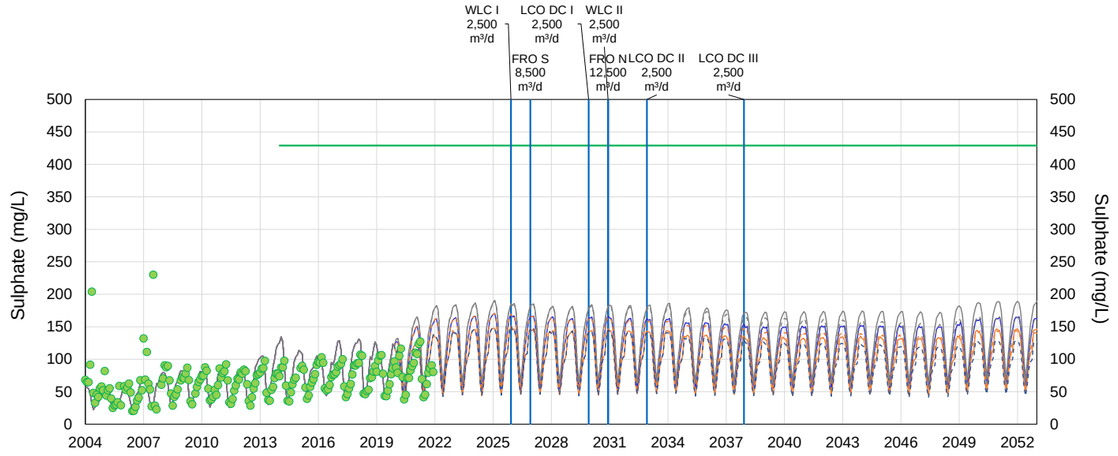
(b) Fording River downstream of Line Creek (LC_LC5; 0200028)



(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)

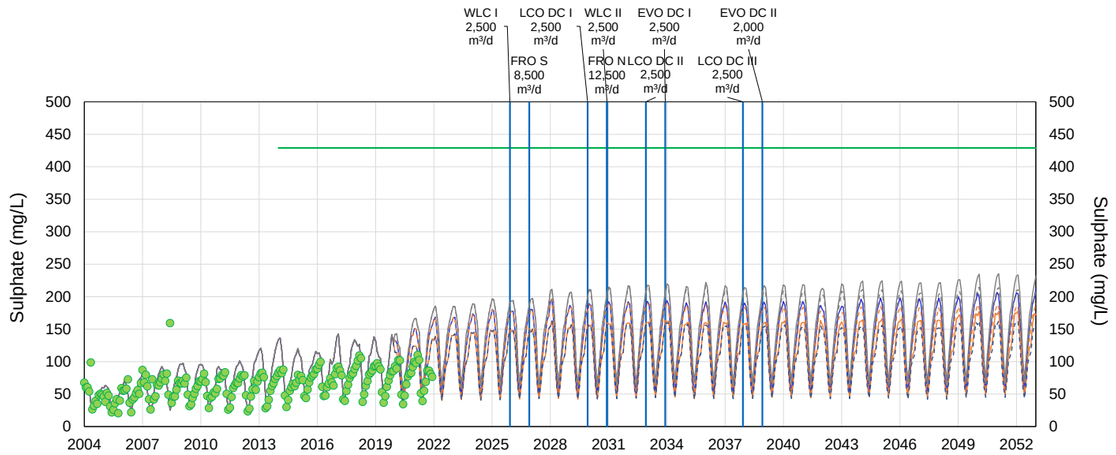


(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)

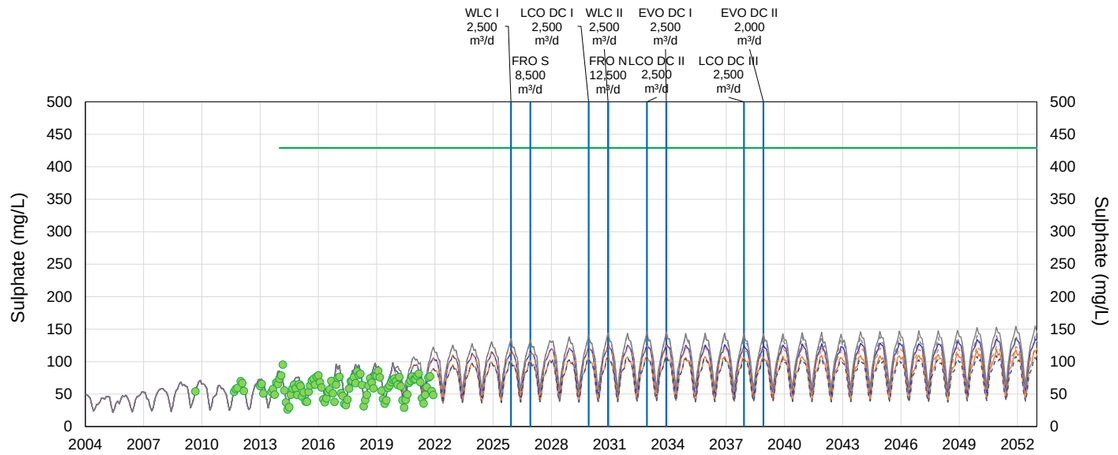


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

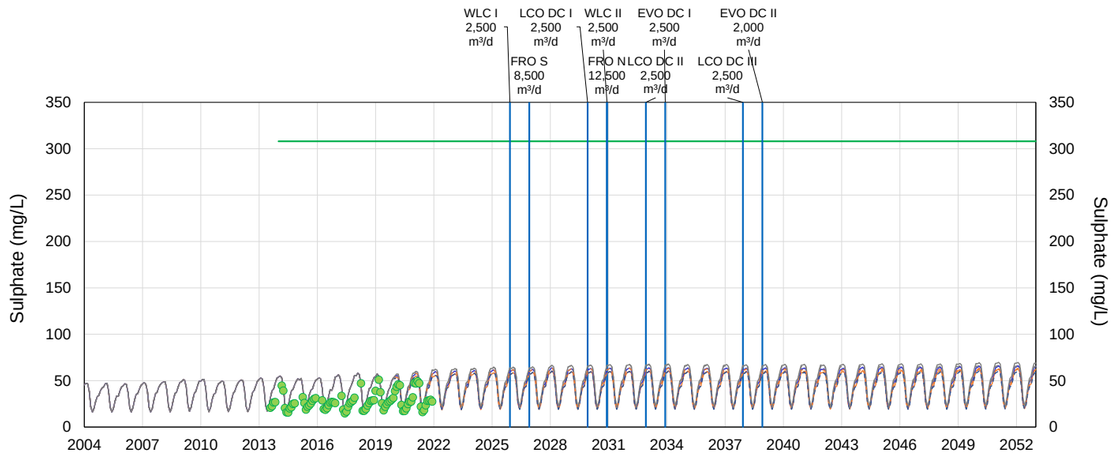
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



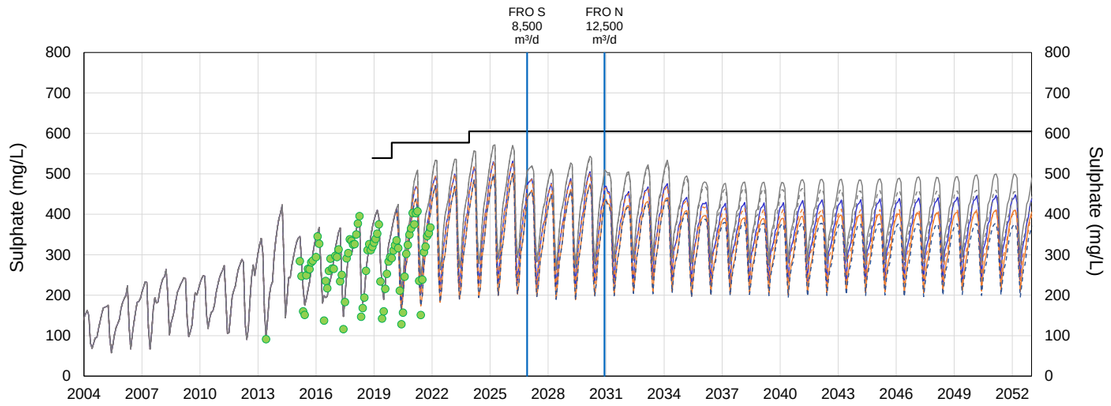
(g) Koocanusa Reservoir (RG_DSELK; E300230)



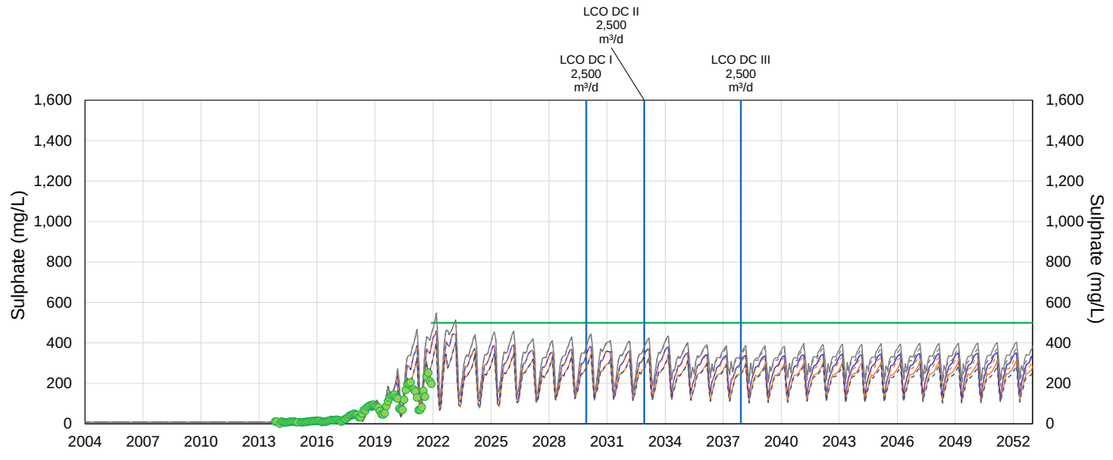
Projected P10 Monthly Average Concentrations - 2022 IPA
Projected P50 Monthly Average Concentrations - 2022 IPA
Projected P90 Monthly Average Concentrations - 2022 IPA
Projected P10 Monthly Average Concentrations - Sensitivity Analysis
Projected P50 Monthly Average Concentrations - Sensitivity Analysis
Projected P90 Monthly Average Concentrations - Sensitivity Analysis
Limit
Site Performance Objective
Monthly Average Measured Concentrations

Figure E-4: Projected Sulphate Concentrations at Compliance Points and in LCO Dry Creek with and without Changes to Release Rates

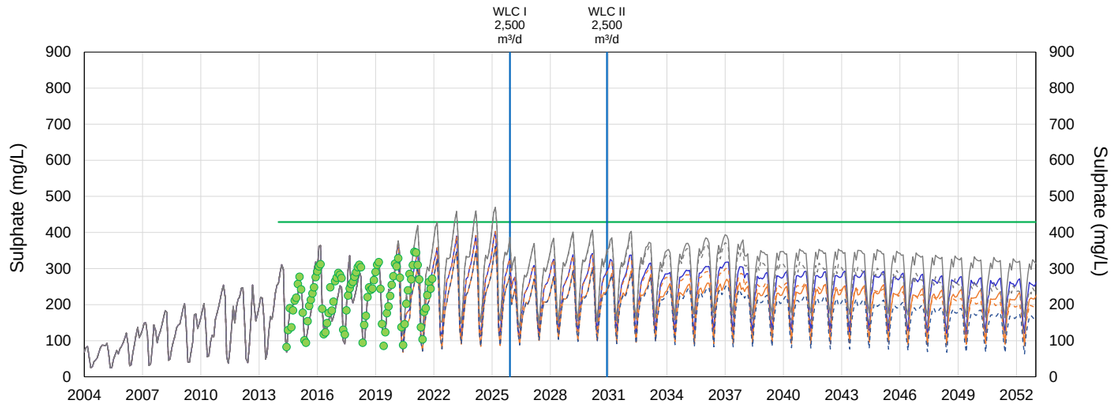
(a) FRO Compliance Point (FR_FRABCH; E223753)



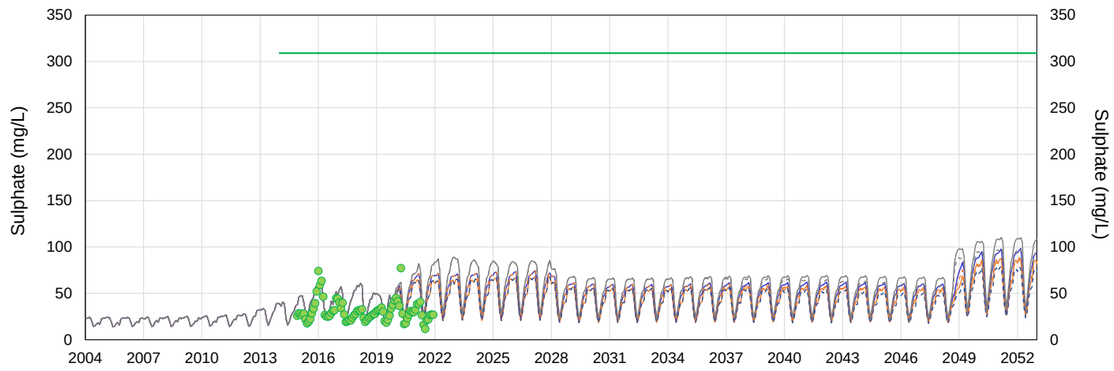
(b) Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)



(c) LCO Compliance Point (LC_LCDSSLCC; E297110)

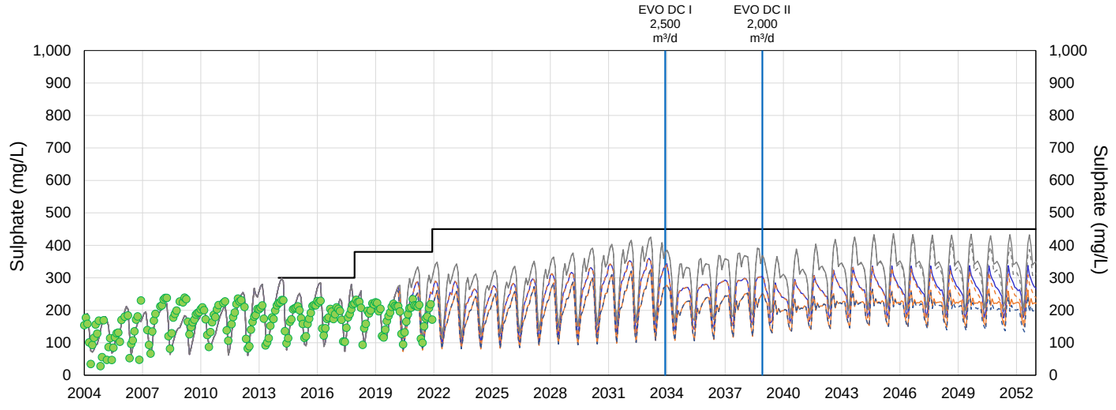


(d) GHO Elk River Compliance Point (GH_ERC; E300090)

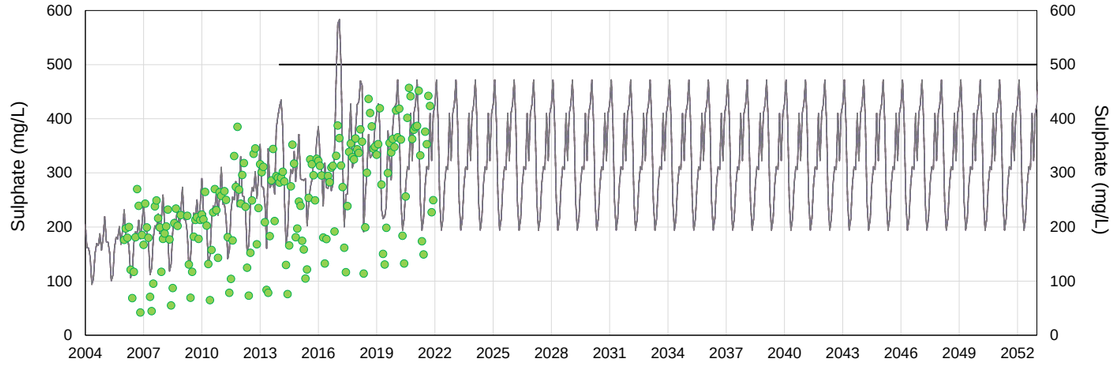


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) EVO Harmer Compliance Point (EV_HC1; E102682)

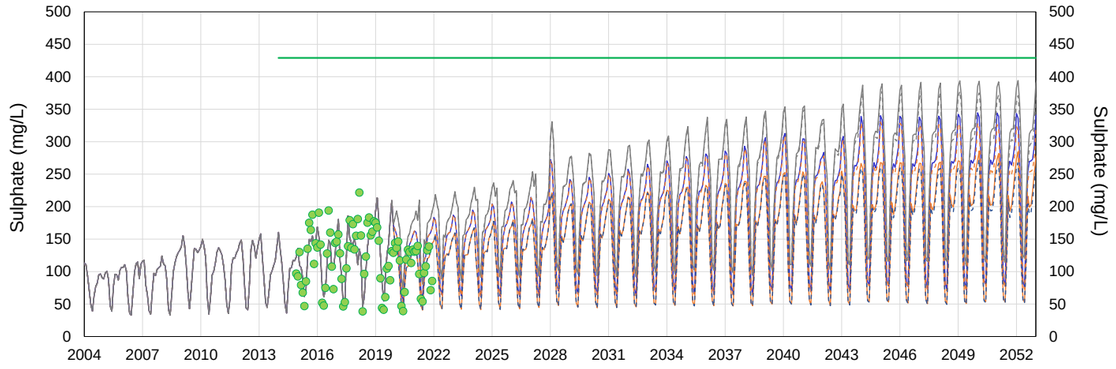


(f) CMO Compliance Point (CM_MC2; E258937)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

(g) EVO Michel Creek Compliance Point (EV_MC2; E300091)



- Projected P10 Monthly Average Concentrations - 2022 IPA
- Projected P50 Monthly Average Concentrations - 2022 IPA
- Projected P90 Monthly Average Concentrations - 2022 IPA
- Projected P10 Monthly Average Concentrations - Sensitivity Analysis
- Projected P50 Monthly Average Concentrations - Sensitivity Analysis
- Projected P90 Monthly Average Concentrations - Sensitivity Analysis
- Limit
- Site Performance Objective / Targeted Receiving Environment Objective
- Monthly Average Measured Concentrations

Appendix F

Projected Flows and Concentrations of Nitrate, Selenium, and Sulphate with Consideration of Climate Change

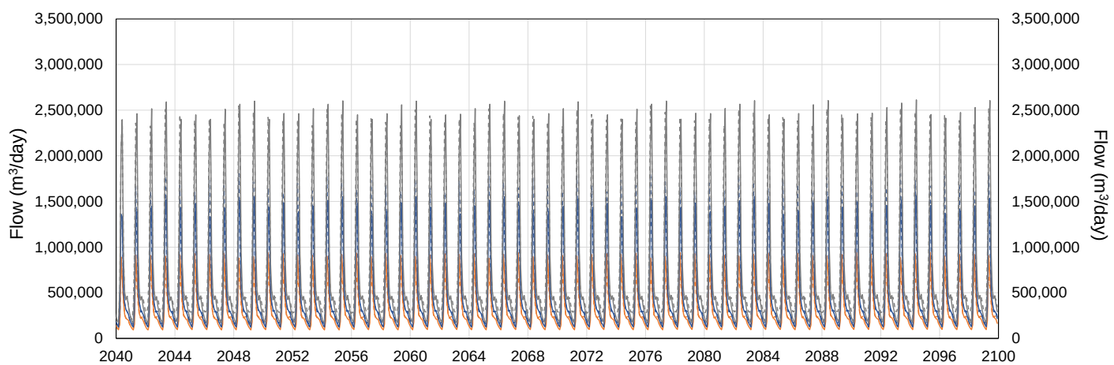
Figures

Projected flows and concentrations of nitrate, selenium, and sulphate at Order Stations, compliance points and in LCO Dry Creek, with and without potential changes to climate are shown in Figures F-1 to F-16. The format of the figures is as follows:

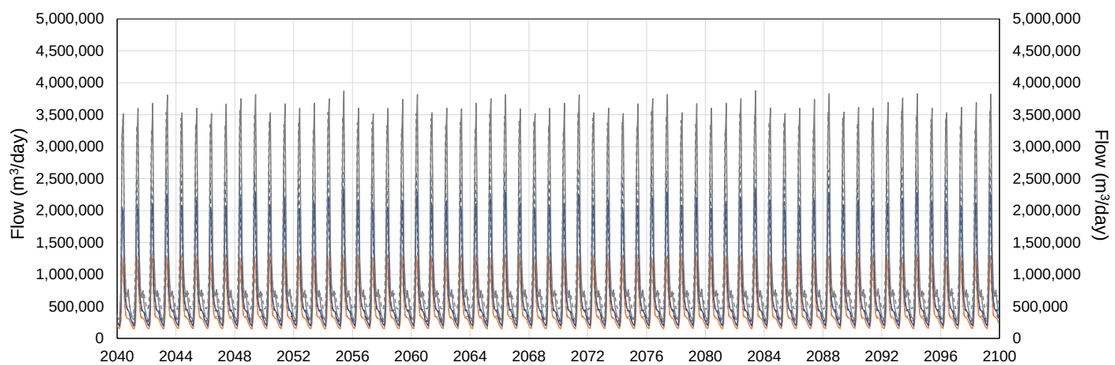
- The x-axis runs from the start of 2040 to the end of 2099. The start date corresponds to the year when climate driven inputs were adjusted in the 2020 RWQM. The end date (2099) corresponds to the end of the simulation period.
- Projected 10th percentile (P_{10}), 50th percentile (P_{50}), and 90th percentile (P_{90}) monthly average concentrations, without climate change are shown as solid orange, blue and grey lines, respectively.
- Projected P_{10}, P_{50}, and P_{90} monthly average concentrations, with climate change are shown as dashed orange, blue and grey lines, respectively.
- Compliance limits are shown as a solid black line, and site performance objectives (SPOs) and/or targeted receiving environment objectives are shown as a solid green line.

Figure F-1: Projected Monthly Average Flows at Order Stations with and without Climate Change (RCP 8.5)

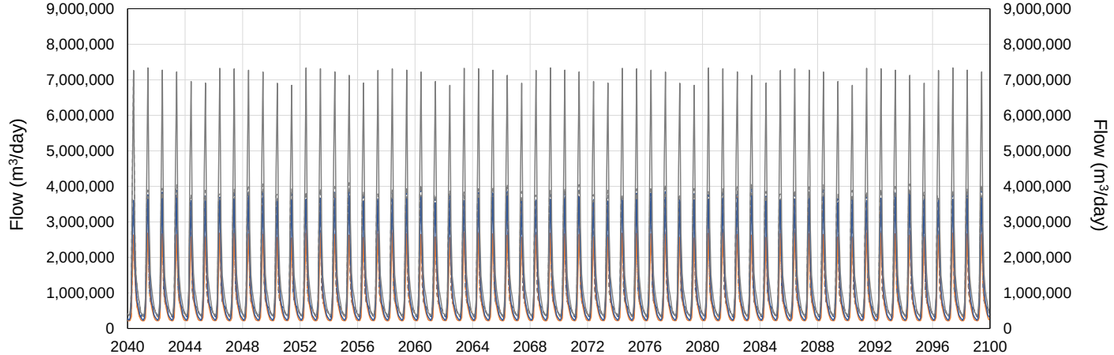
(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)



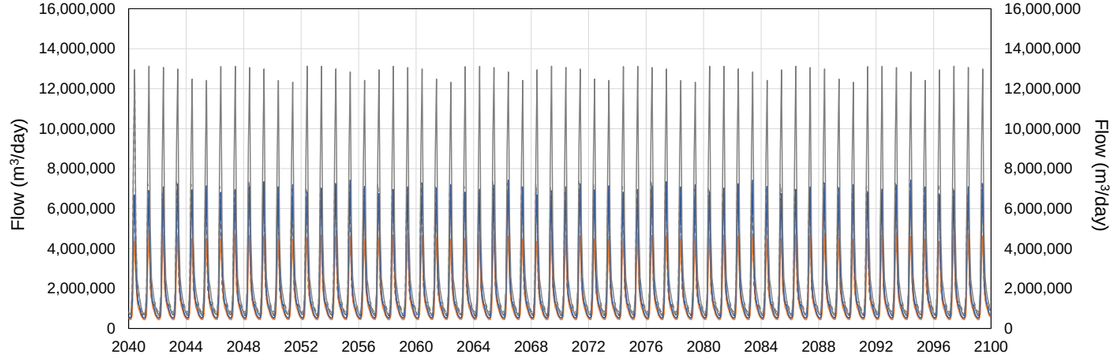
(b) Fording River downstream of Line Creek (LC_LC5; 0200028)



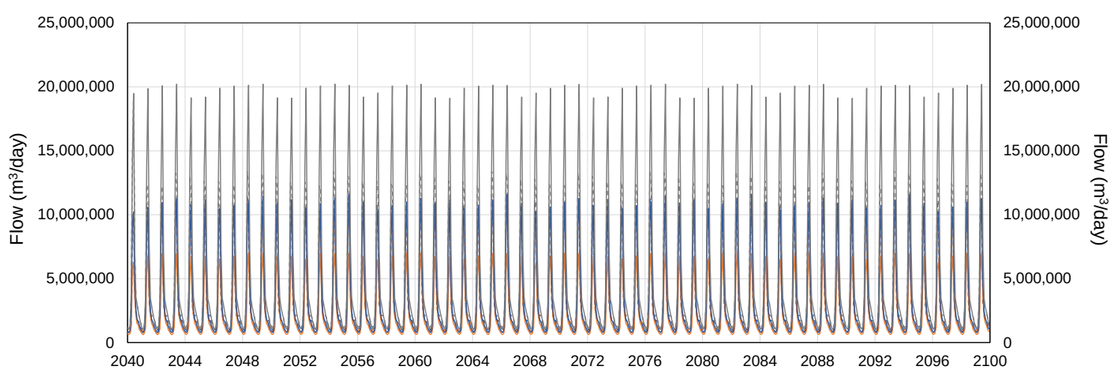
(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)



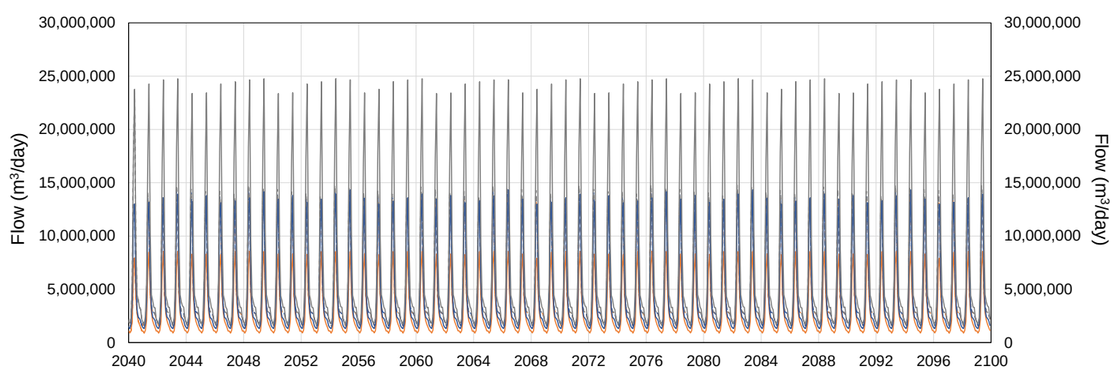
(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)



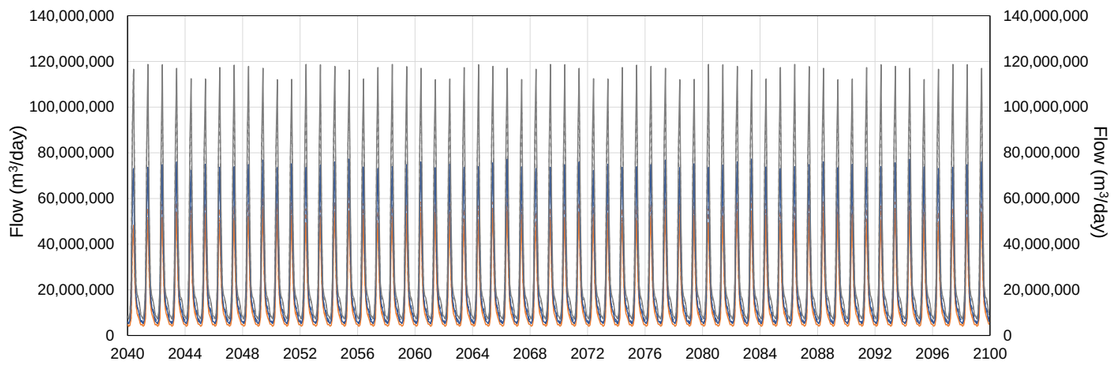
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



(g) Koocanusa Reservoir (RG_DSELK; E300230)



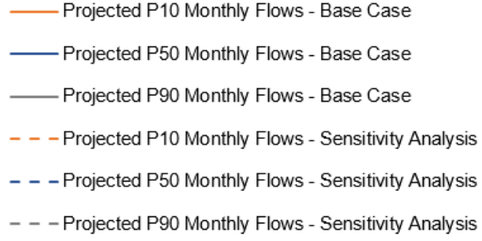
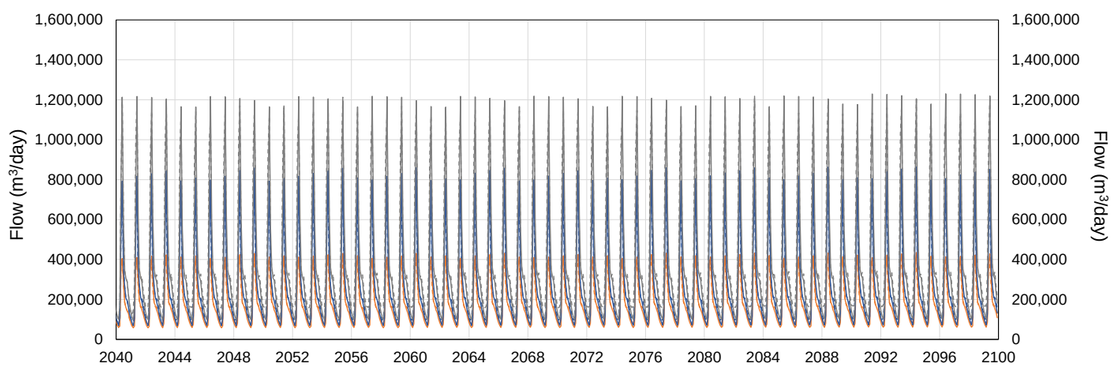
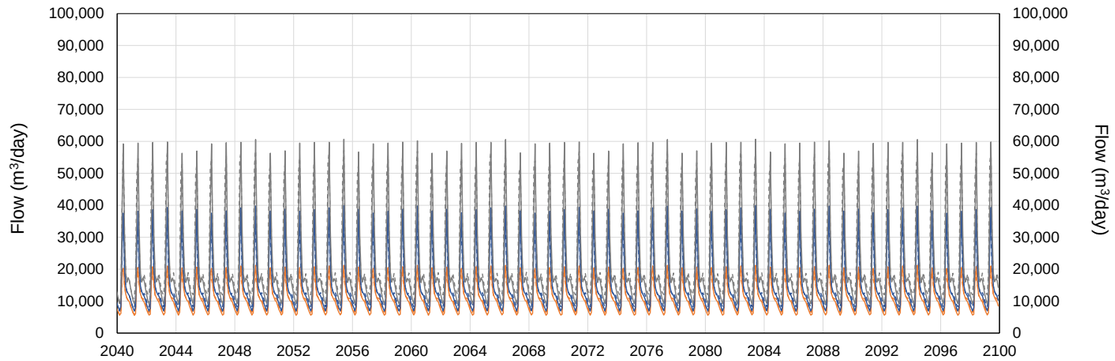


Figure F-2: Projected Monthly Average Flows at Compliance Points and in LCO Dry Creek with and without Climate Change (RCP 8.5)

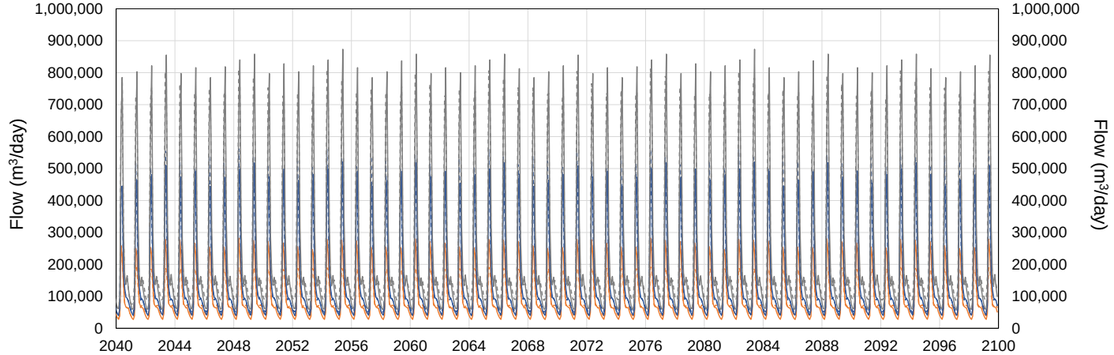
(a) FRO Compliance Point (FR_FRABCH; E223753)



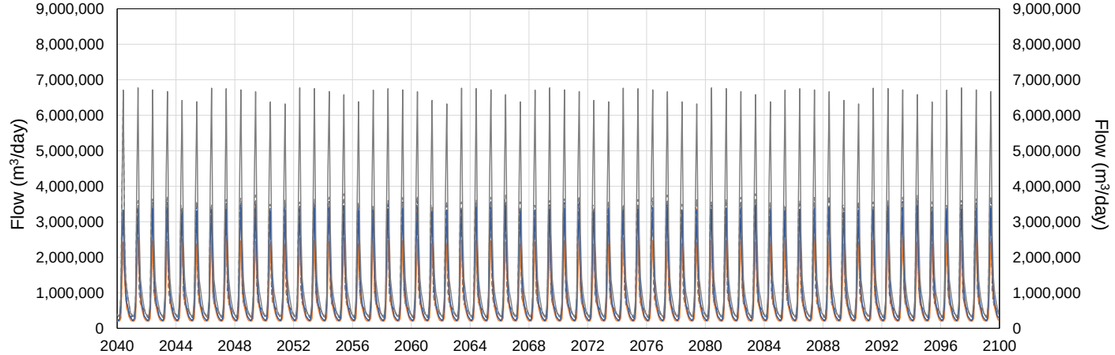
(b) Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)



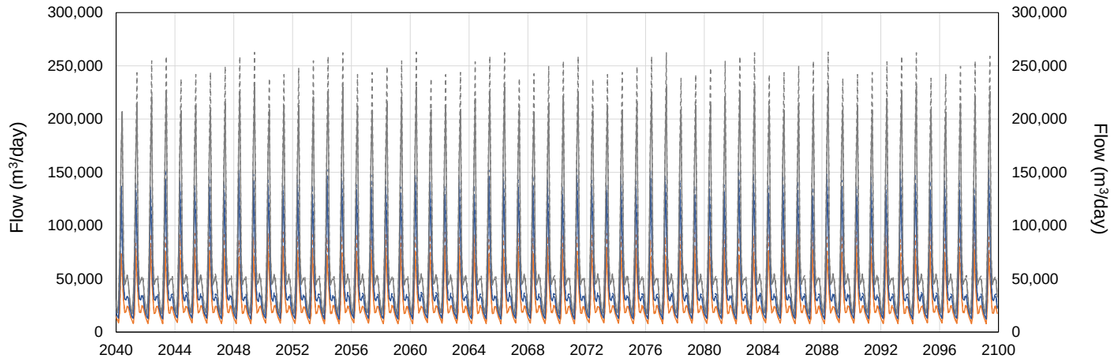
(c) LCO Compliance Point (LC_LCDSSLCC; E297110)



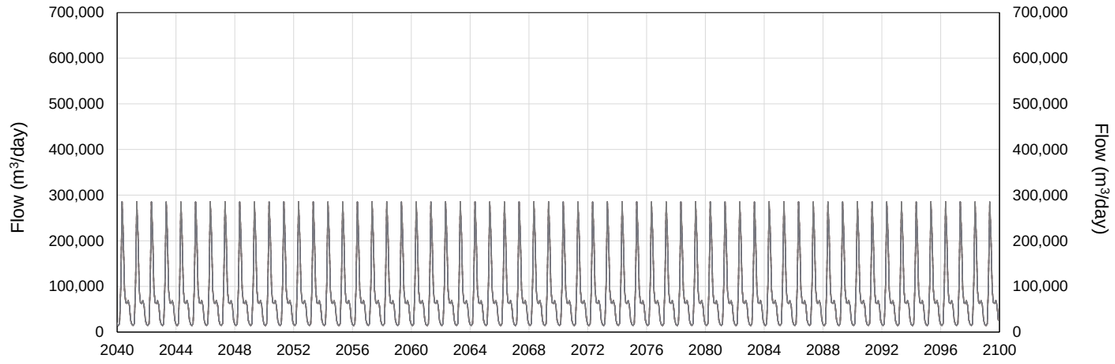
(d) GHO Elk River Compliance Point (GH_ERC; E300090)



(e) EVO Harmer Compliance Point (EV_HC1; E102682)



(f) CMO Compliance Point (CM_MC2; E258937)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

(g) EVO Michel Creek Compliance Point (EV_MC2; E300091)

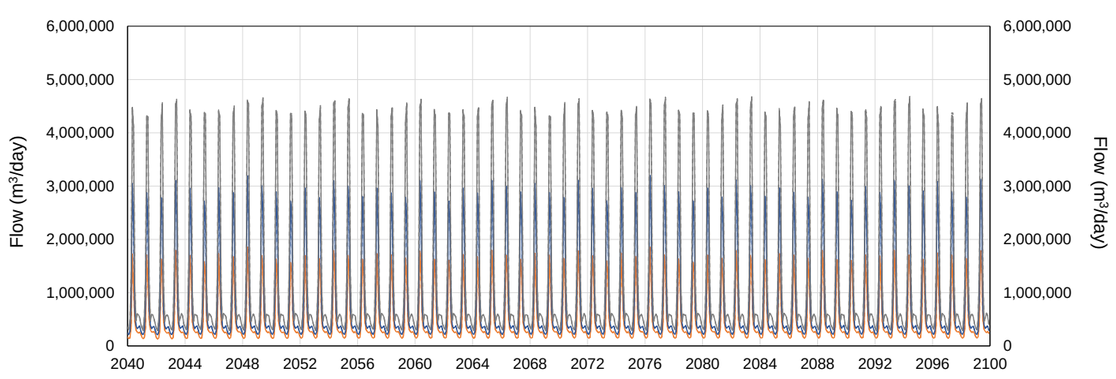
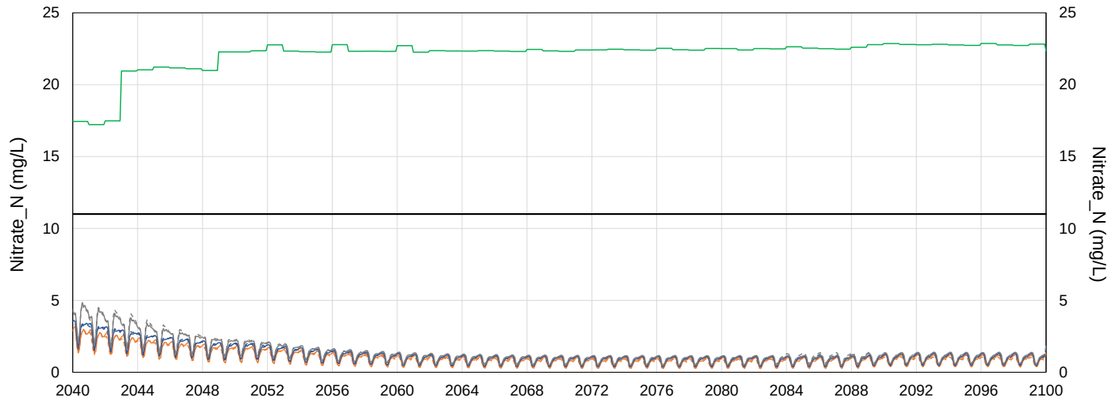


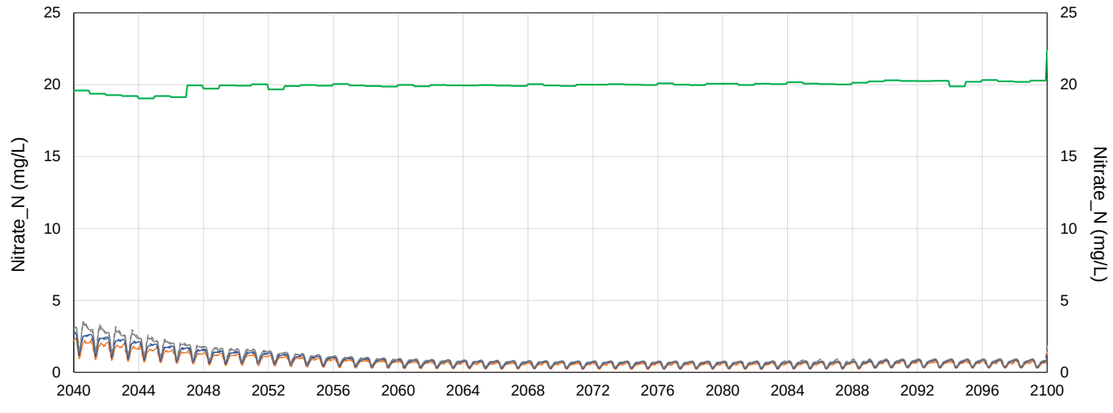
Figure F-3: Projected Monthly Average Concentrations of Nitrate at Order Stations with and without Climate Change (RCP 8.5)

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)



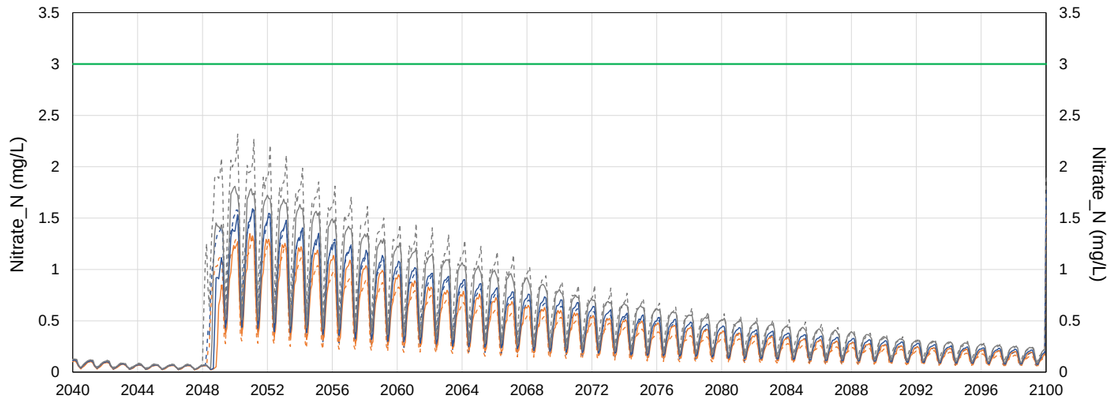
Note: This location is also the GHO Fording River Compliance Point. Site Performance Objective is hardness dependent from 2023 onward and is calculated using the following formula: N (in mg-N/L) = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$.; it varies with time to reflect projected hardness concentrations in the month when maximum monthly nitrate concentrations are projected to occur.

(b) Fording River downstream of Line Creek (LC_LC5; 0200028)



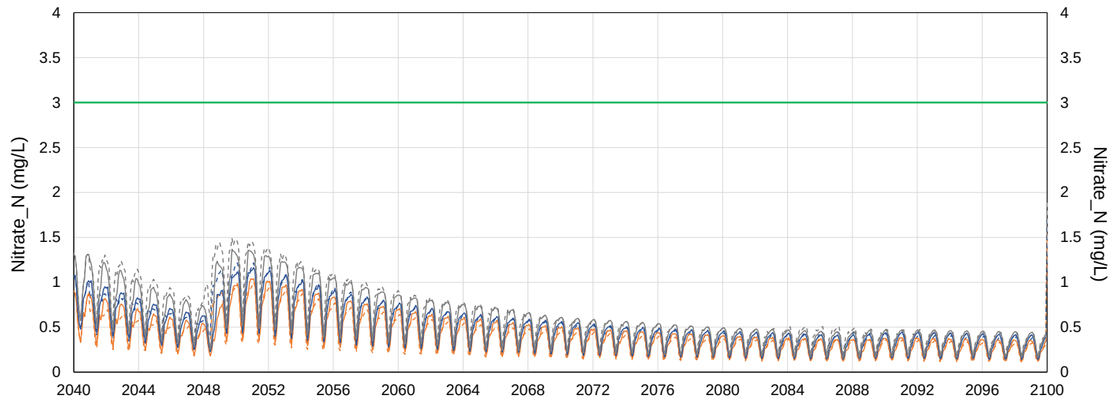
Note: Site Performance Objective is hardness dependent from 2019 onward and is calculated using the following formula: N (in mg-N/L) = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$.; it varies with time to reflect projected hardness concentrations in the month when maximum monthly nitrate concentrations are projected to occur.

(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)



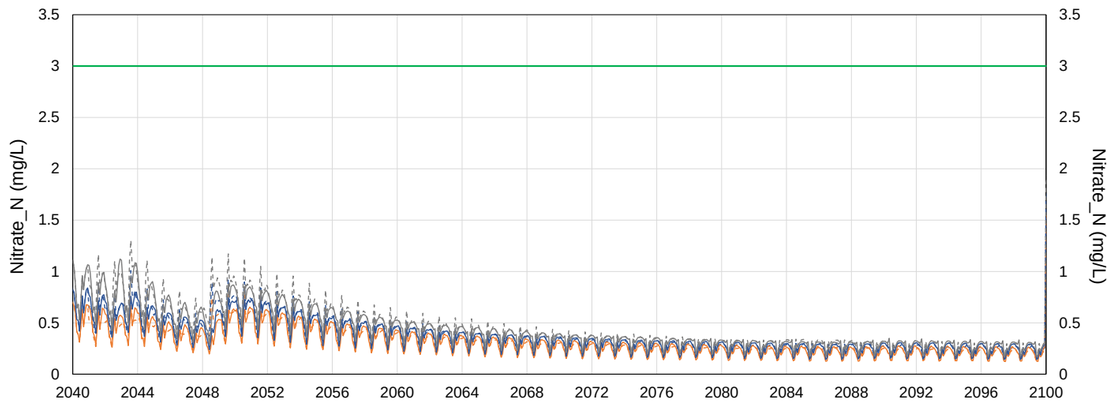
Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)



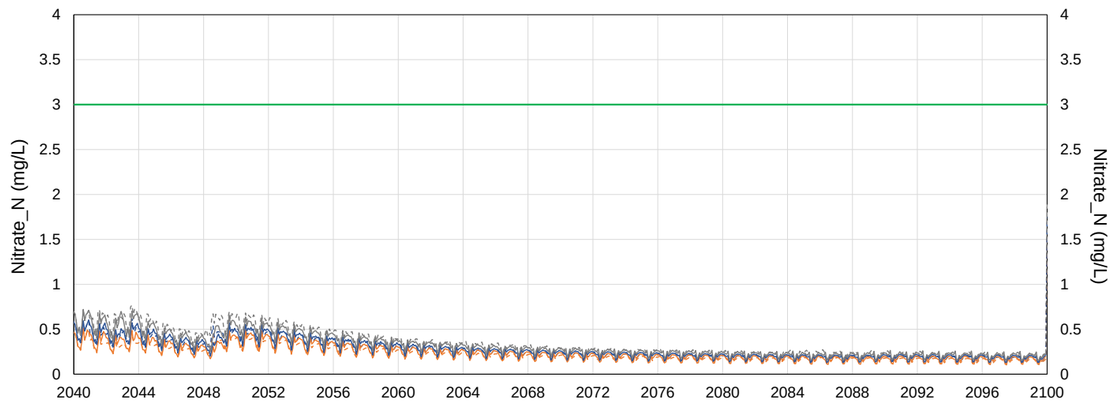
Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(g) Koocanusa Reservoir (RG_DSELK; E300230)

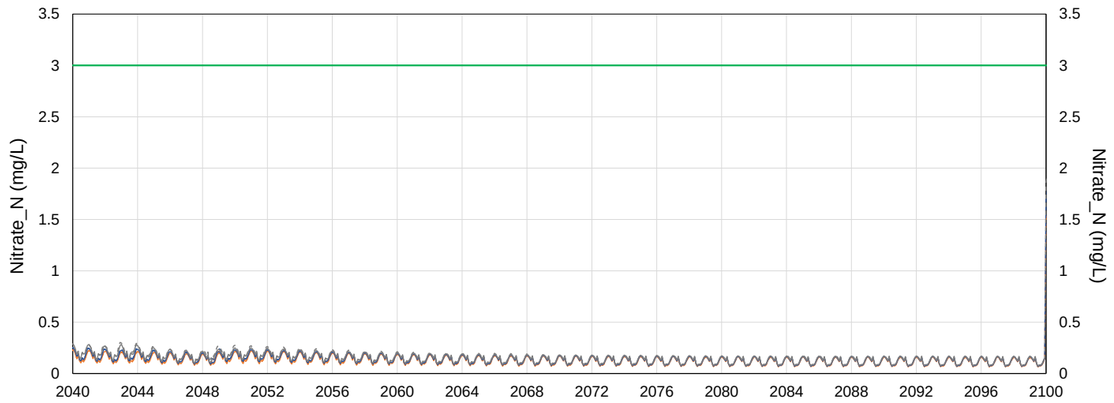
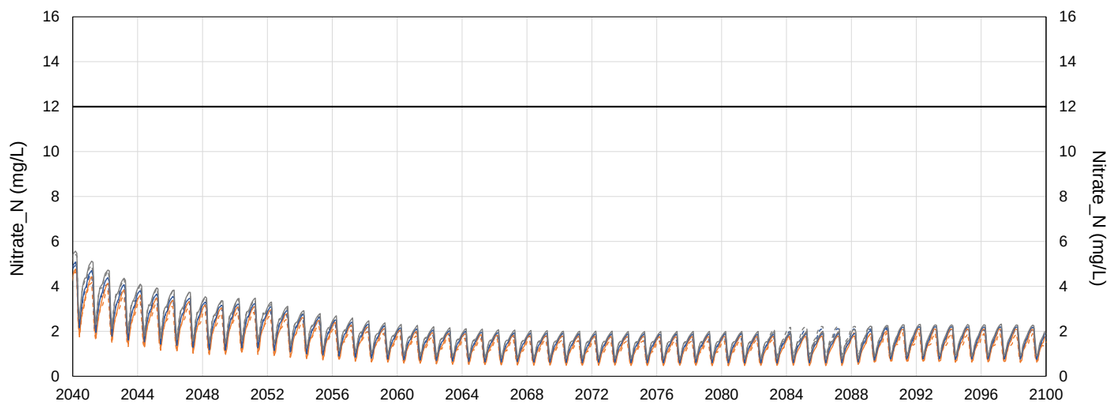
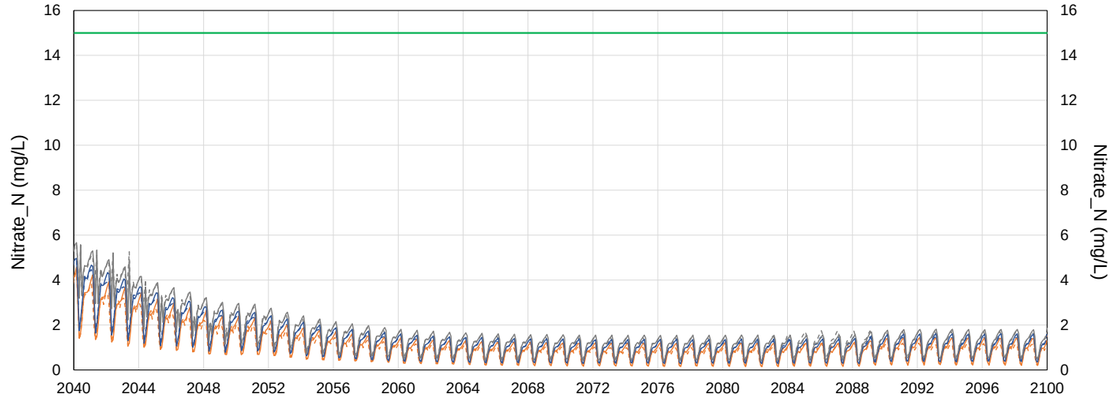


Figure F-4: Projected Monthly Average Concentrations of Nitrate at Compliance Points and in LCO Dry Creek with and without Climate Change (RCP 8.5)

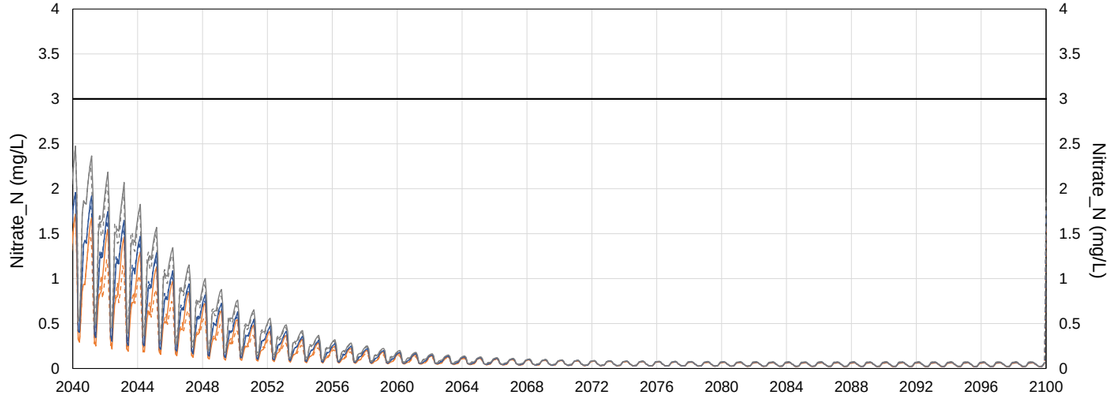
(a) FRO Compliance Point (FR_FRABCH; E223753)



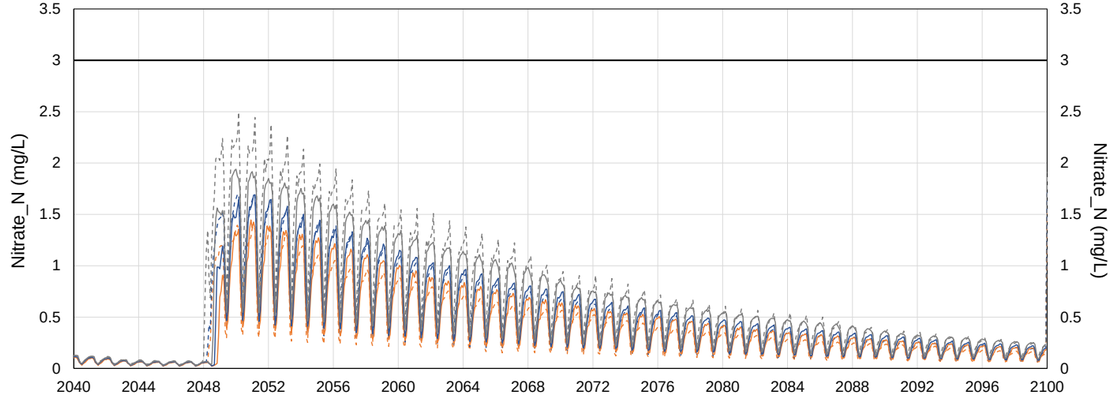
(b) Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)



(c) LCO Compliance Point (LC_LCDSSLCC; E297110)

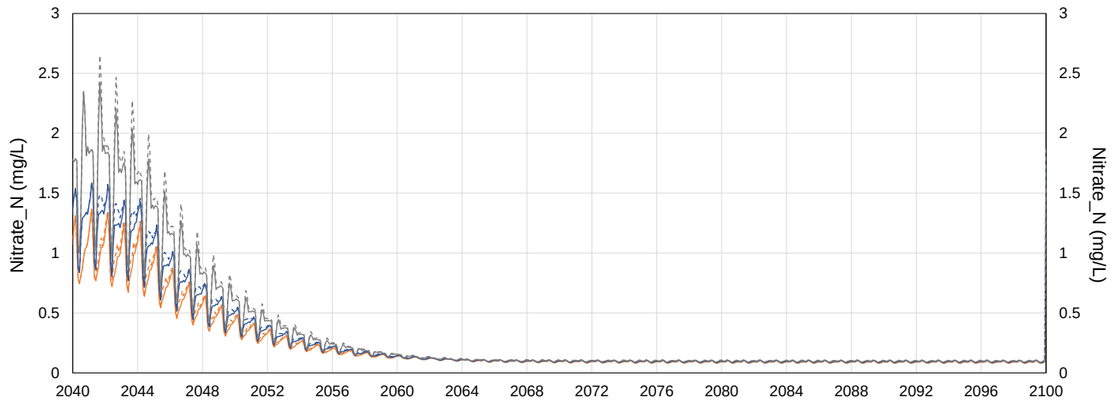


(d) GHO Elk River Compliance Point (GH_ERC; E300090)

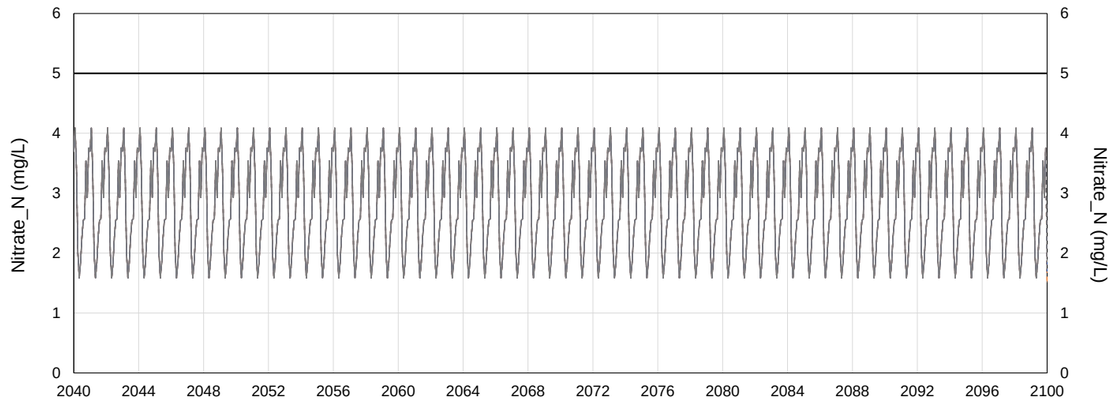


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) EVO Harmer Compliance Point (EV_HC1; E102682)



(f) CMO Compliance Point (CM_MC2; E258937)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

(g) EVO Michel Creek Compliance Point (EV_MC2; E300091)

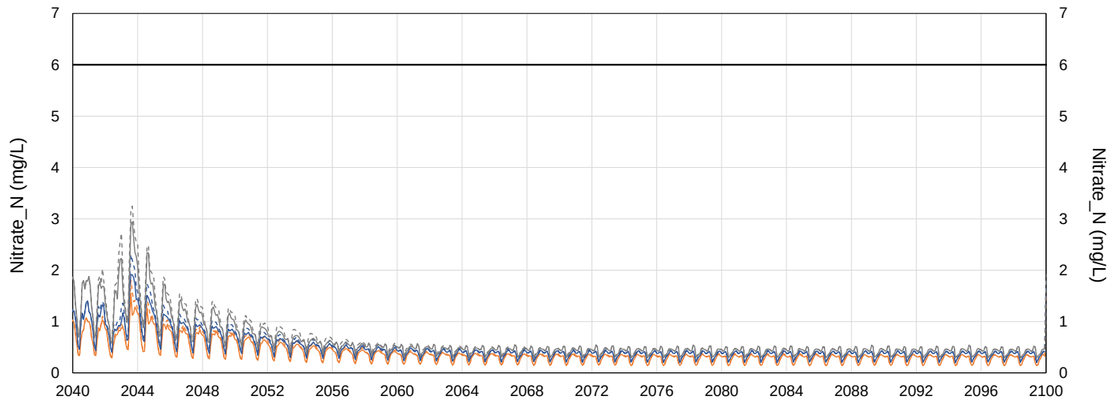
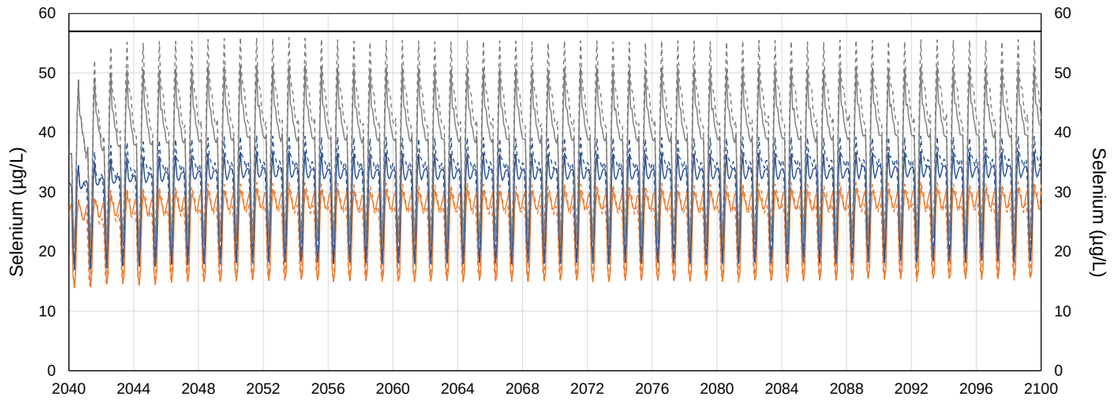
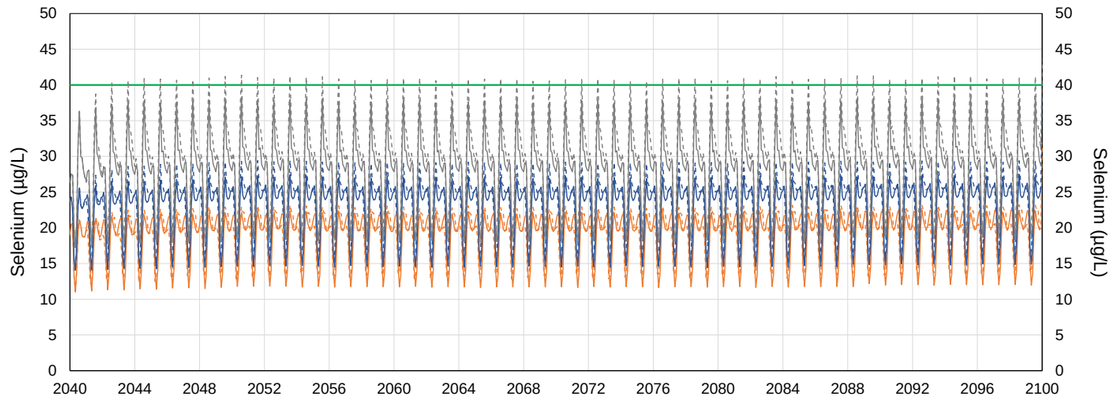


Figure F-5: Projected Monthly Average Concentrations of Selenium at Order Stations with and without Climate Change (RCP 8.5)

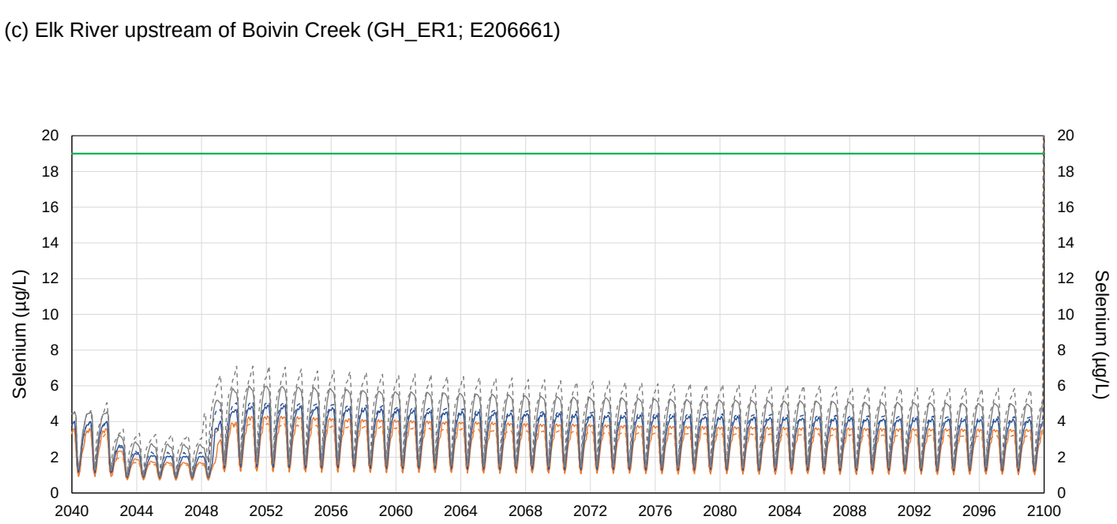
(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)



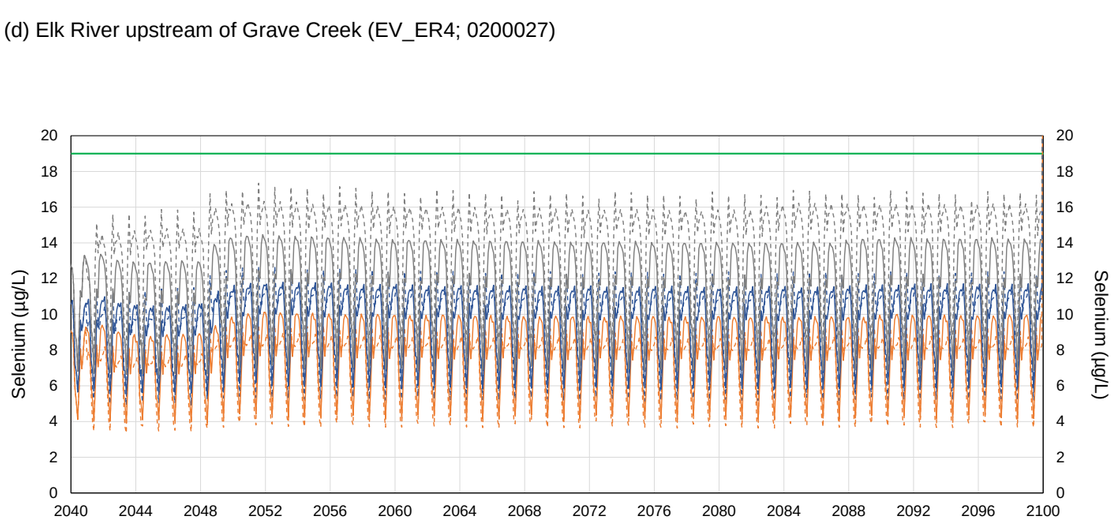
(b) Fording River downstream of Line Creek (LC_LC5; 0200028)



(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)

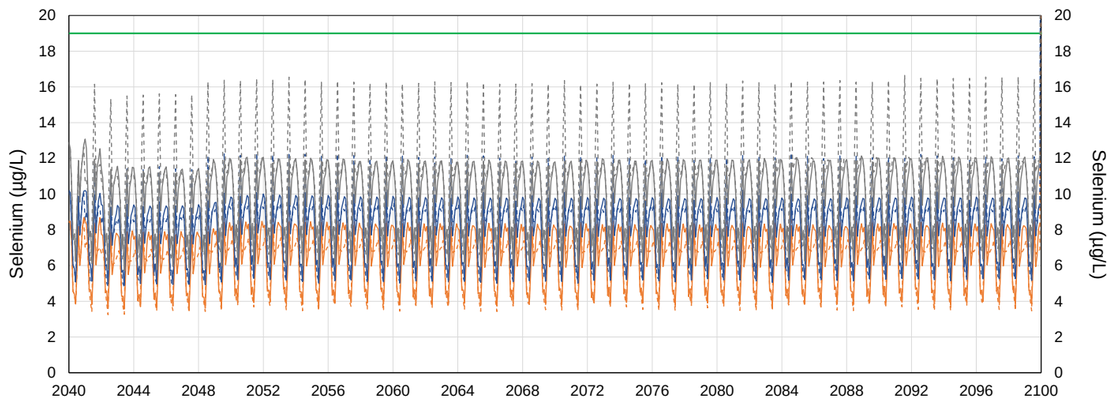


(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)

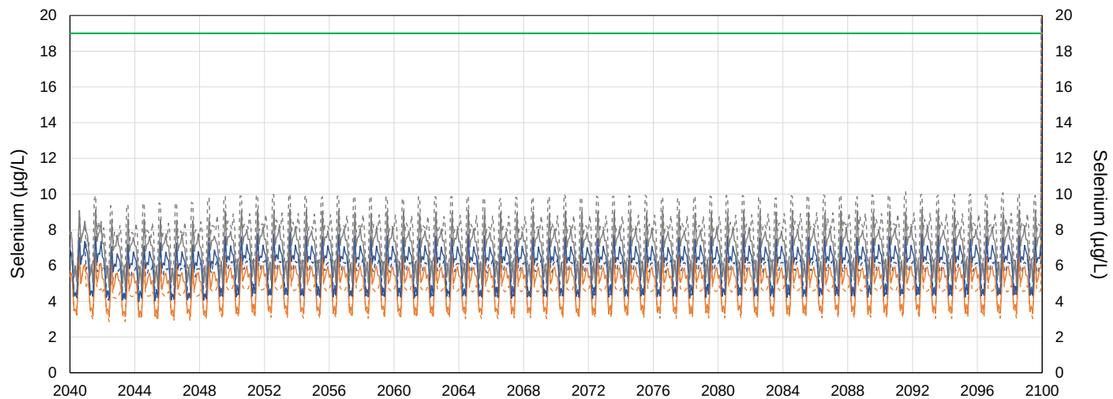


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



(g) Koocanusa Reservoir (RG_DSELK; E300230)

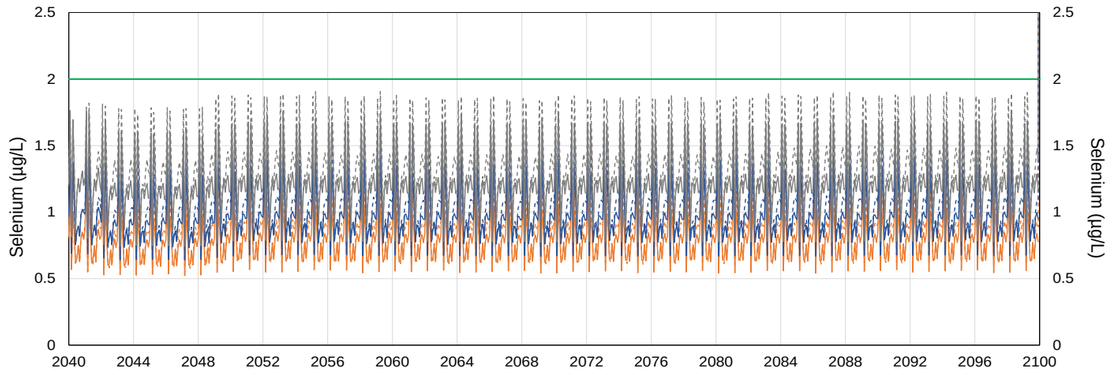
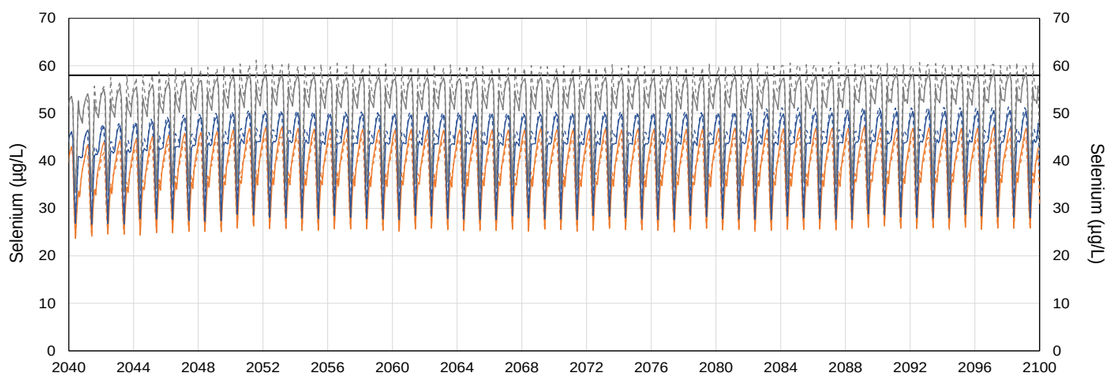
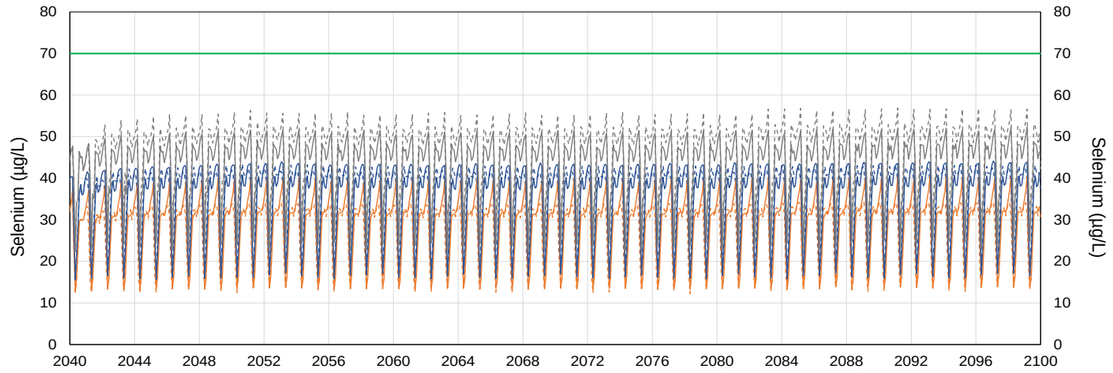


Figure F-6: Projected Monthly Average Concentrations of Selenium at Compliance Points and in LCO Dry Creek with and without Climate Change (RCP 8.5)

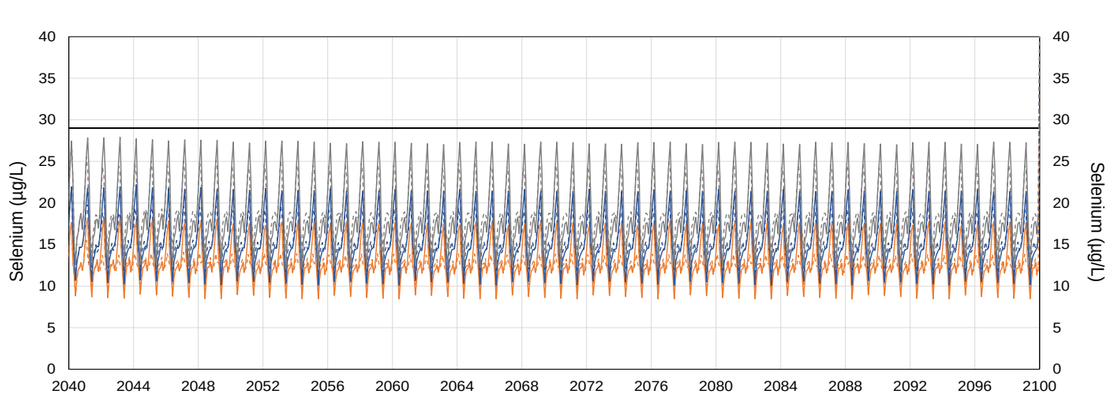
(a) FRO Compliance Point (FR_FRABCH; E223753)



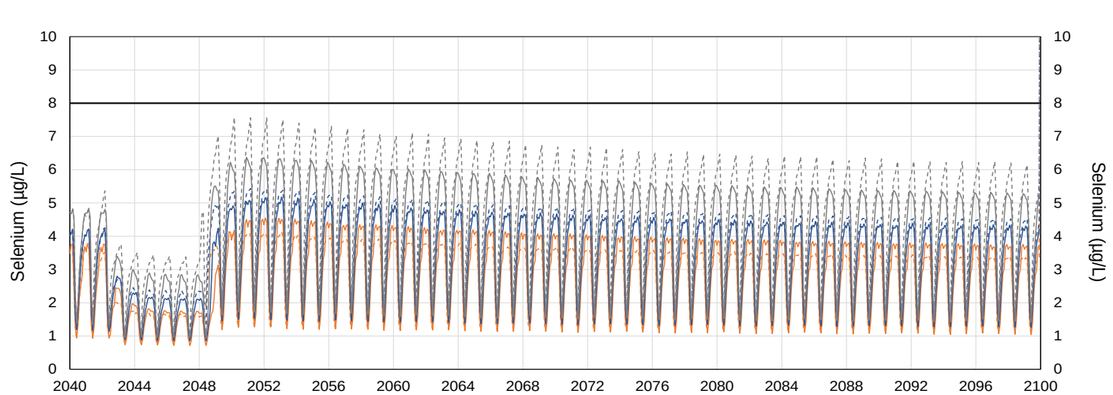
(b) Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)



(c) LCO Compliance Point (LC_LCDSSLCC; E297110)

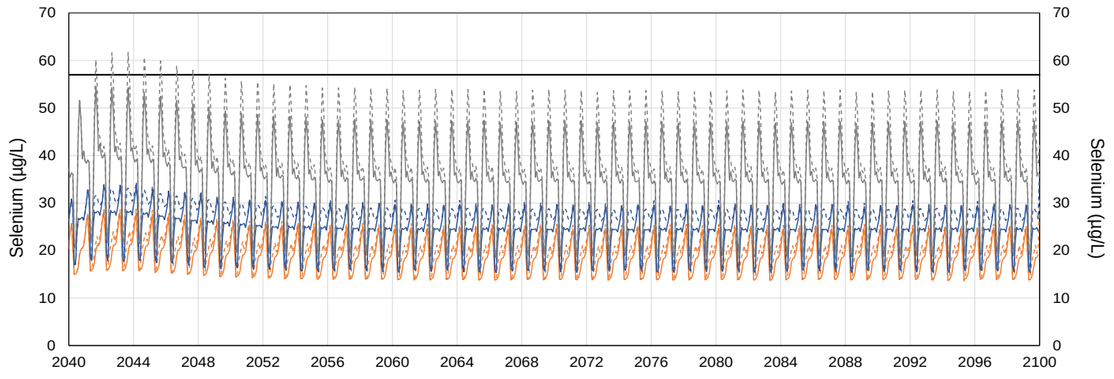


(d) GHO Elk River Compliance Point (GH_ERC; E300090)

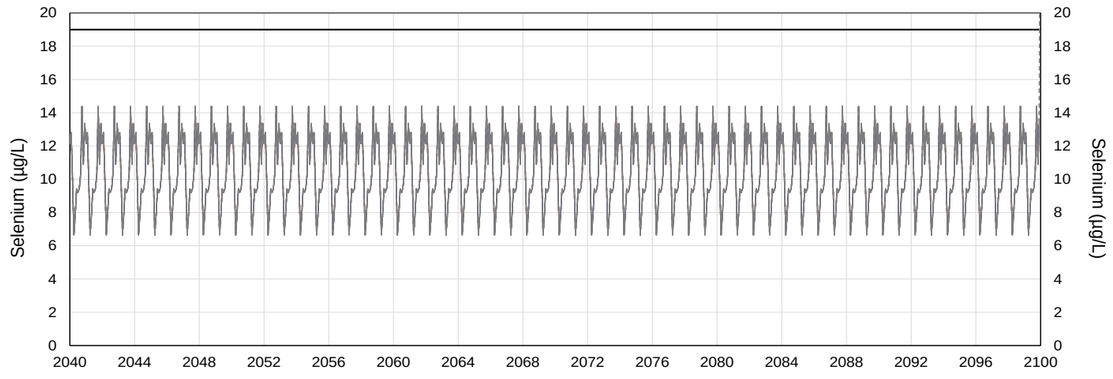


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) EVO Harmer Compliance Point (EV_HC1; E102682)



(f) CMO Compliance Point (CM_MC2; E258937)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

(g) EVO Michel Creek Compliance Point (EV_MC2; E300091)

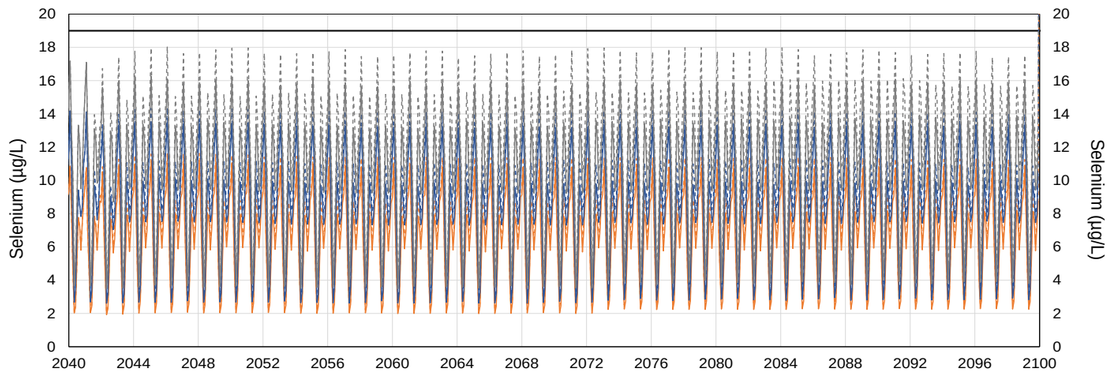
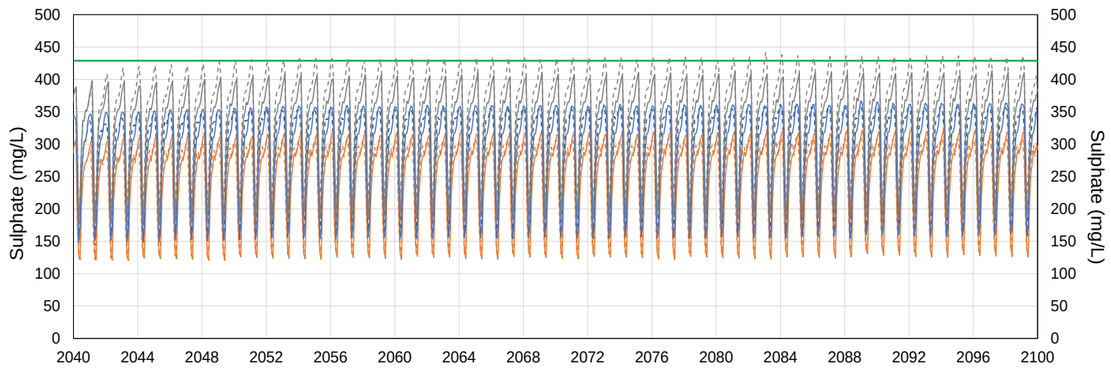
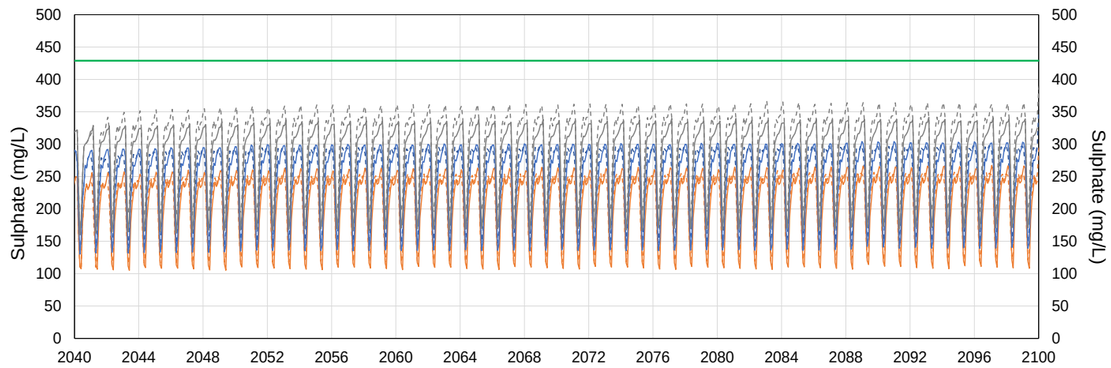


Figure F-7: Projected Monthly Average Concentrations of Sulphate at Order Stations with and without Climate Change (RCP 8.5)

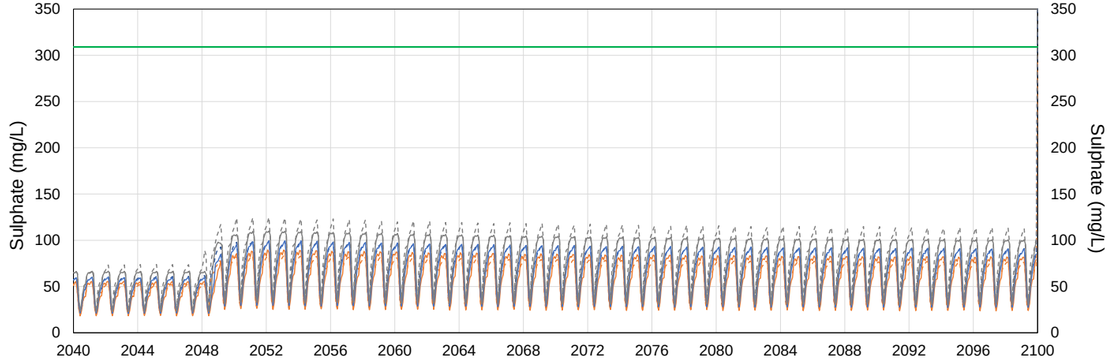
(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)



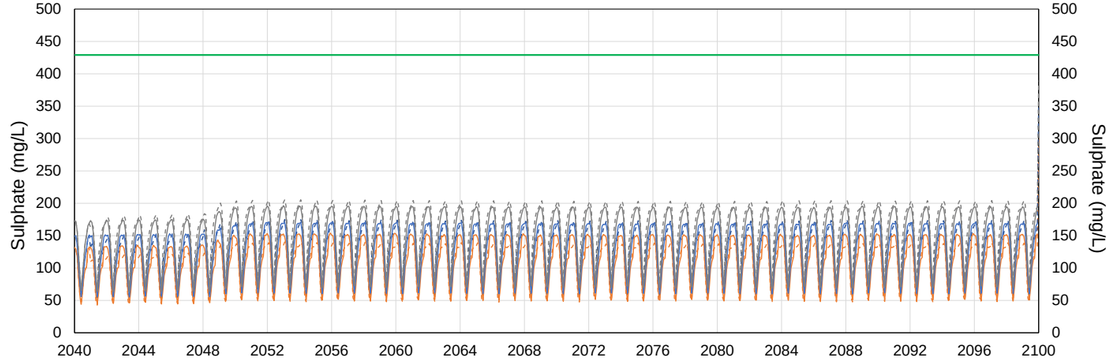
(b) Fording River downstream of Line Creek (LC_LC5; 0200028)



(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)

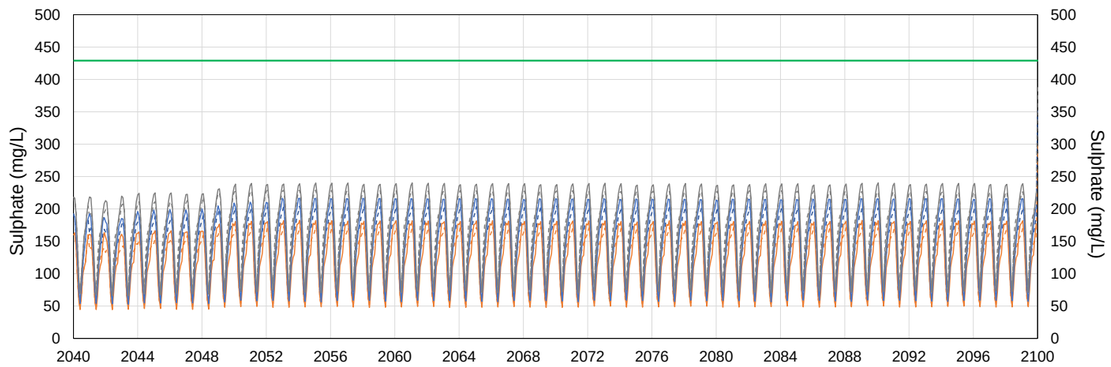


(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)

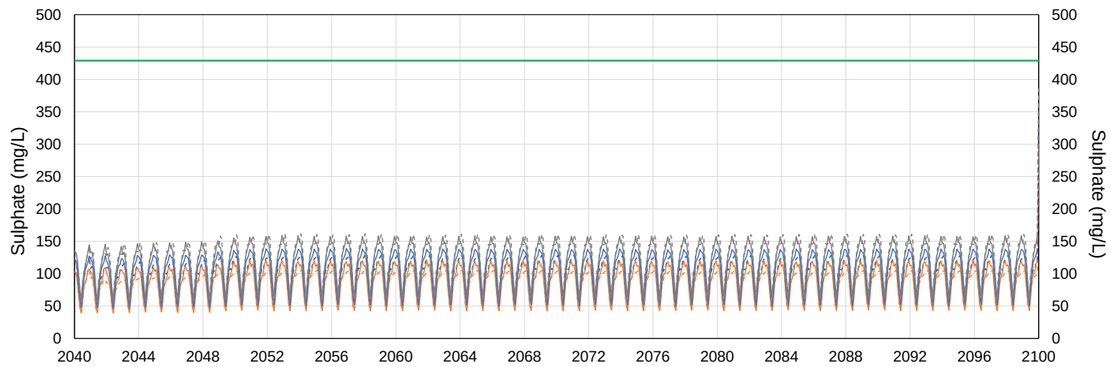


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

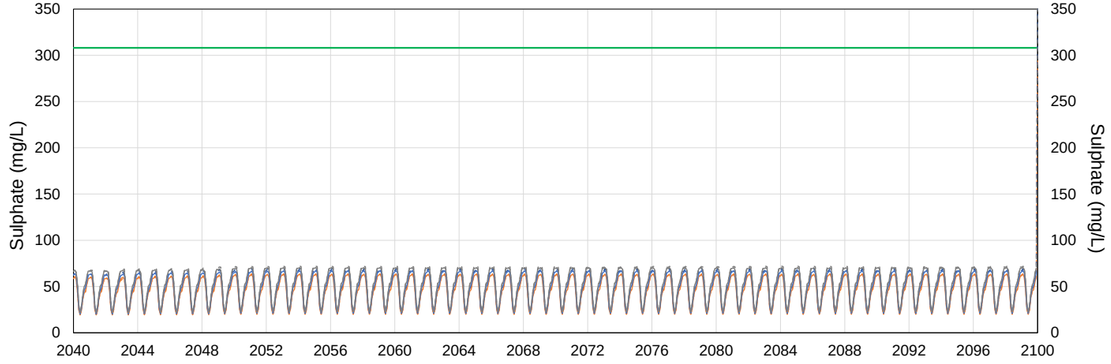
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



(g) Koocanusa Reservoir (RG_DSELK; E300230)



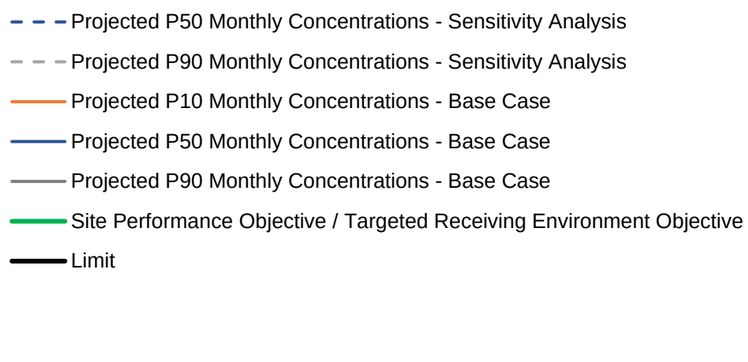
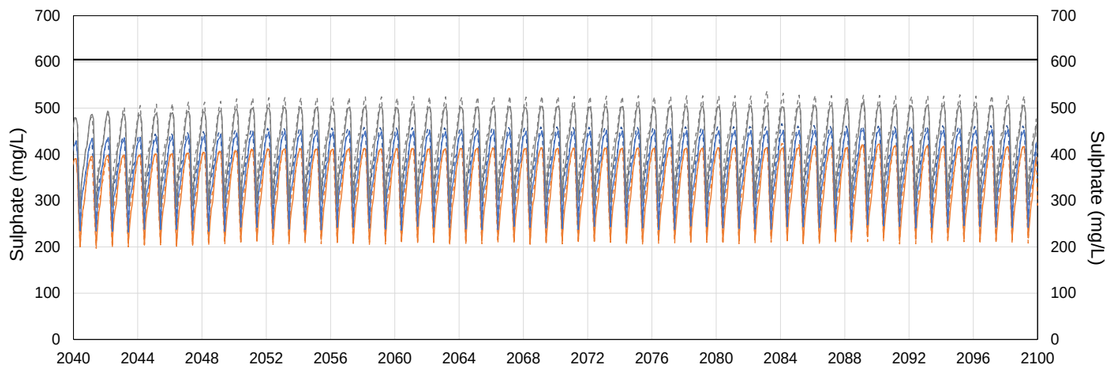
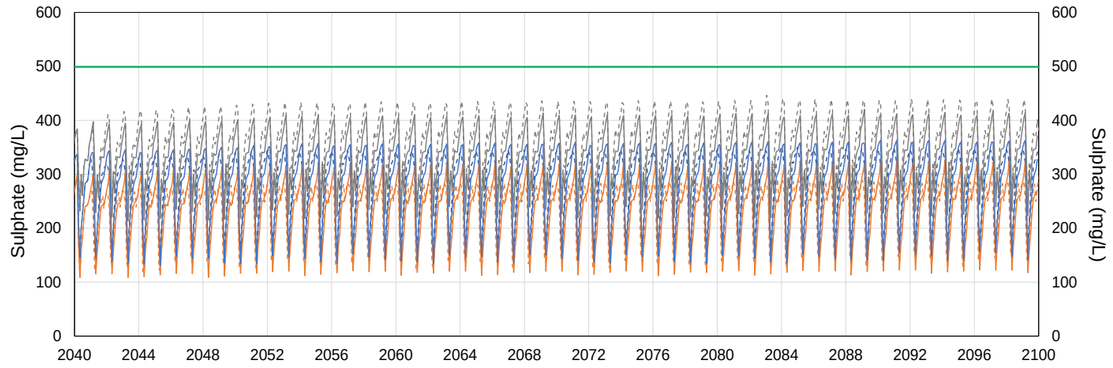


Figure F-8: Projected Monthly Average Concentrations of Sulphate at Compliance Points and in LCO Dry Creek with and without Climate Change (RCP 8.5)

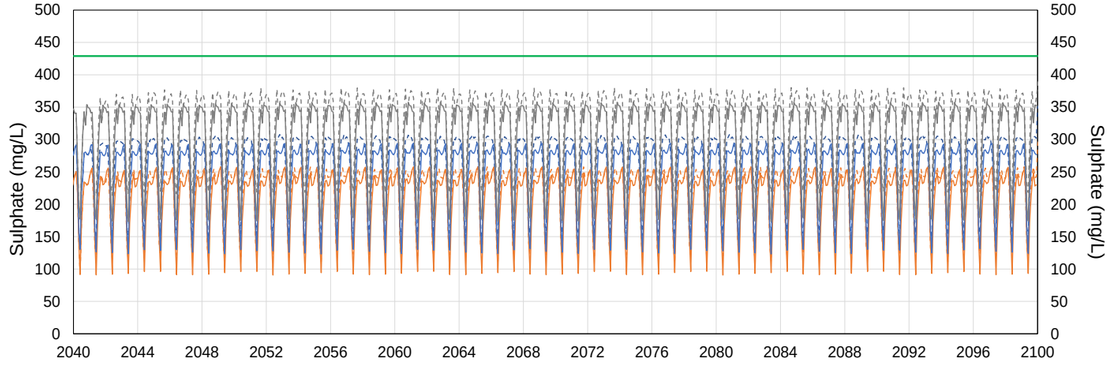
(a) FRO Compliance Point (FR_FRABCH; E223753)



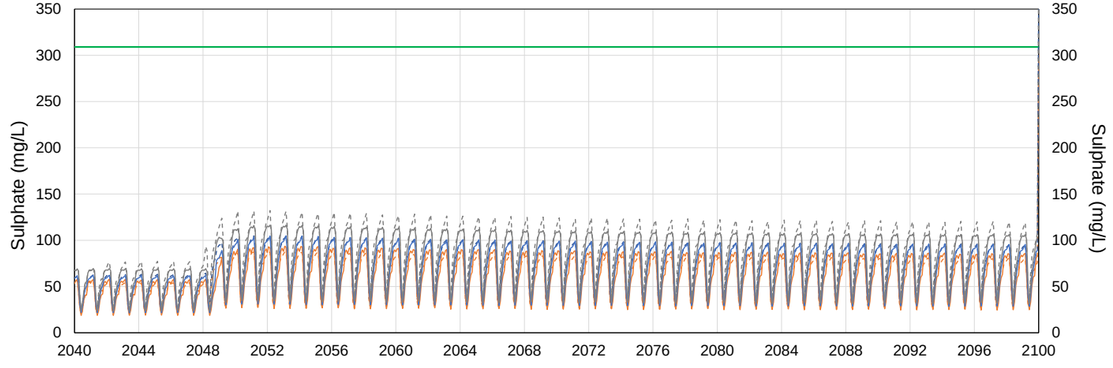
(b) Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)



(c) LCO Compliance Point (LC_LCDSSLCC; E297110)

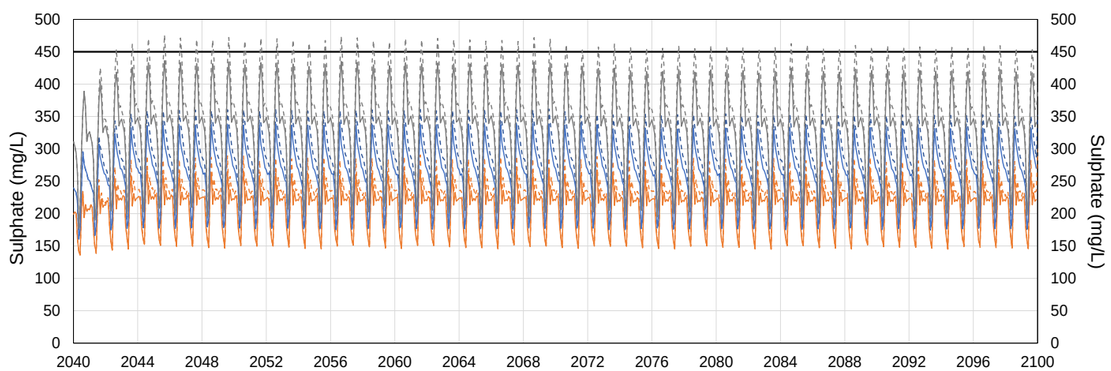


(d) GHO Elk River Compliance Point (GH_ERC; E300090)

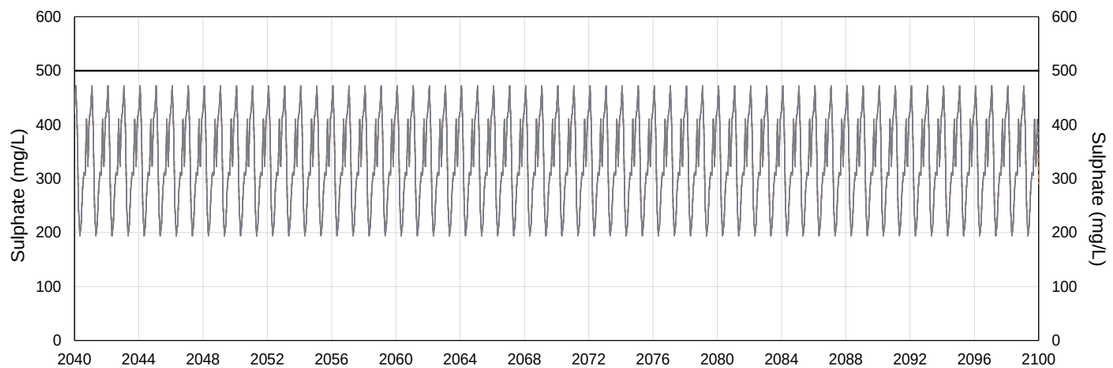


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) EVO Harmer Compliance Point (EV_HC1; E102682)



(f) CMO Compliance Point (CM_MC2; E258937)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

(g) EVO Michel Creek Compliance Point (EV_MC2; E300091)

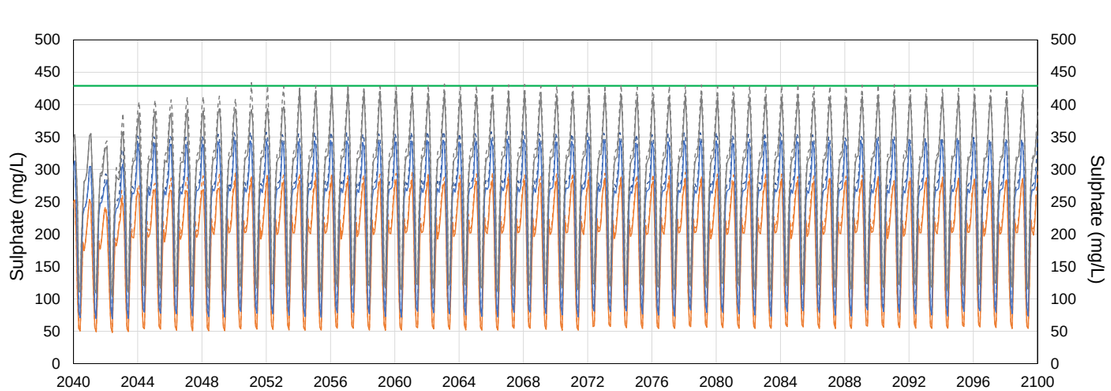
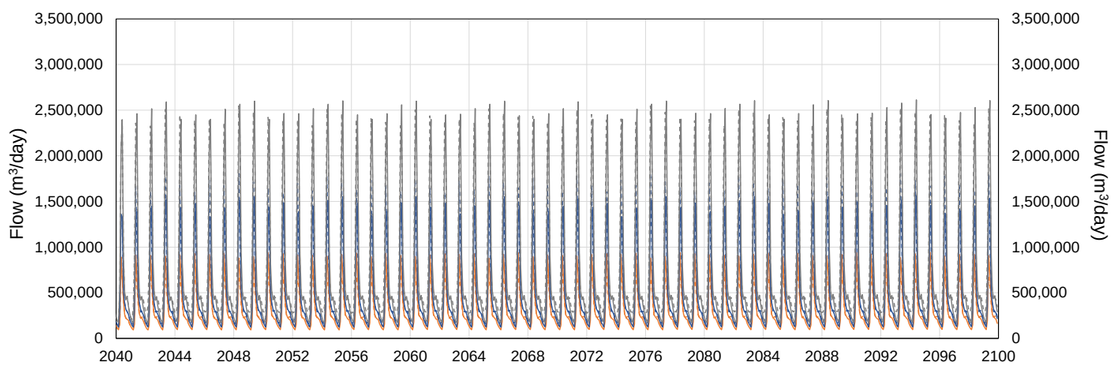
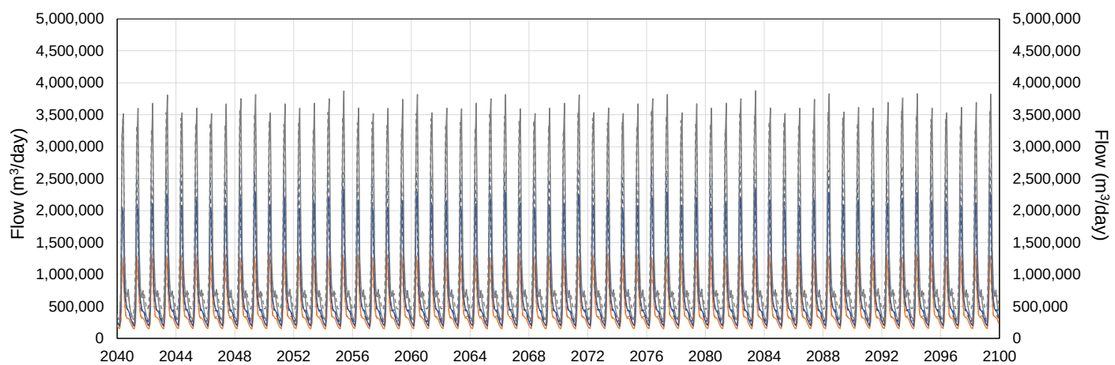


Figure F-9: Projected Monthly Average Flows at Order Stations with and without Climate Change (RCP 4.5)

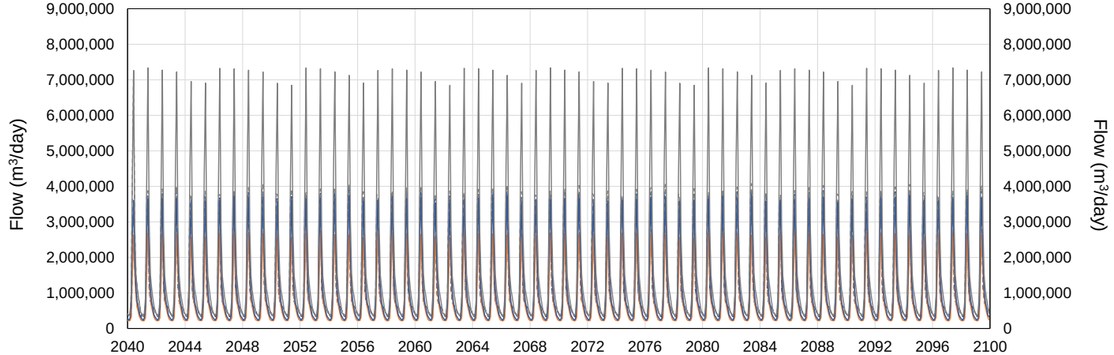
(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)



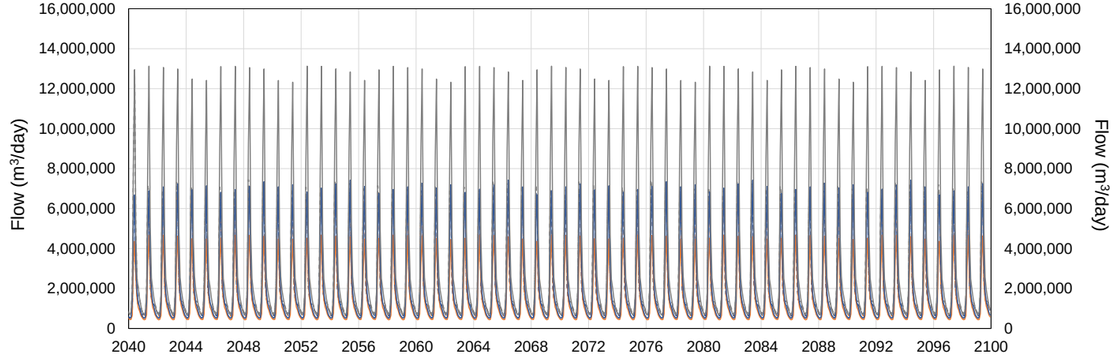
(b) Fording River downstream of Line Creek (LC_LC5; 0200028)



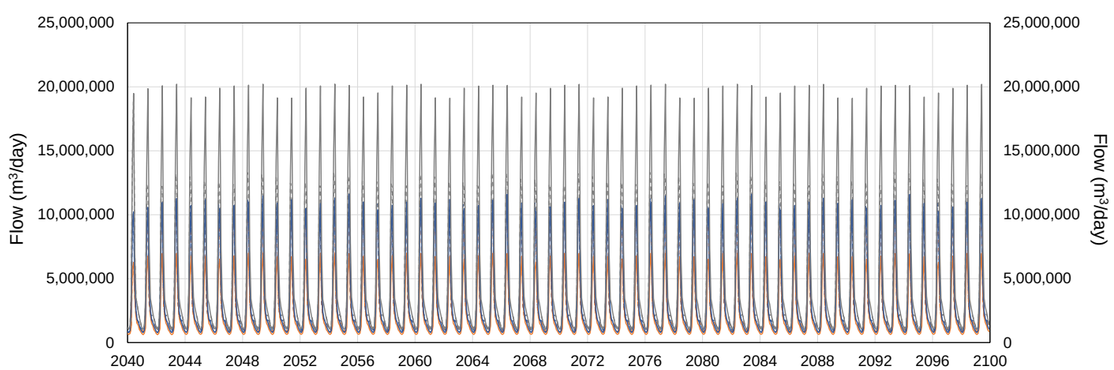
(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)



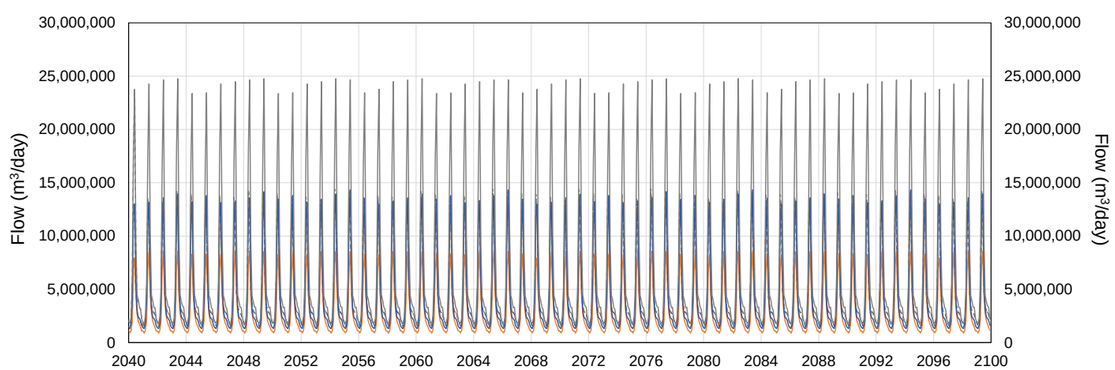
(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)



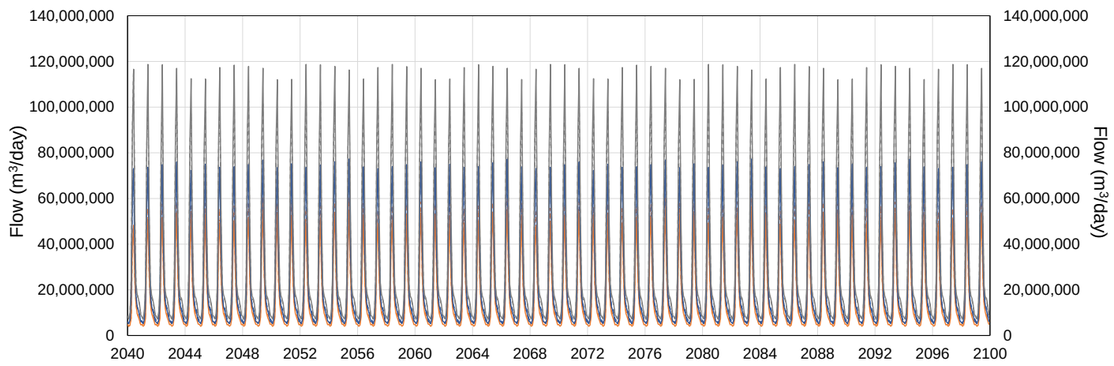
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



(g) Koocanusa Reservoir (RG_DSELK; E300230)



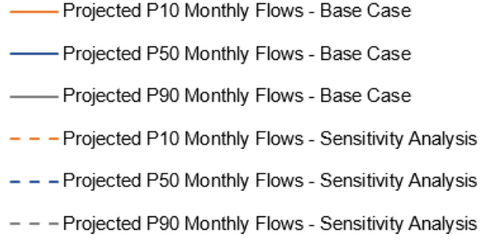
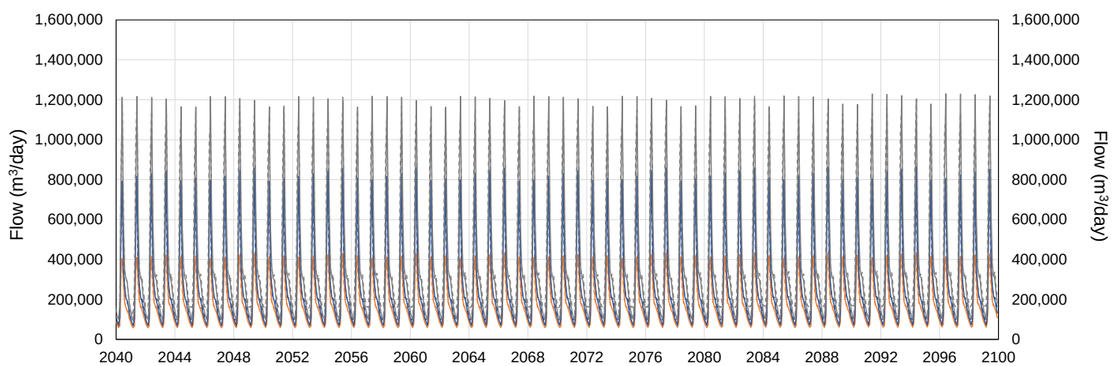
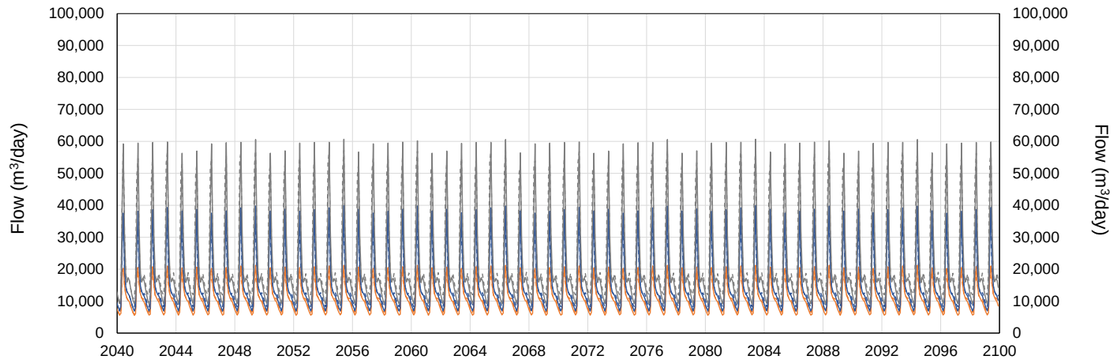


Figure F-10: Projected Monthly Average Flows at Compliance Points and in LCO Dry Creek with and without Climate Change (RCP 4.5)

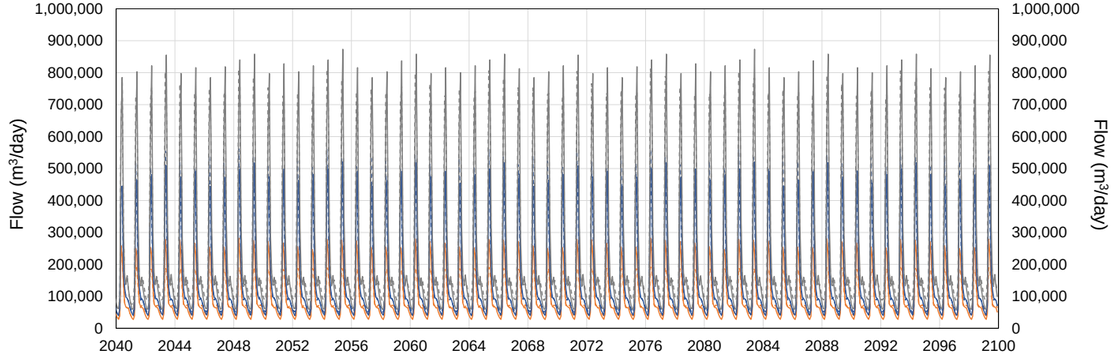
(a) FRO Compliance Point (FR_FRABCH; E223753)



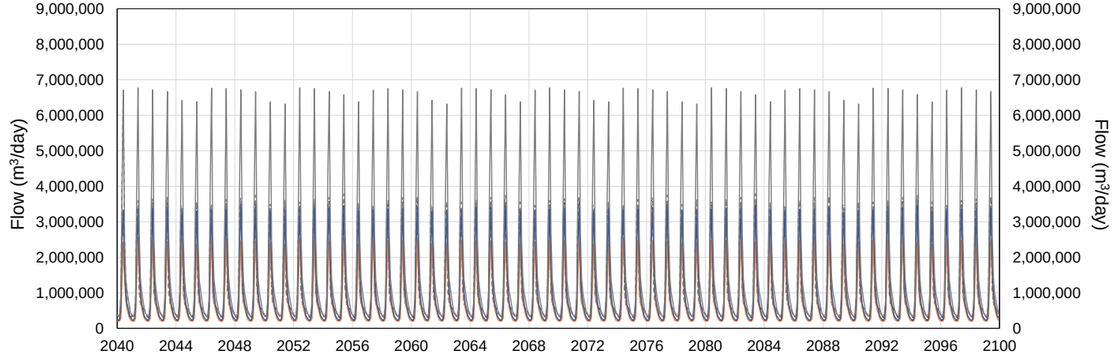
(b) Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)



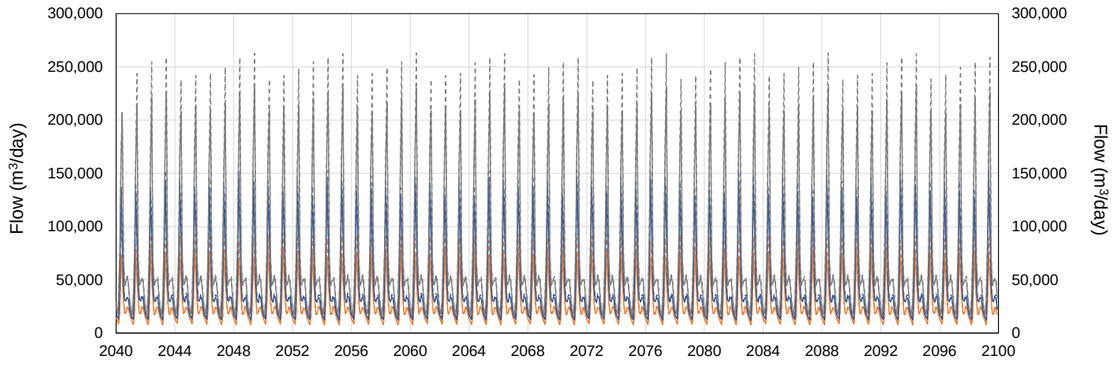
(c) LCO Compliance Point (LC_LCDSSLCC; E297110)



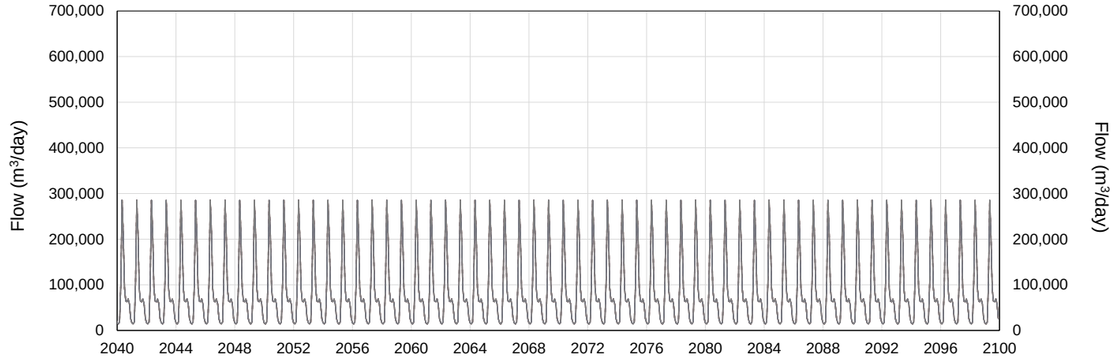
(d) GHO Elk River Compliance Point (GH_ERC; E300090)



(e) EVO Harmer Compliance Point (EV_HC1; E102682)



(f) CMO Compliance Point (CM_MC2; E258937)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

(g) EVO Michel Creek Compliance Point (EV_MC2; E300091)

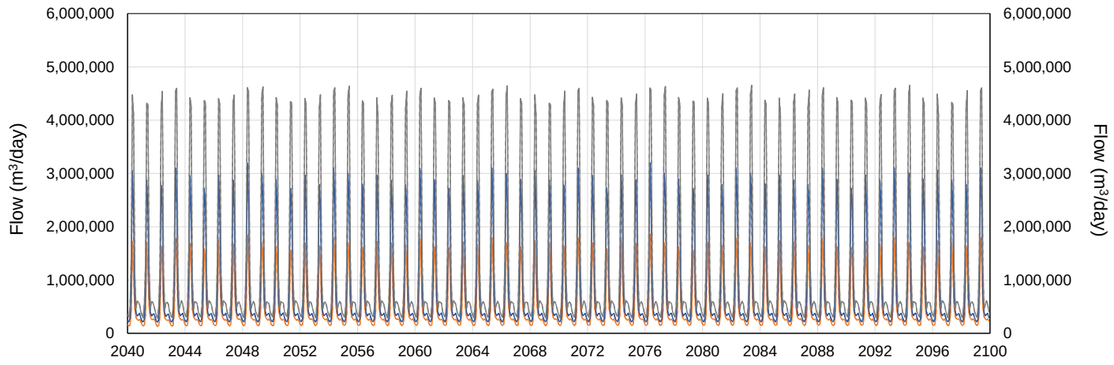
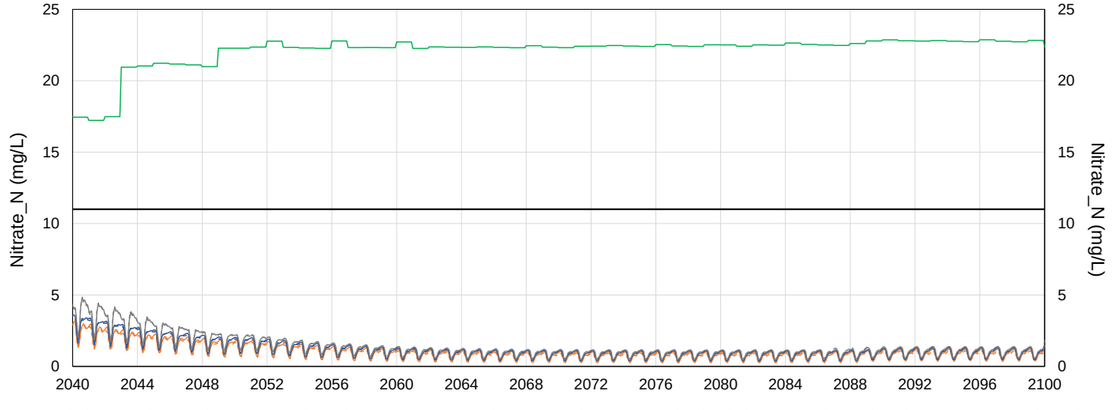


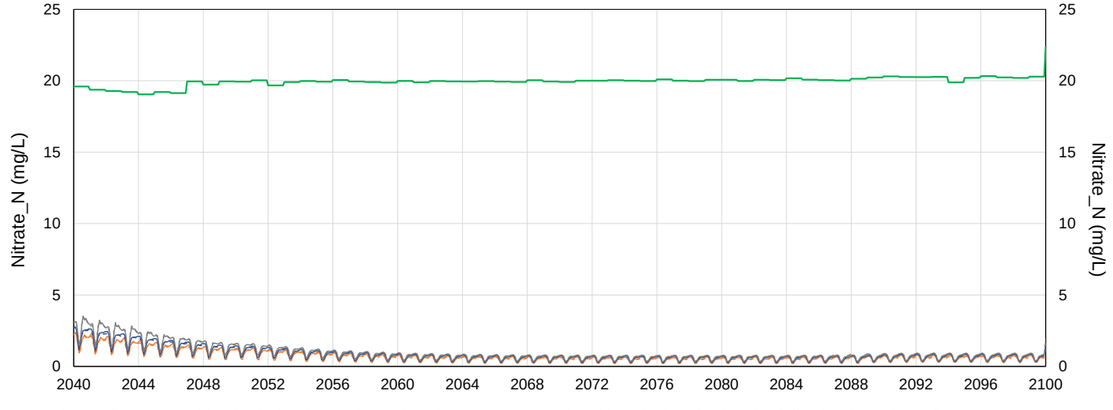
Figure F-11: Projected Monthly Average Concentrations of Nitrate at Order Stations with and without Climate Change (RCP 4.5)

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)



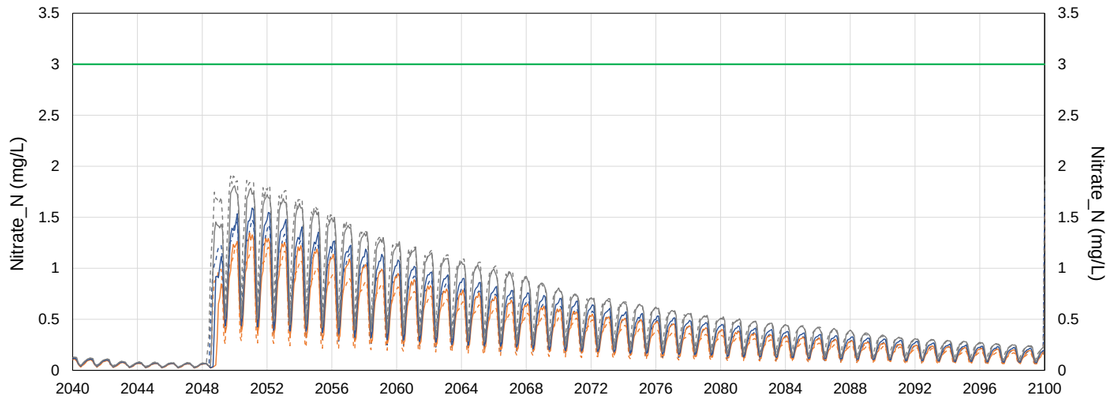
Note: This location is also the GHO Fording River Compliance Point. Site Performance Objective is hardness dependent from 2023 onward and is calculated using the following formula: N (in mg-N/L) = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$.; it varies with time to reflect projected hardness concentrations in the month when maximum monthly nitrate concentrations are projected to occur.

(b) Fording River downstream of Line Creek (LC_LC5; 0200028)



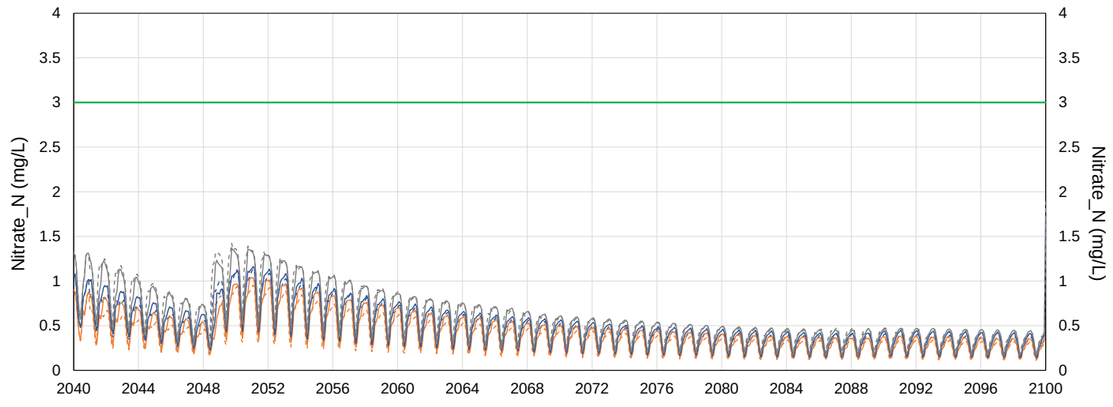
Note: Site Performance Objective is hardness dependent from 2019 onward and is calculated using the following formula: N (in mg-N/L) = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$.; it varies with time to reflect projected hardness concentrations in the month when maximum monthly nitrate concentrations are projected to occur.

(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)



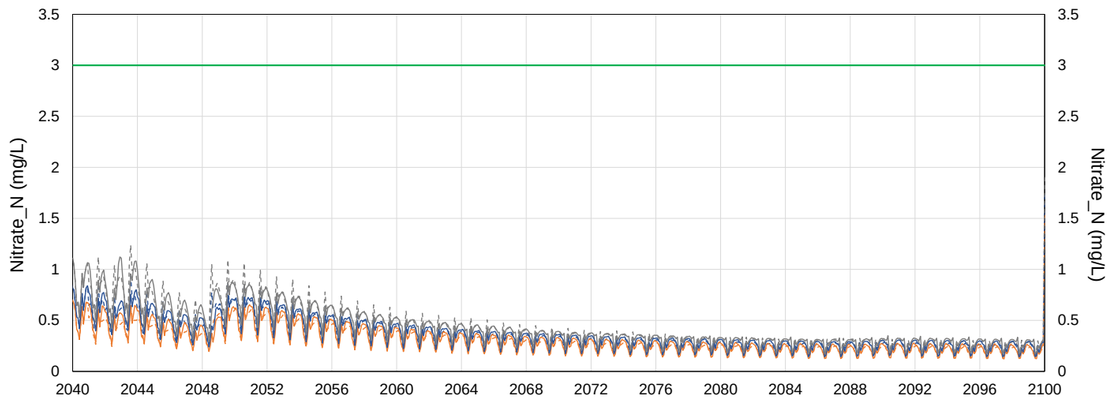
Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)



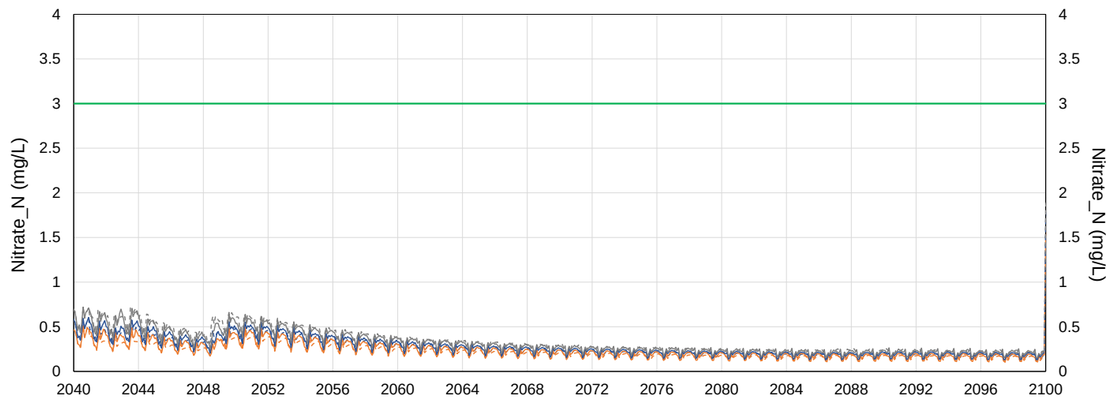
Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



(g) Koocanusa Reservoir (RG_DSELK; E300230)

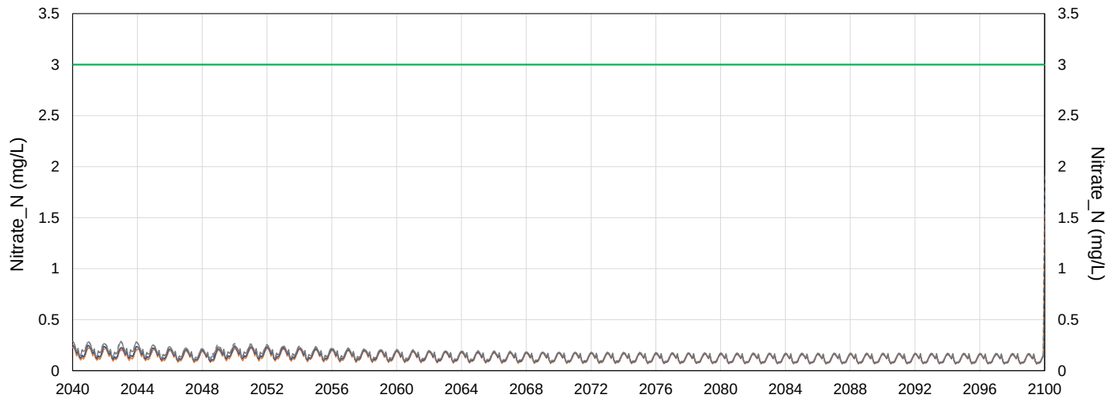
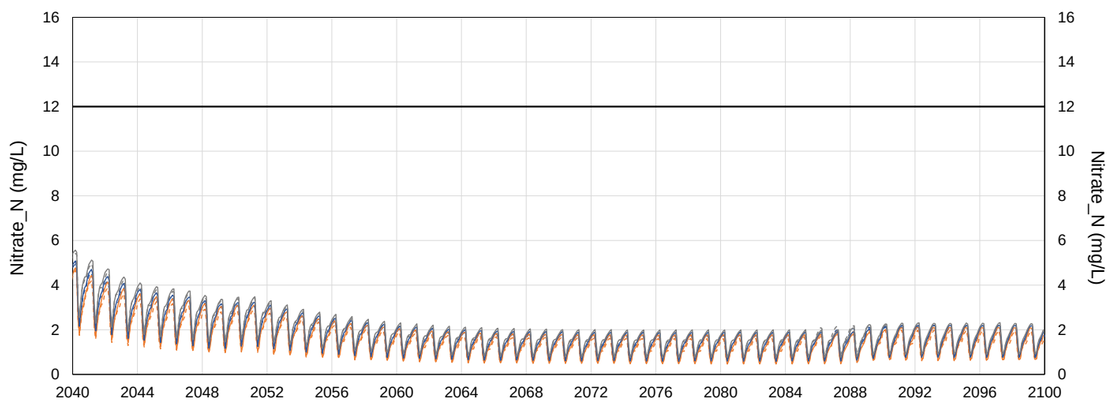
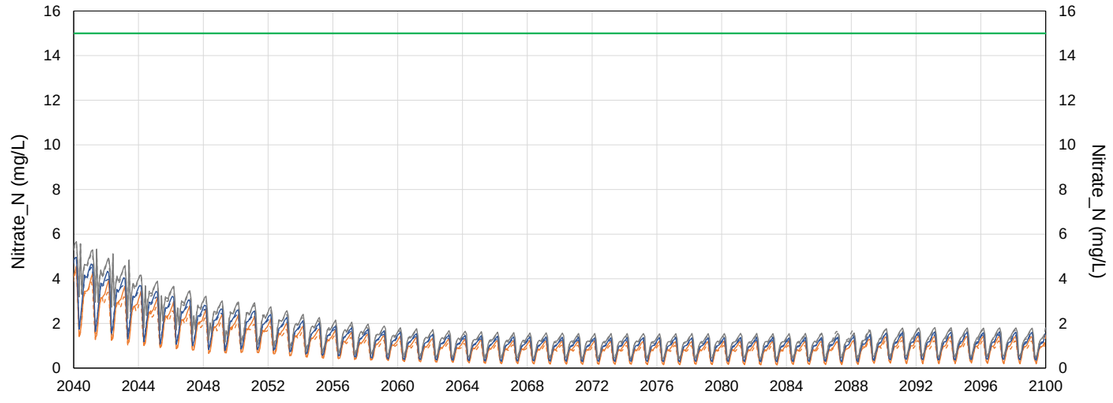


Figure F-12: Projected Monthly Average Concentrations of Nitrate at Compliance Points and in LCO Dry Creek with and without Climate Change (RCP 4.5)

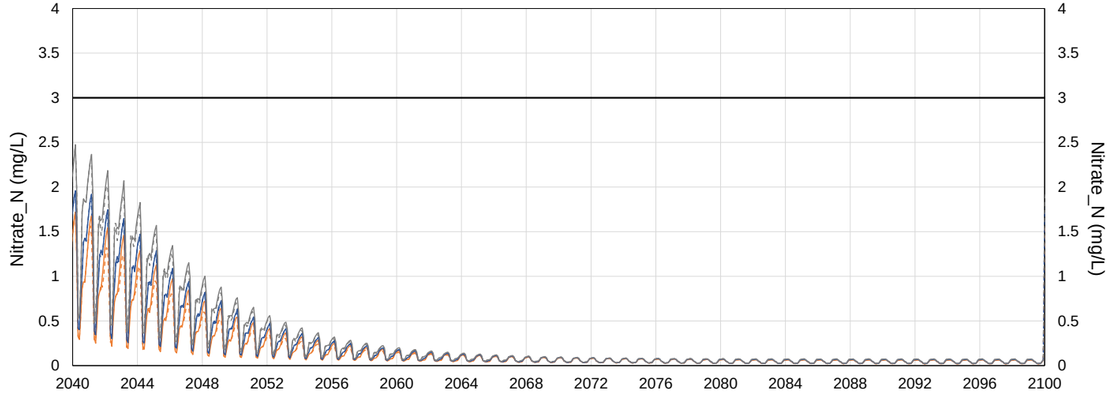
(a) FRO Compliance Point (FR_FRABCH; E223753)



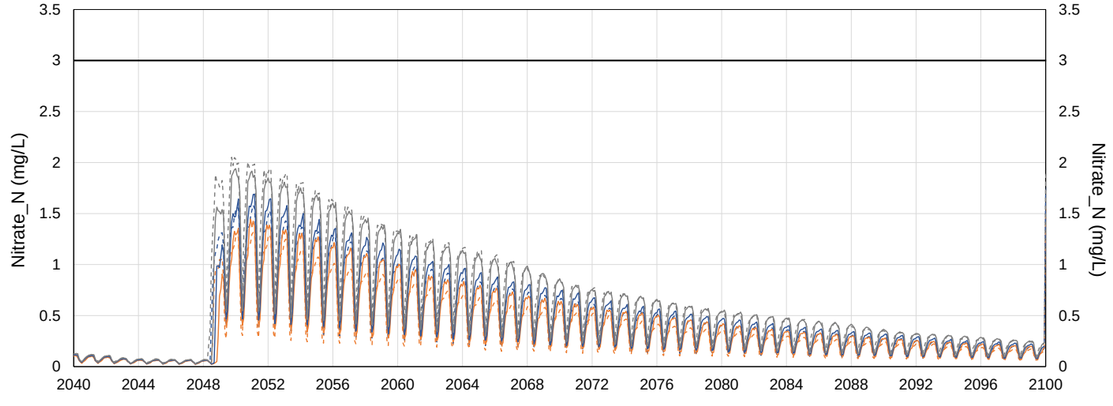
(b) Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)



(c) LCO Compliance Point (LC_LCDSSLCC; E297110)

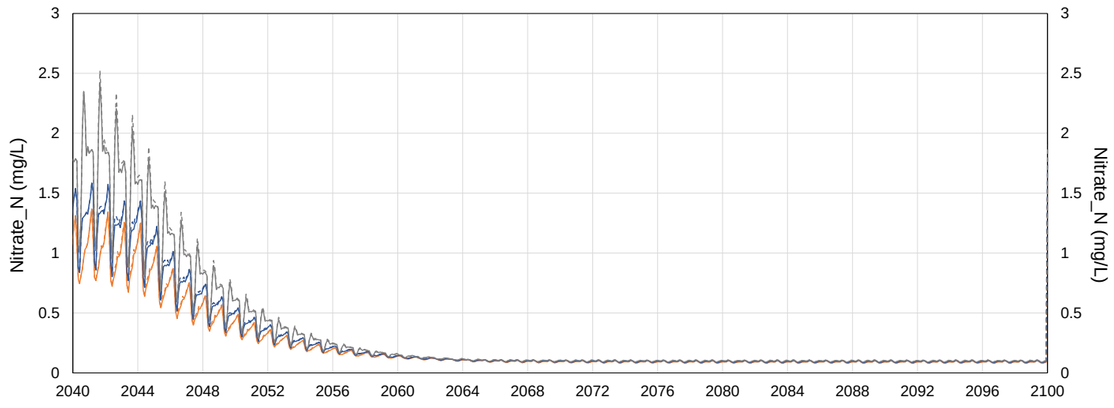


(d) GHO Elk River Compliance Point (GH_ERC; E300090)

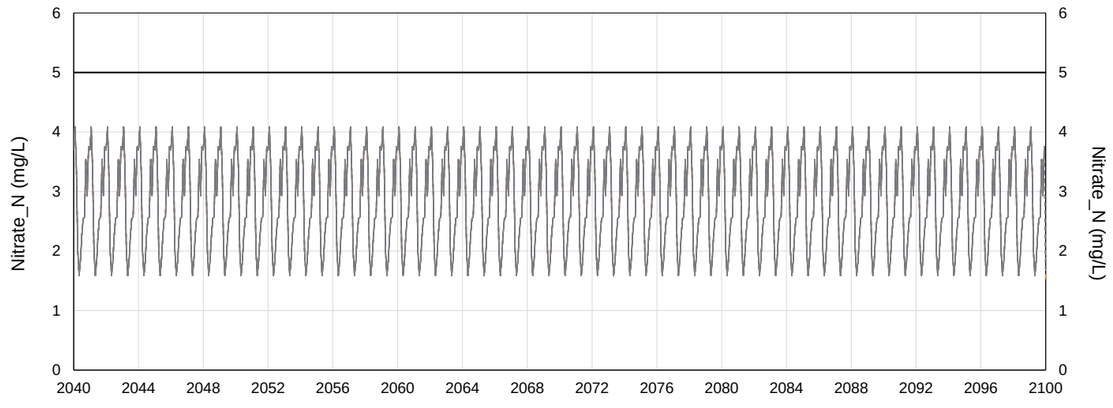


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) EVO Harmer Compliance Point (EV_HC1; E102682)



(f) CMO Compliance Point (CM_MC2; E258937)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

(g) EVO Michel Creek Compliance Point (EV_MC2; E300091)

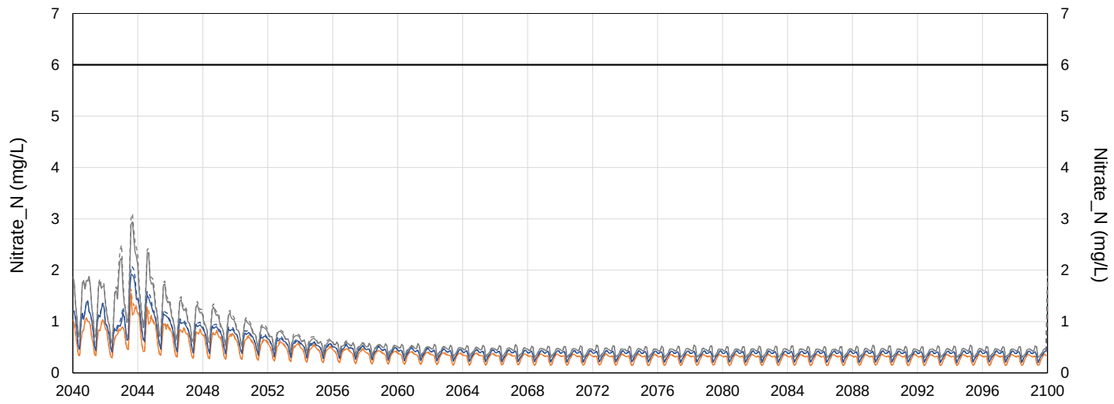
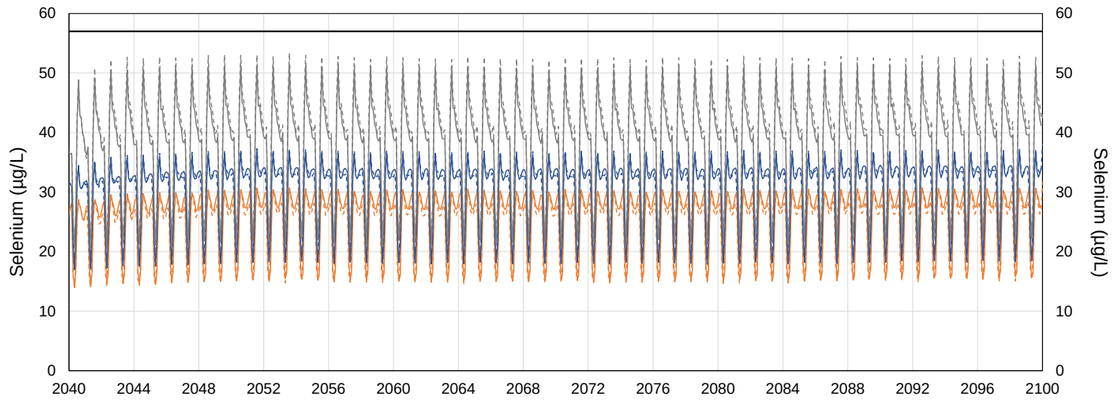
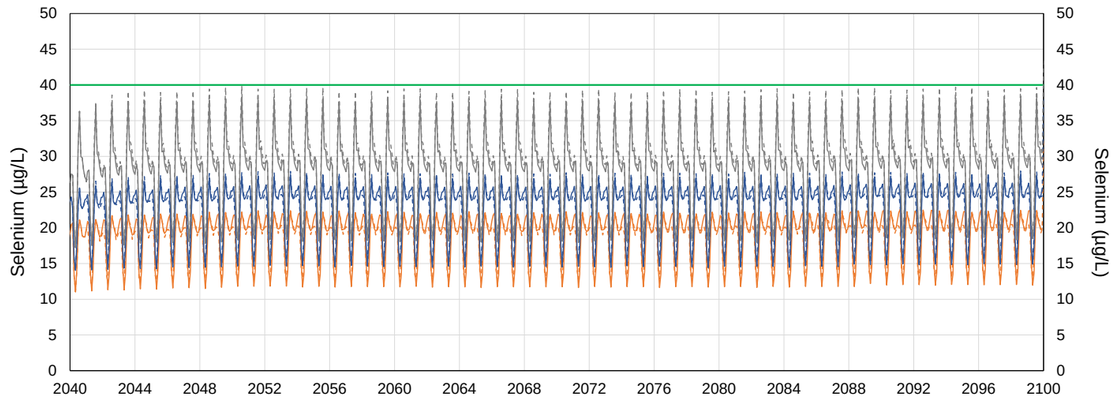


Figure F-13: Projected Monthly Average Concentrations of Selenium at Order Stations with and without Climate Change (RCP 4.5)

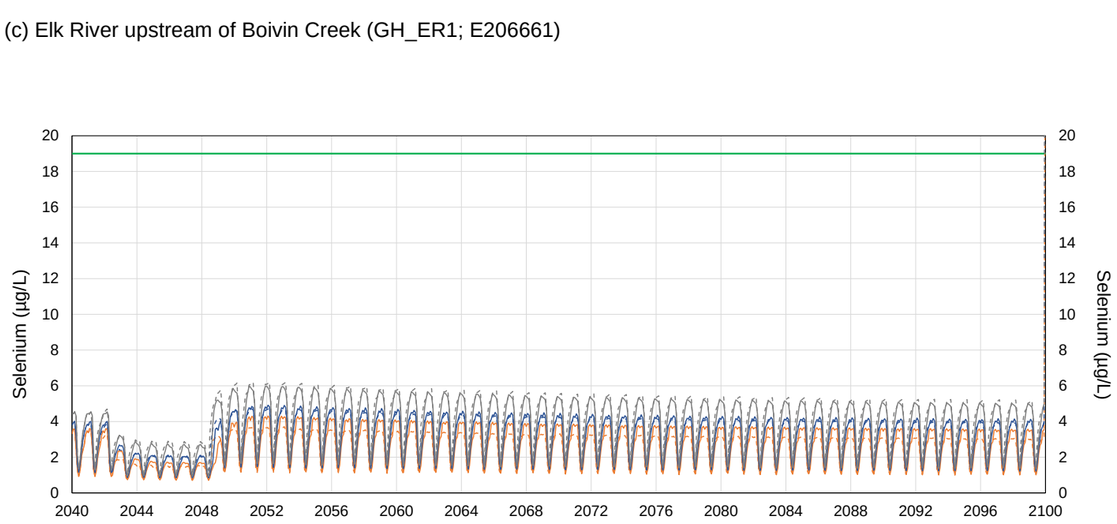
(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)



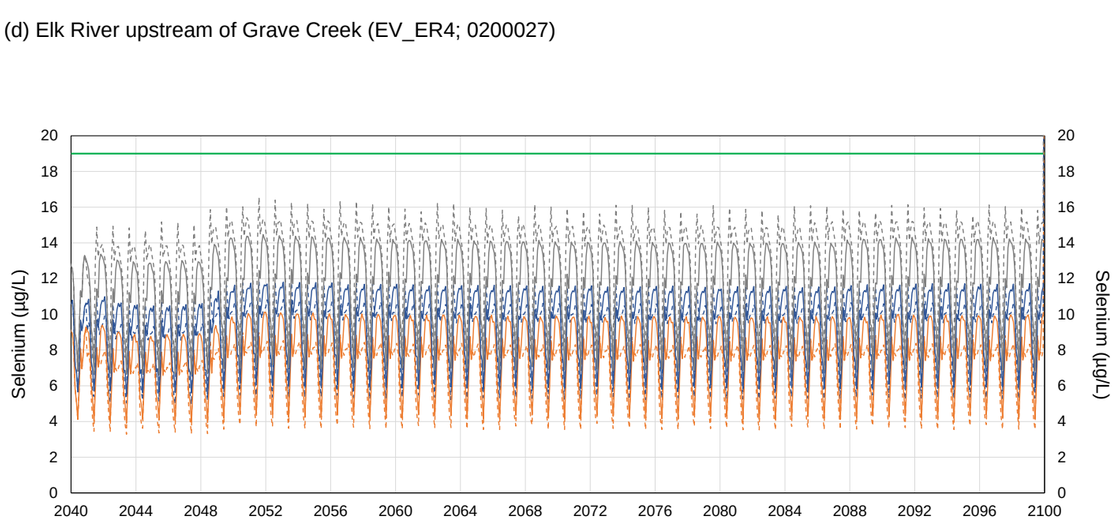
(b) Fording River downstream of Line Creek (LC_LC5; 0200028)



(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)

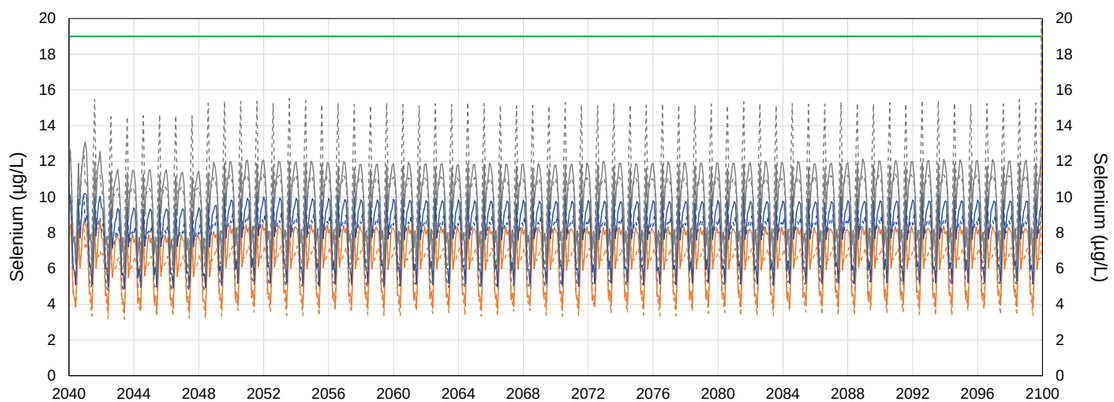


(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)

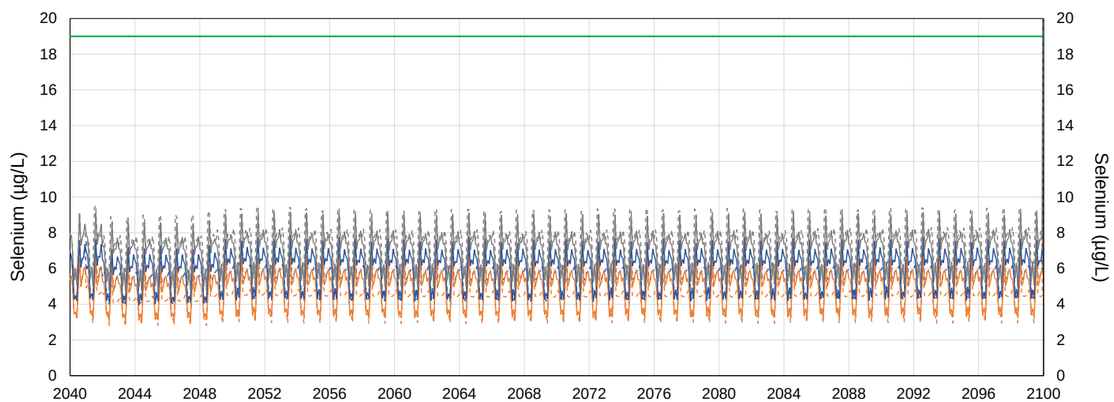


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

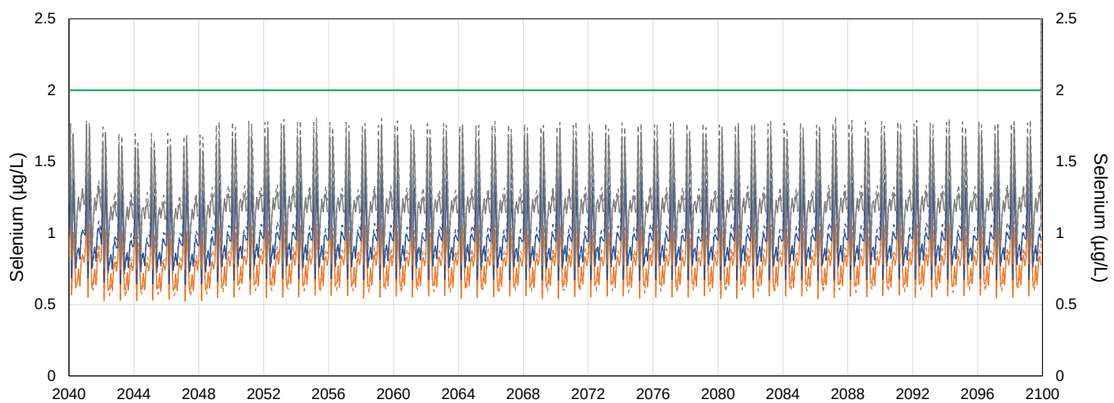
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



(g) Koocanusa Reservoir (RG_DSELK; E300230)



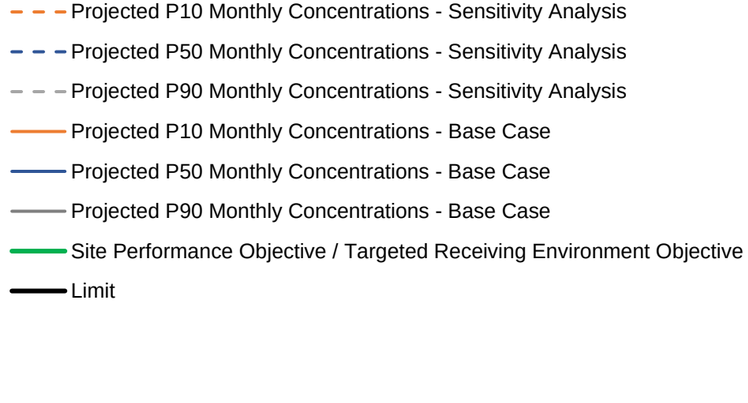
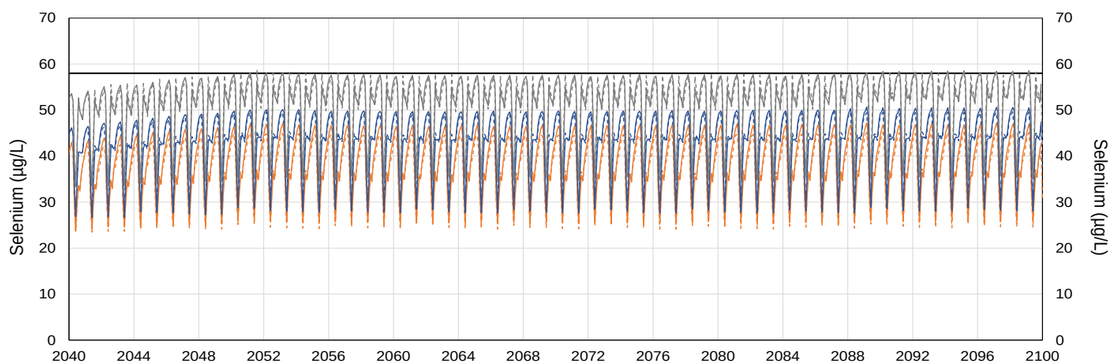
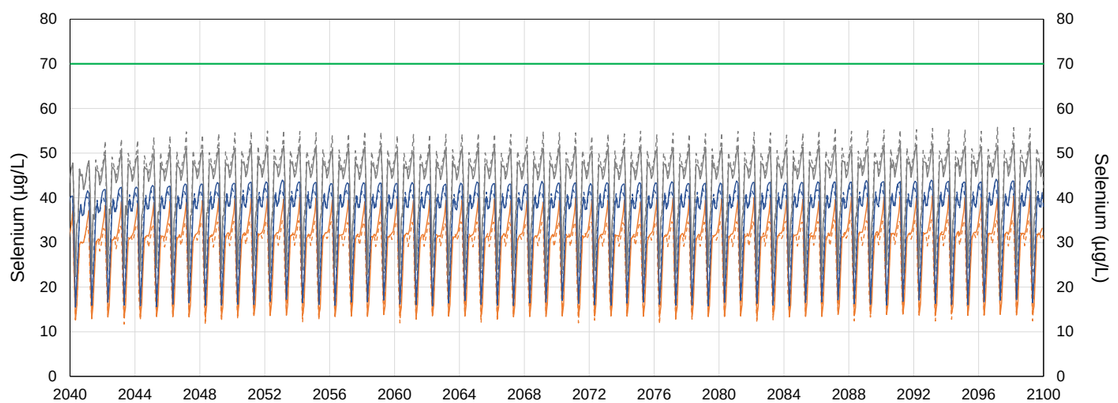


Figure F-14: Projected Monthly Average Concentrations of Selenium at Compliance Points and in LCO Dry Creek with and without Climate Change (RCP 4.5)

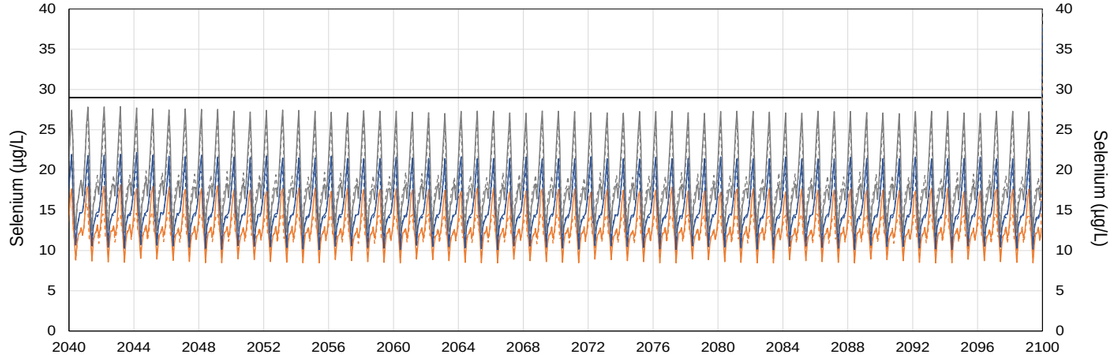
(a) FRO Compliance Point (FR_FRABCH; E223753)



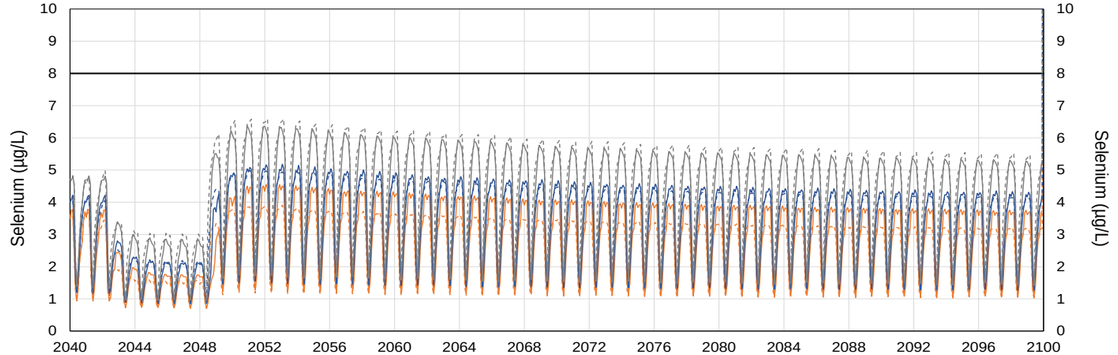
(b) Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)



(c) LCO Compliance Point (LC_LCDSSLCC; E297110)

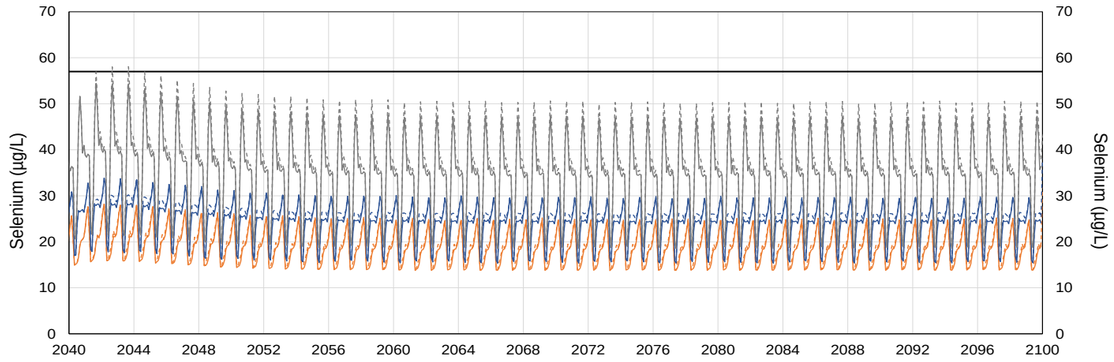


(d) GHO Elk River Compliance Point (GH_ERC; E300090)

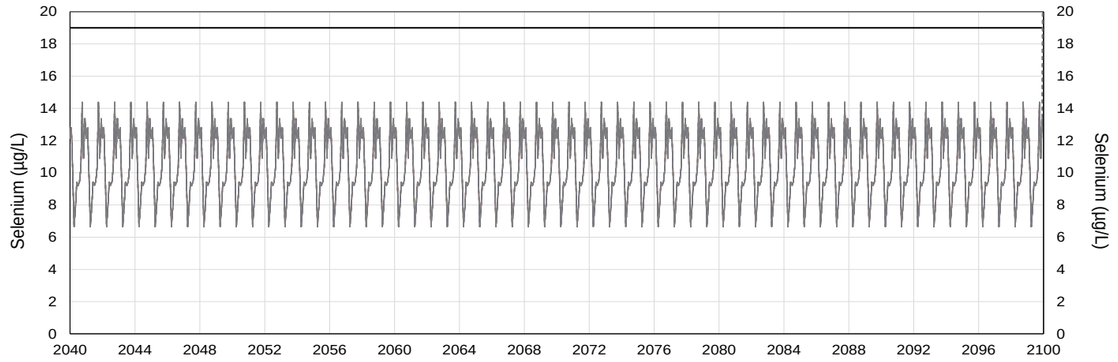


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) EVO Harmer Compliance Point (EV_HC1; E102682)

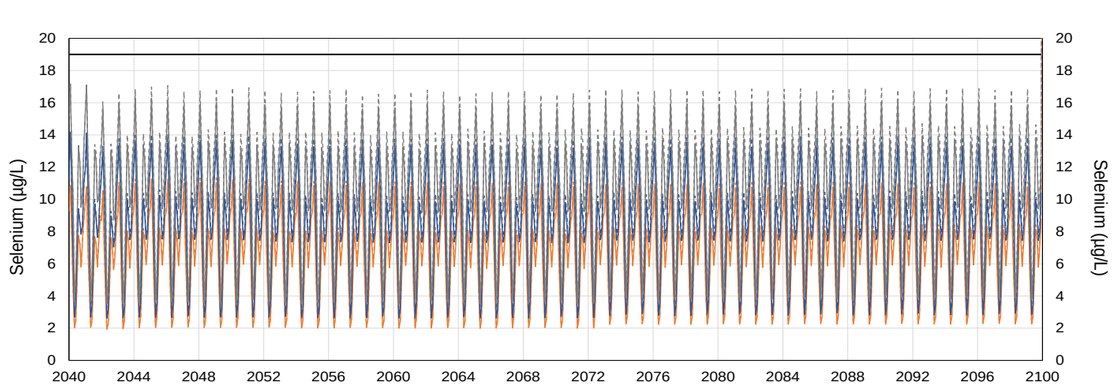


(f) CMO Compliance Point (CM_MC2; E258937)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

(g) EVO Michel Creek Compliance Point (EV_MC2; E300091)



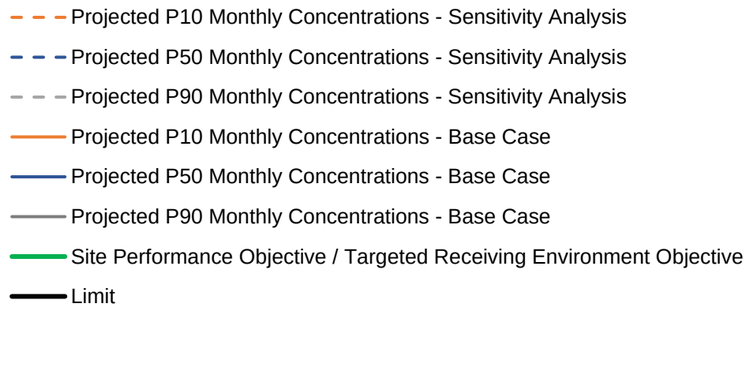
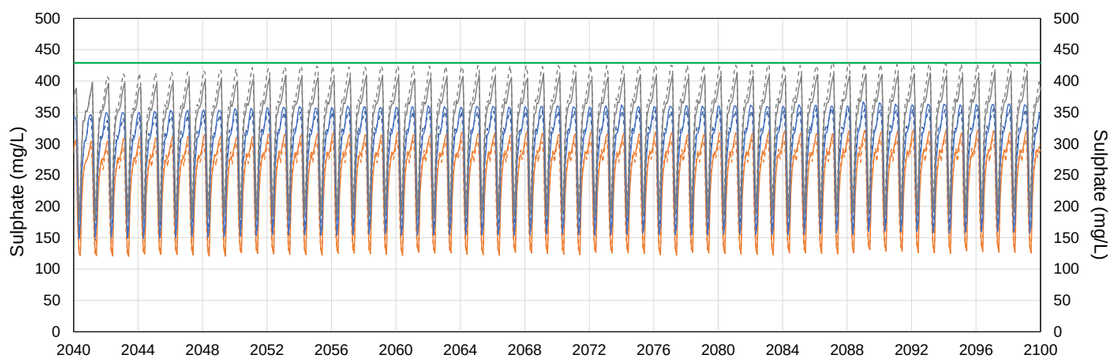
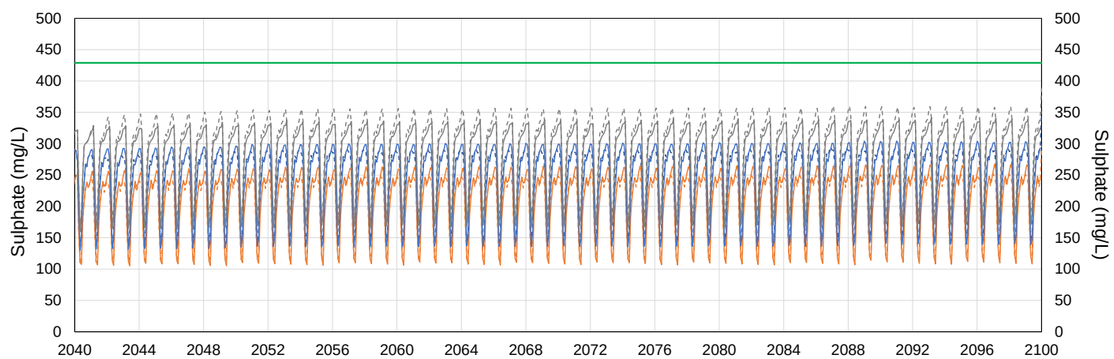


Figure F-15: Projected Monthly Average Concentrations of Sulphate at Order Stations with and without Climate Change (RCP 4.5)

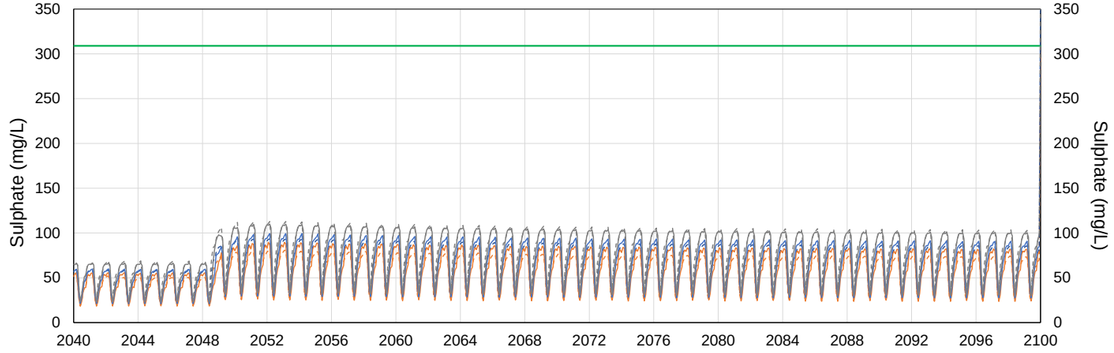
(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)



(b) Fording River downstream of Line Creek (LC_LC5; 0200028)

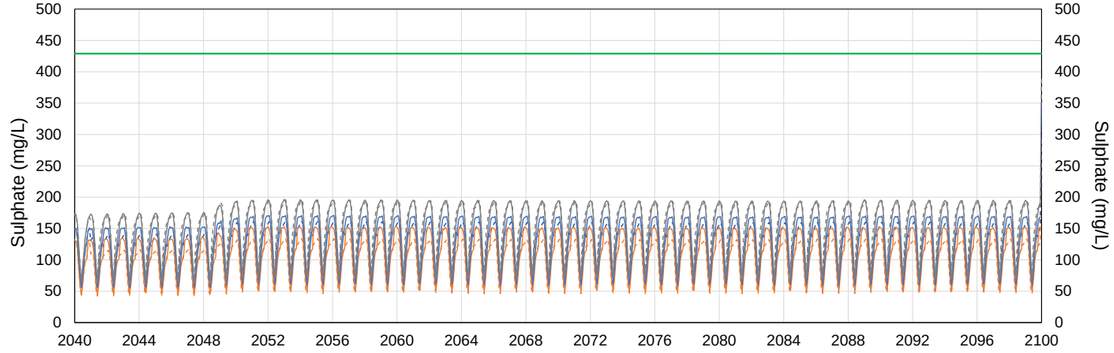


(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)



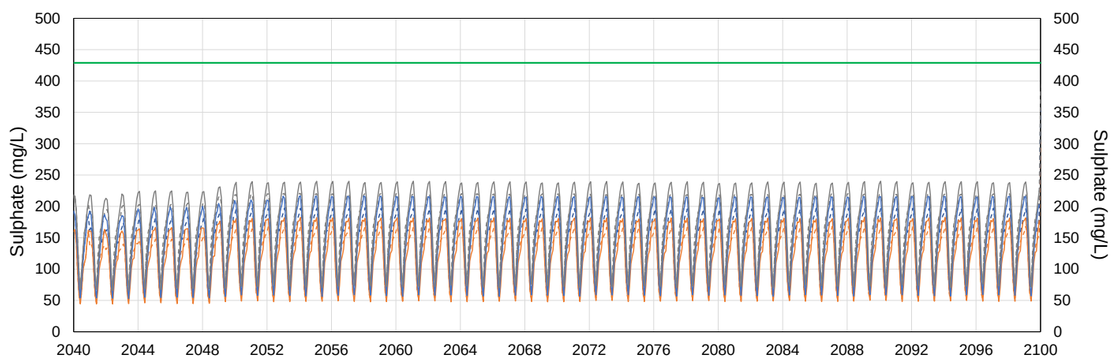
Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)

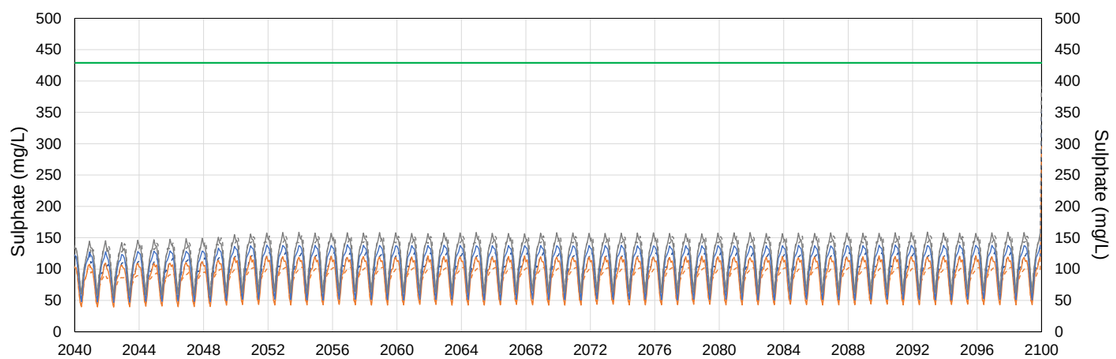


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

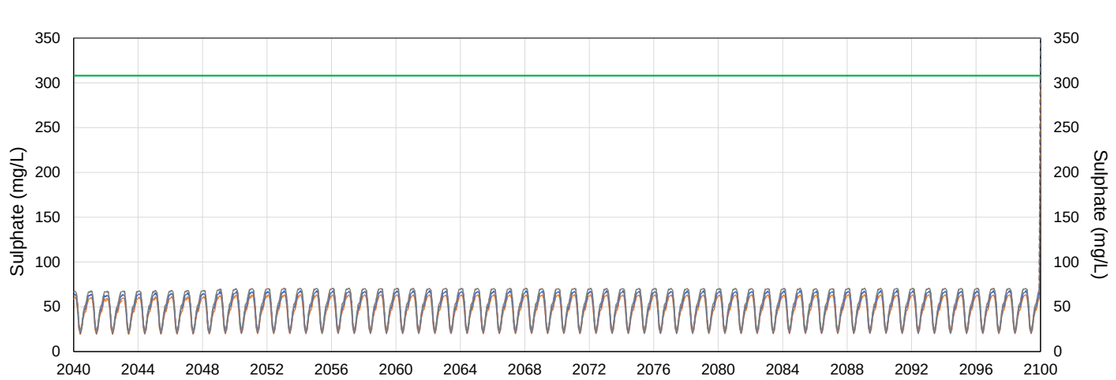
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



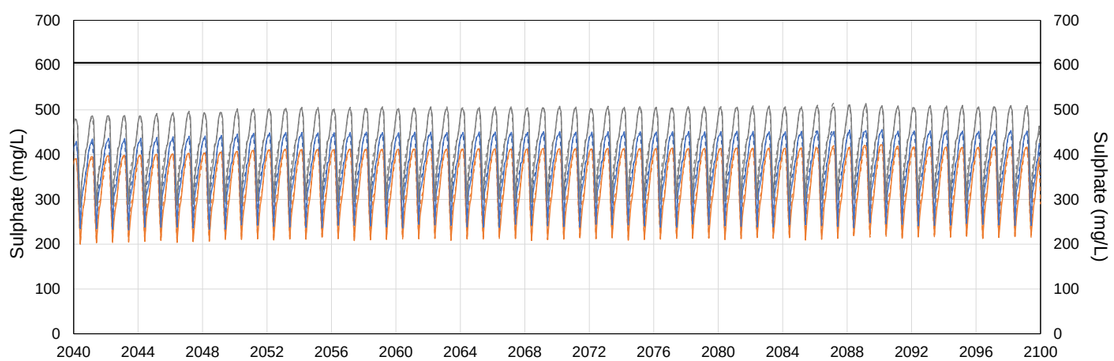
(g) Koocanusa Reservoir (RG_DSELK; E300230)



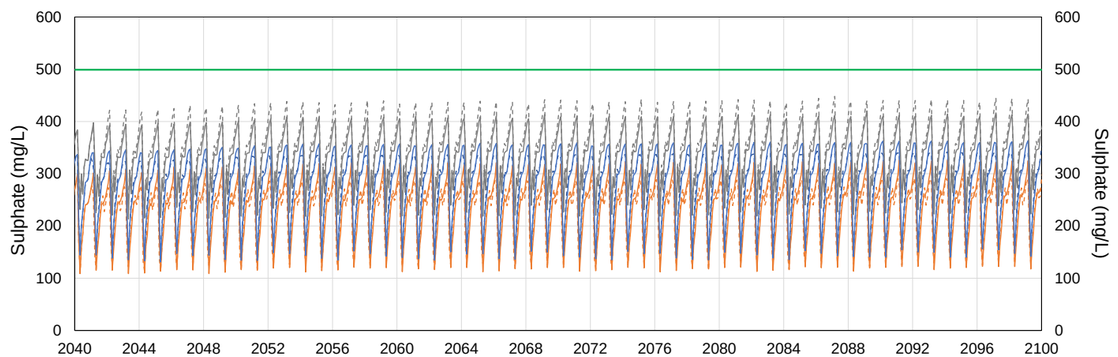
Projected P10 Monthly Concentrations - Sensitivity Analysis
Projected P50 Monthly Concentrations - Sensitivity Analysis
Projected P90 Monthly Concentrations - Sensitivity Analysis
Projected P10 Monthly Concentrations - Base Case
Projected P50 Monthly Concentrations - Base Case
Projected P90 Monthly Concentrations - Base Case
Site Performance Objective / Targeted Receiving Environment Objective
Limit

Figure F-16: Projected Monthly Average Concentrations of Sulphate at Compliance Points and in LCO Dry Creek with and without Climate Change (RCP 4.5)

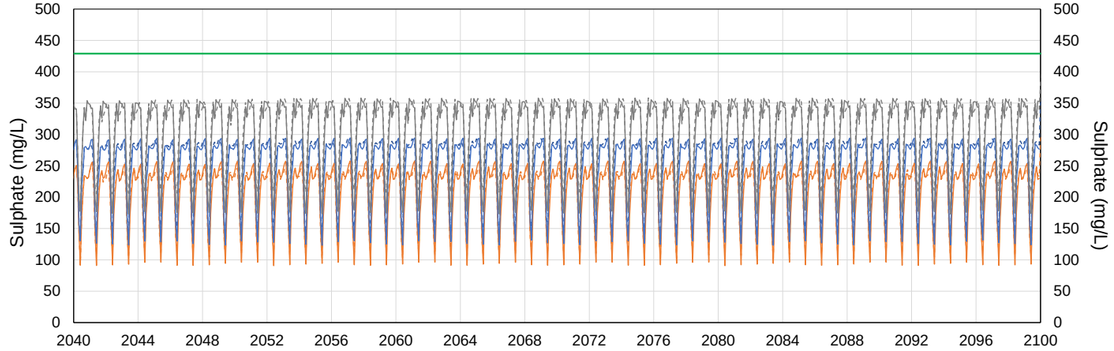
(a) FRO Compliance Point (FR_FRABCH; E223753)



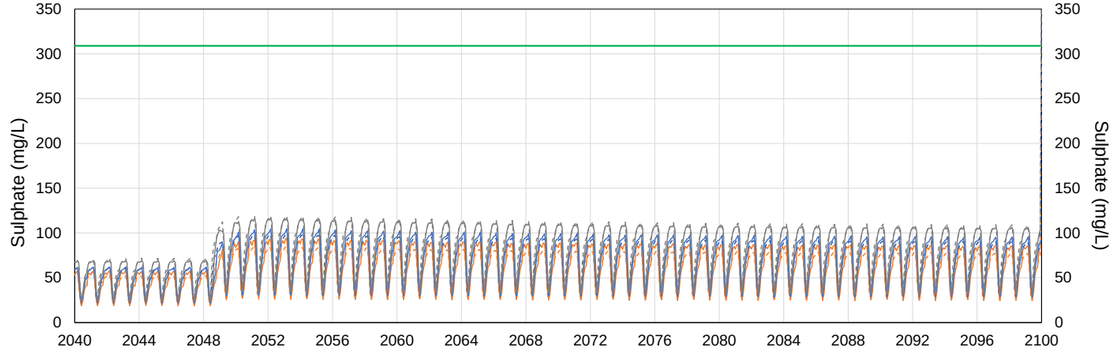
(b) Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)



(c) LCO Compliance Point (LC_LCDSSLCC; E297110)

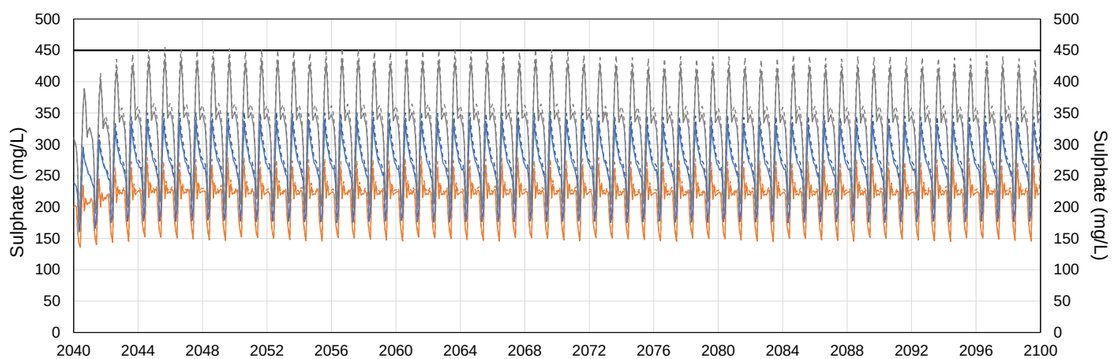


(d) GHO Elk River Compliance Point (GH_ERC; E300090)

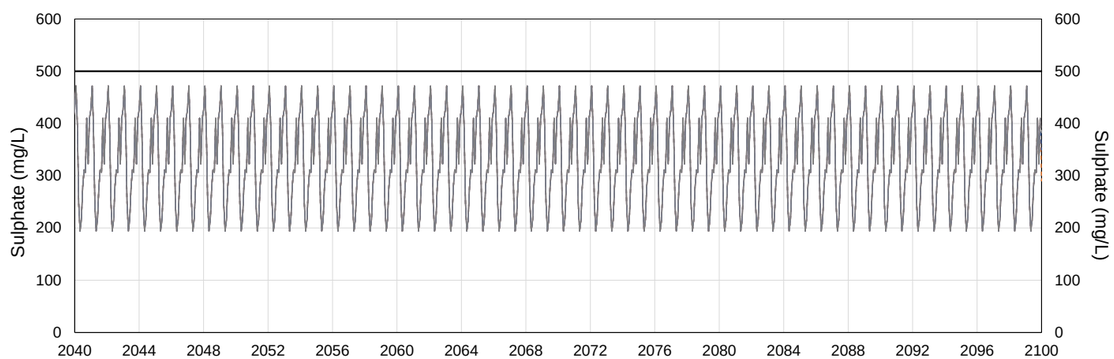


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) EVO Harmer Compliance Point (EV_HC1; E102682)

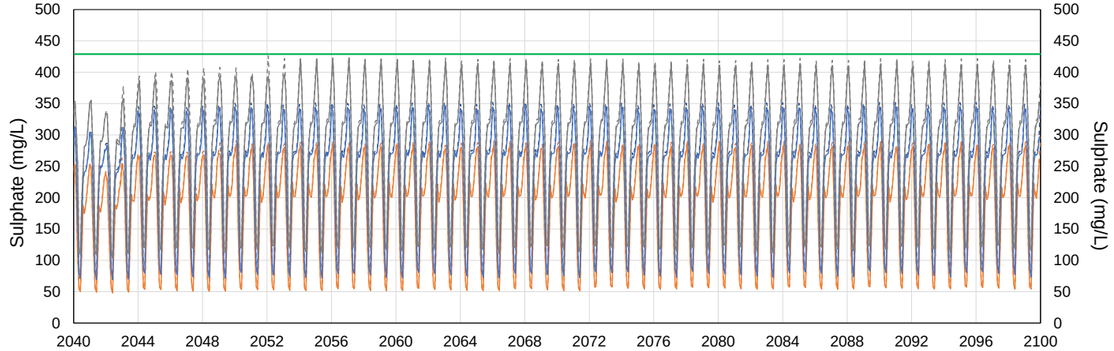


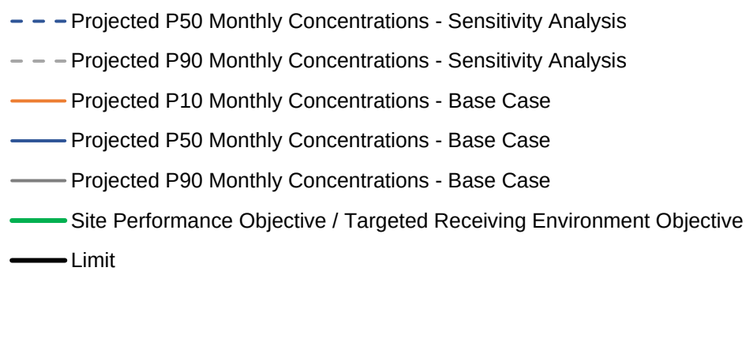
(f) CMO Compliance Point (CM_MC2; E258937)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

(g) EVO Michel Creek Compliance Point (EV_MC2; E300091)





Appendix G

Projected Concentrations of Selenium without Ongoing Improvements to Selenium Effluent Quality

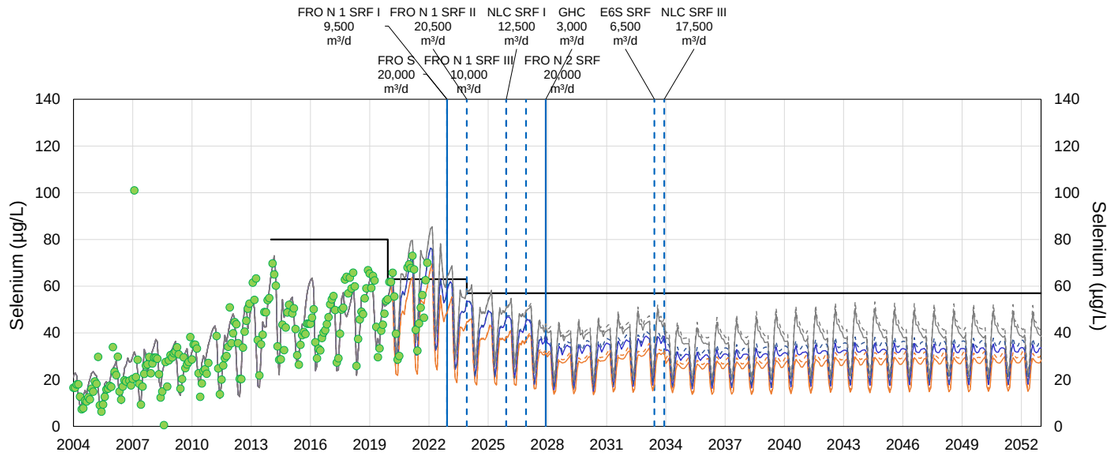
Figures

Projected concentrations of selenium at Order Stations, compliance points, and in LCO Dry Creek with and without ongoing improvements to selenium effluent quality are shown in Figures G-1 and G-2. The format of the figures is as follows:

- The x-axis runs from the start of 2004 to the end of 2053. The start date corresponds to the start of the calibration period for selenium in the 2020 RWQM. The end date (2053) corresponds to the modelled time period at which all permitted waste rock has been deposited and the lag associated with that rock has passed (i.e., all waste rock is contributing selenium load).
- Projected 10th percentile (P_{10}), 50th percentile (P_{50}), and 90th percentile (P_{90}) monthly average concentrations, with ongoing improvements to selenium effluent quality are shown as solid orange, blue and grey lines, respectively.
- Projected P_{10}, P_{50}, and P_{90} monthly average concentrations, without ongoing improvements to selenium effluent quality are shown as dashed orange, blue and grey lines, respectively.
- Measured monthly average concentrations are shown as green points.
- Modelled information shown prior to 2020 was developed based on calibrated flows. Those shown thereafter were developed using multiple climate realizations, as described in the 2020 update (Teck 2021).
- Compliance limits are shown as a solid black line, and Site Performance Objectives (SPOs) are shown as a solid green line.
- The fully effective dates for the Saturated Rock Fills (SRFs) and active water treatment facilities (AWTFs) are shown as a vertical blue line.

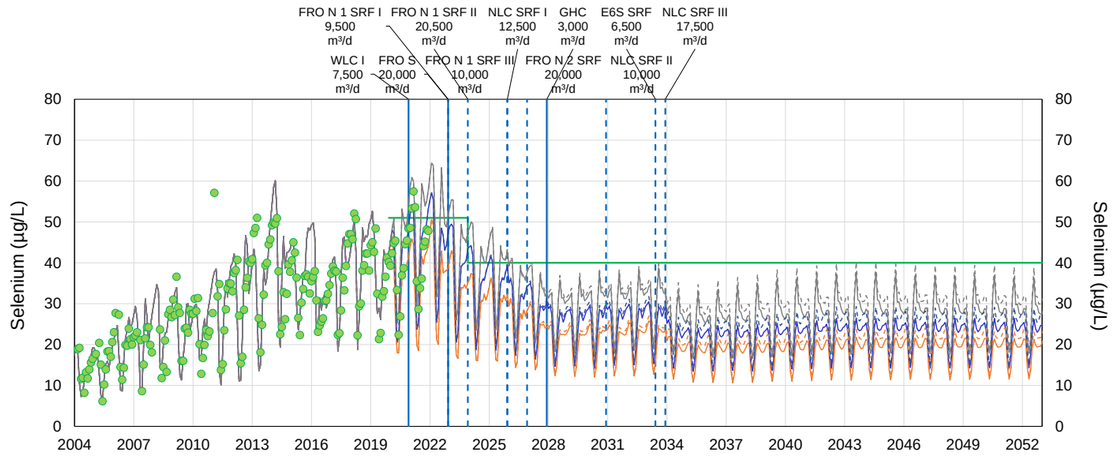
Figure G-1: Projected Selenium Concentrations at Order Stations with and without Ongoing Improvements to Selenium Effluent Quality

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)

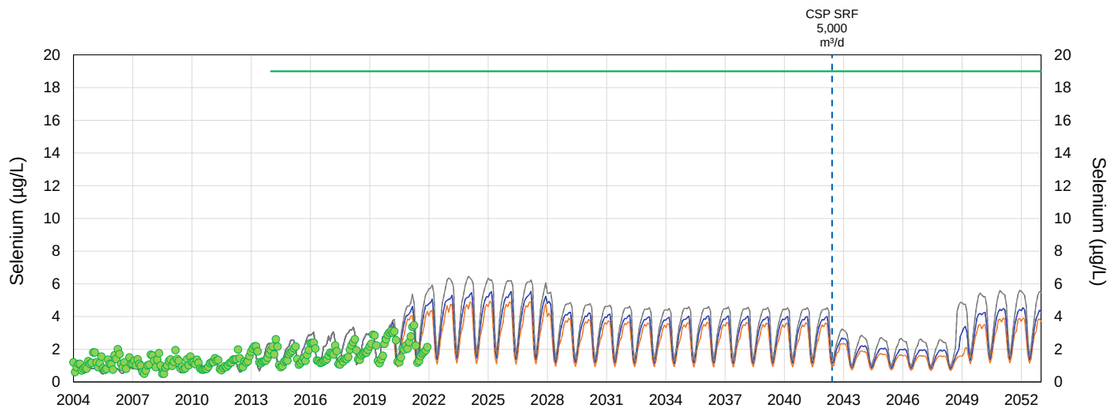


Note: This location is also the GHO Fording River Compliance Point.

(b) Fording River downstream of Line Creek (LC_LC5; 0200028)

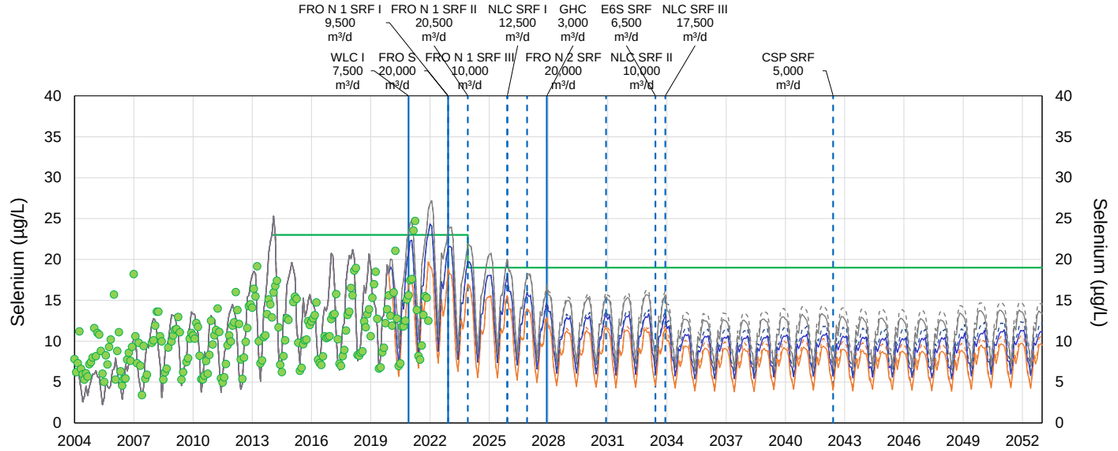


(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)

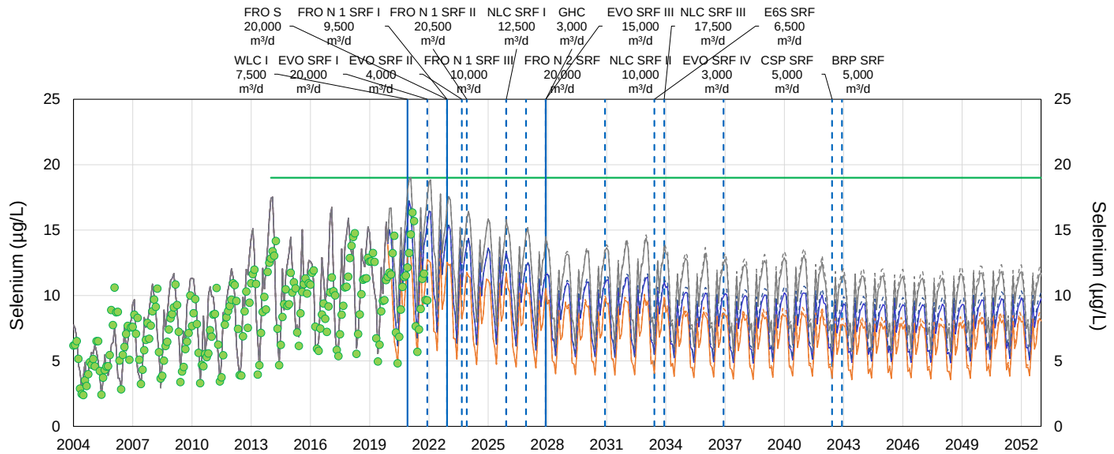


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

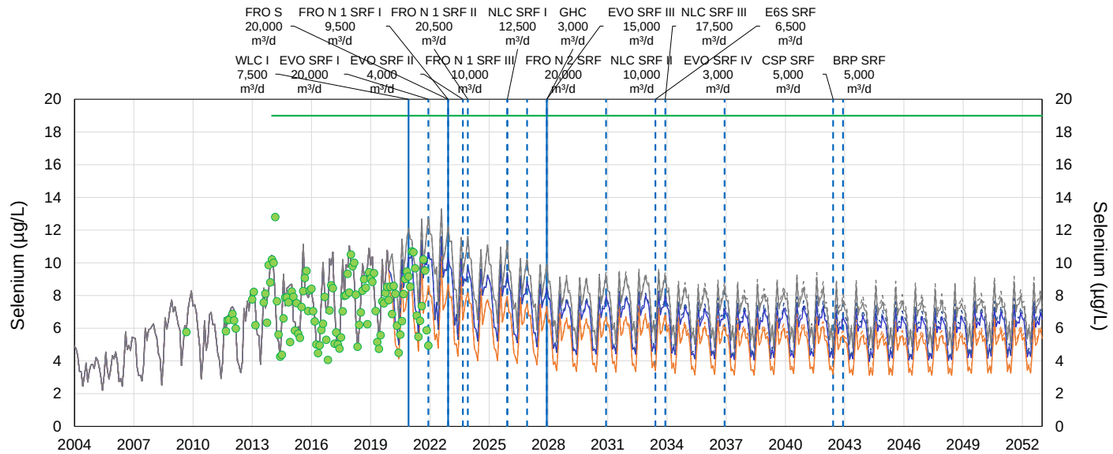
(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)



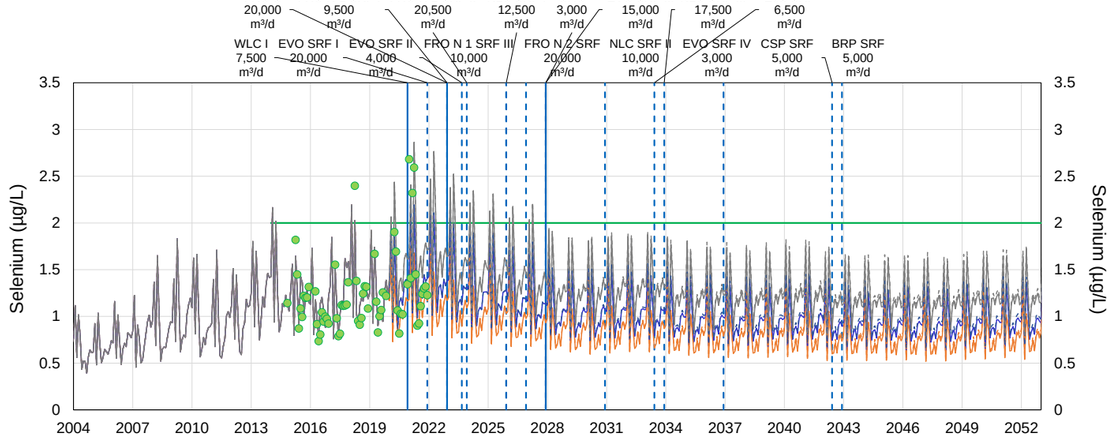
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



(g) Koocanusa Reservoir (RG_DSELK; E300230)



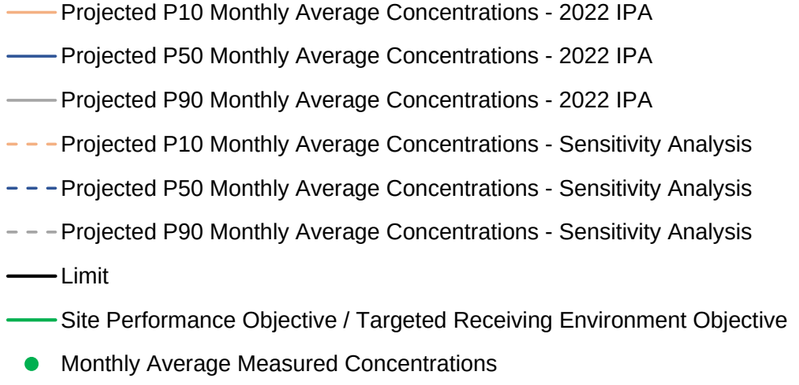
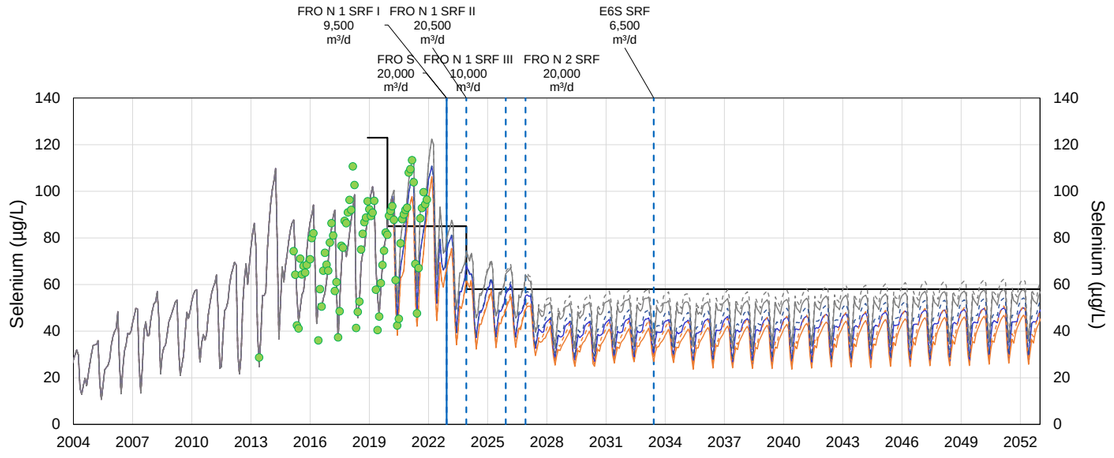
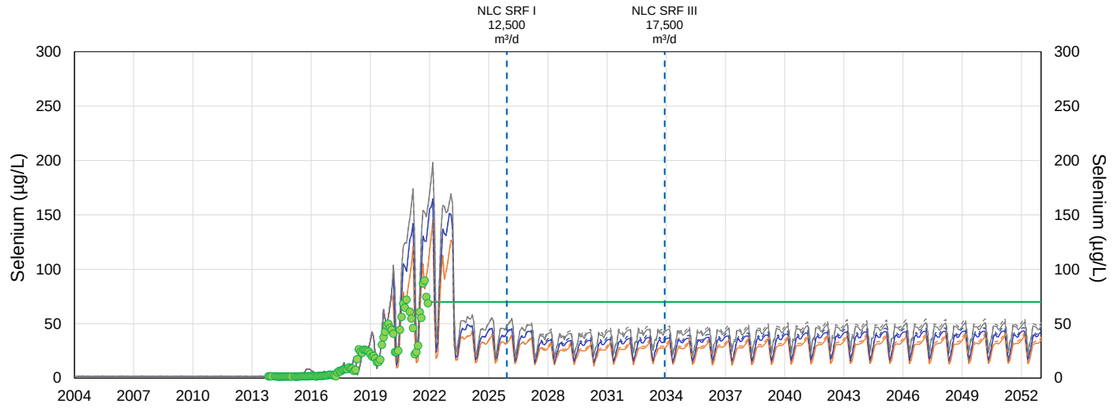


Figure G-2: Projected Selenium Concentrations at Compliance Points and in LCO Dry Creek with and without Ongoing Improvements to Selenium Effluent Quality

(a) FRO Compliance Point (FR_FRABCH; E223753)

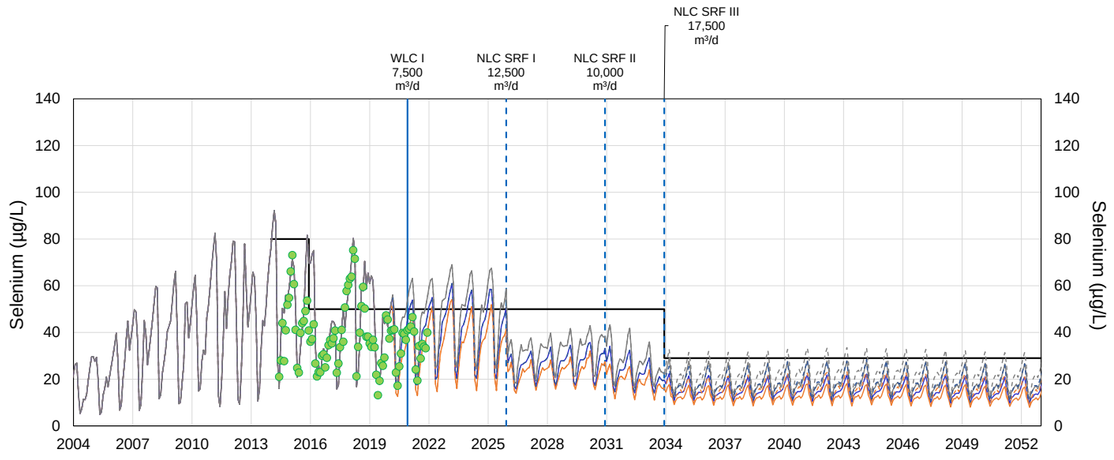


(b) Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)

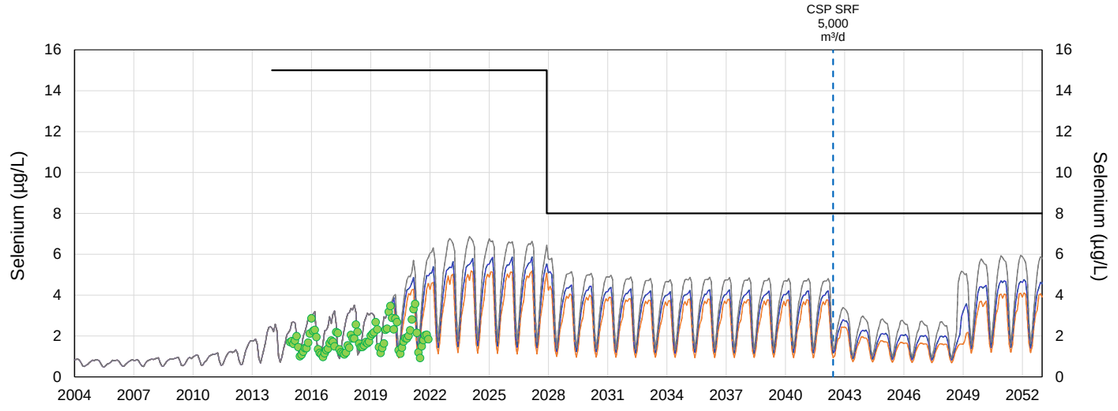


Note: Projected concentrations decrease in 2023 due to conveyance and supplementation.

(c) LCO Compliance Point (LC_LCDSSLCC; E297110)

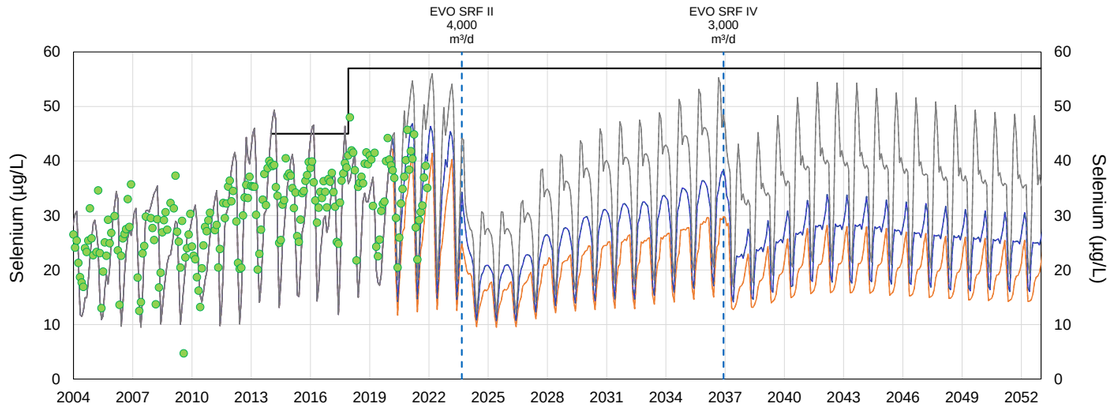


(d) GHO Elk River Compliance Point (GH_ERC; E300090)

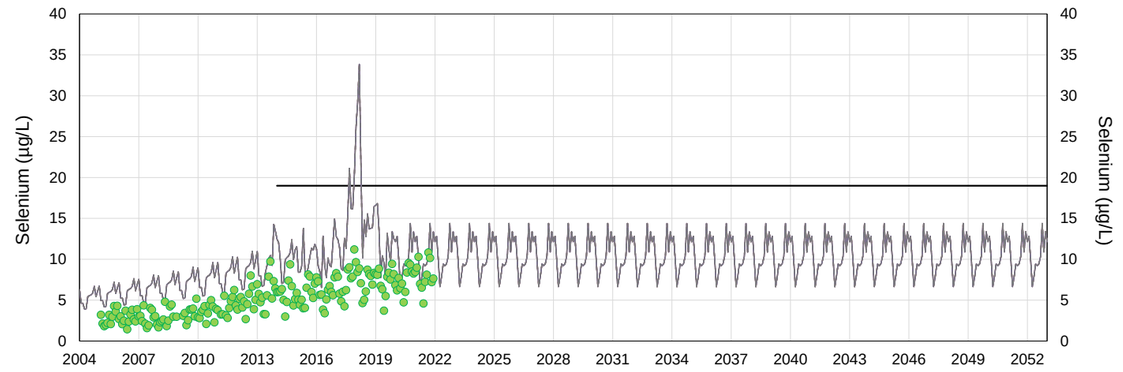


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) EVO Harmer Compliance Point (EV_HC1; E102682)

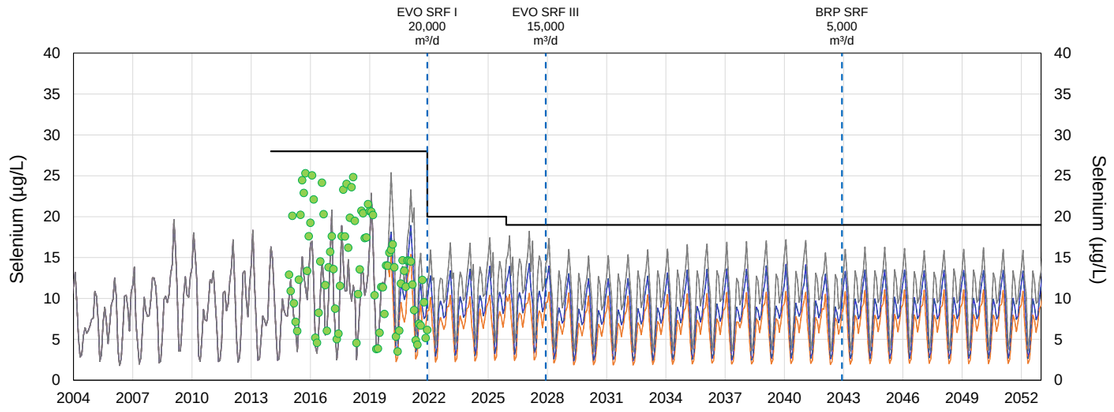


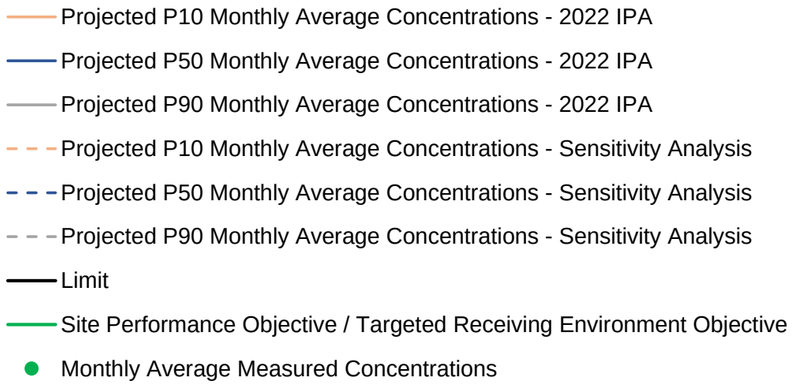
(f) CMO Compliance Point (CM_MC2; E258937)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

(g) EVO Michel Creek Compliance Point (EV_MC2; E300091)





Appendix H

Projected Concentrations of Nitrate and Selenium with Changes to Instream Sinks

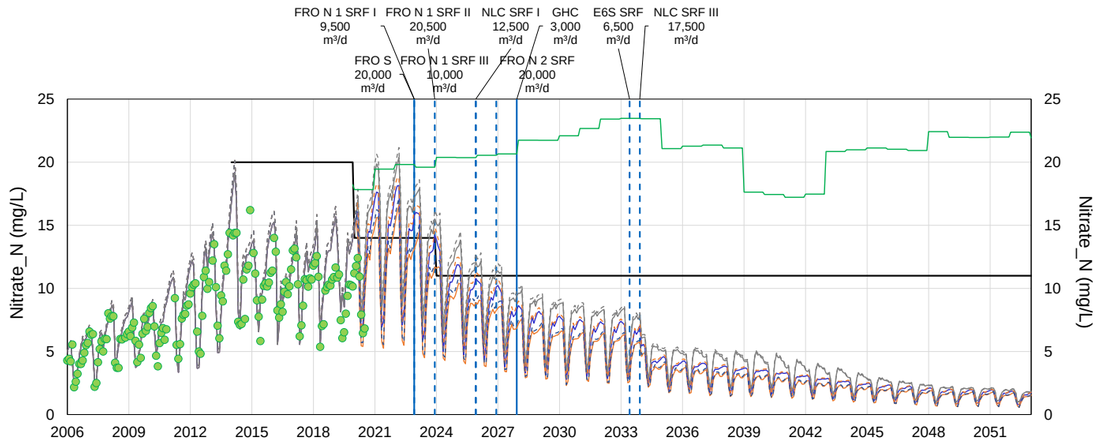
Figures

Projected concentrations of nitrate and selenium at Order Stations and compliance points, with and without changes to instream sinks are shown in Figures H-1 to H-4. The format of the figures is as follows:

- The x-axis runs from the start of 2004 (for selenium) or 2006 (for nitrate) to the end of 2053. The start date corresponds to the start of the calibration period for the 2020 RWQM. The end date (2053) corresponds to the modelled time period at which all permitted waste rock has been deposited and the lag associated with that rock has passed (i.e., all waste rock is contributing selenium and nitrate load).
- Projected 10th percentile (P_{10}), 50th percentile (P_{50}), and 90th percentile (P_{90}) monthly average concentrations, without changes to instream sinks are shown as solid orange, blue and grey lines, respectively.
- Projected P_{10}, P_{50}, and P_{90} monthly average concentrations, with changes to instream sinks are shown as dashed orange, blue and grey lines, respectively.
- Measured monthly average concentrations are shown as green points.
- Modelled information shown prior to 2020 was developed based on calibrated flows. Those shown thereafter were developed using multiple climate realizations, as described in the 2020 update (Teck 2021).
- Compliance limits are shown as a solid black line, and Site Performance Objectives (SPOs) are shown as a solid green line.
- The fully effective dates for the Saturated Rock Rills (SRFs) and active water treatment facilities (AWTFs) are shown as a vertical blue line.

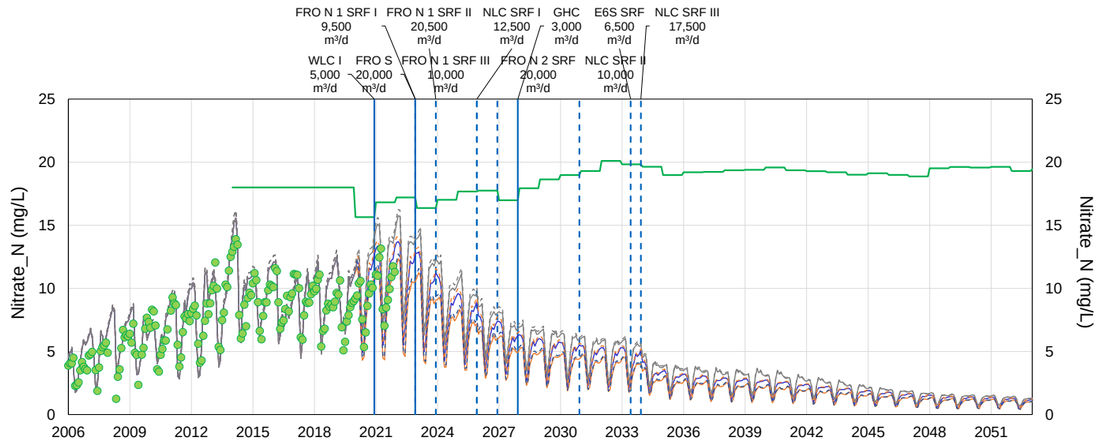
Figure H-1: Projected Nitrate Concentrations at Order Stations with and without Changes to Instream Sinks

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)



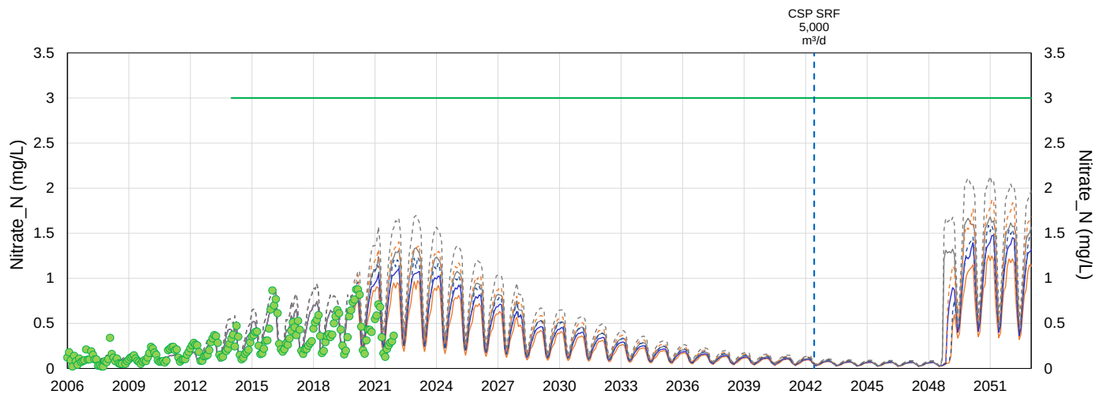
Note: This location is also the GHO Fording River Compliance Point. Site Performance Objective is hardness dependent from 2023 onward and is calculated using the following formula: N (in mg-N/L) = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$.; it varies with time to reflect projected hardness concentrations in the month when maximum monthly nitrate concentrations are projected to occur.

(b) Fording River downstream of Line Creek (LC_LC5; 0200028)



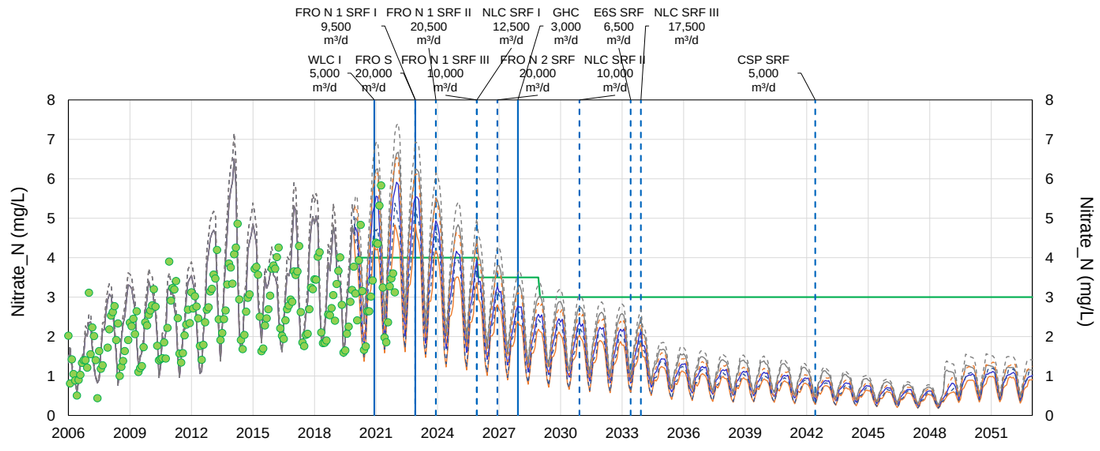
Note: Site Performance Objective is hardness dependent from 2019 onward and is calculated using the following formula: N (in mg-N/L) = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$.; it varies with time to reflect projected hardness concentrations in the month when maximum monthly nitrate concentrations are projected to occur.

(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)



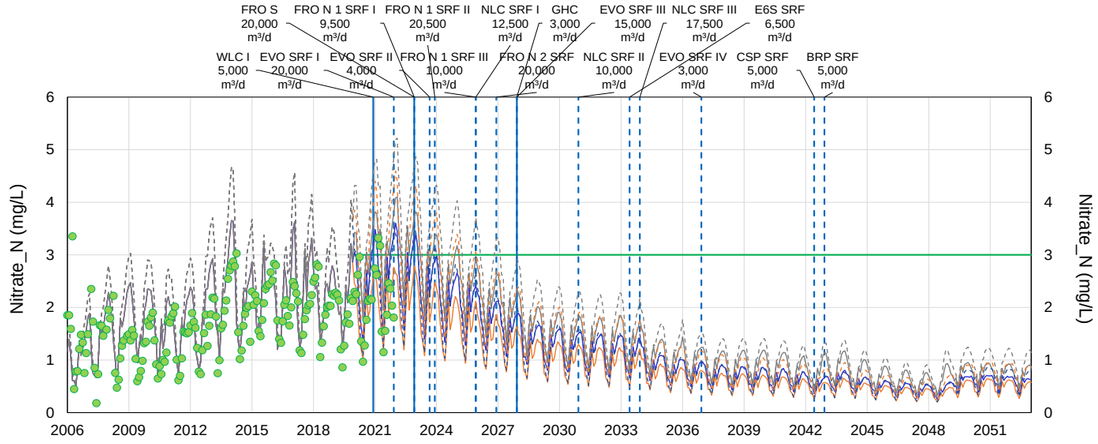
Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)

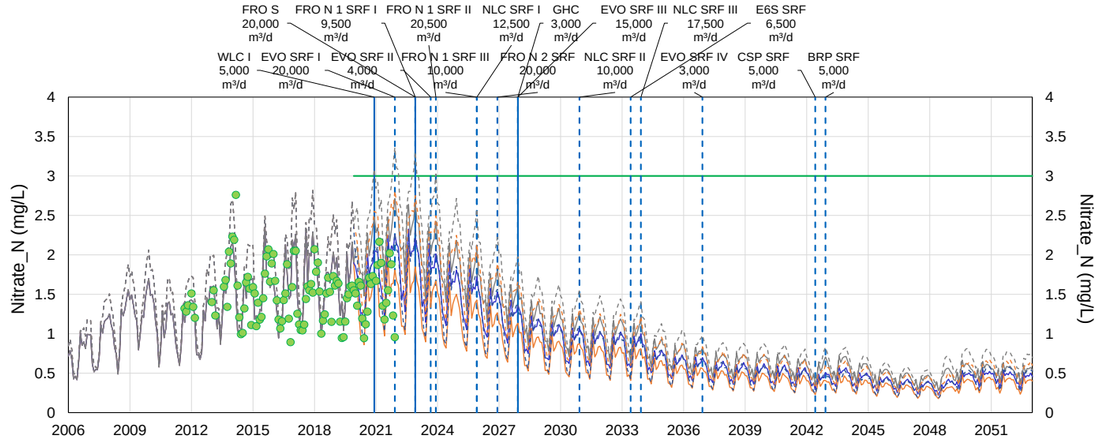


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

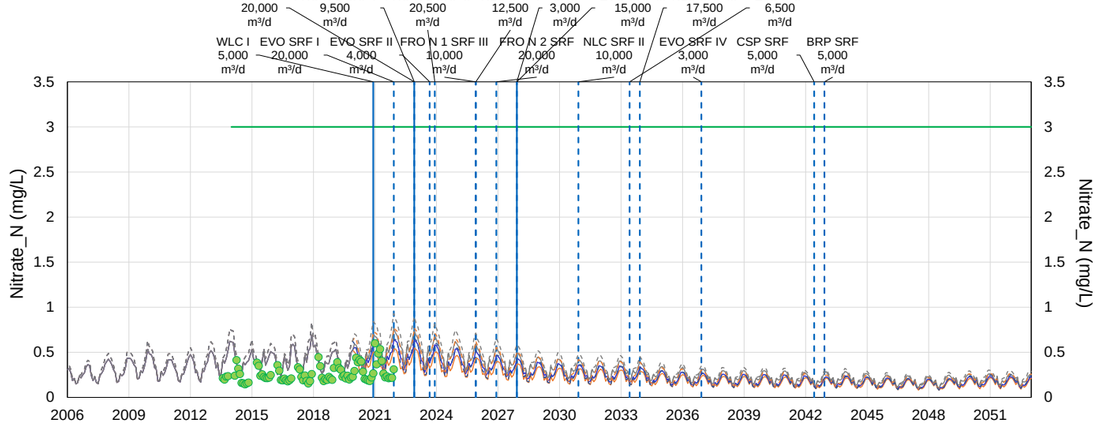
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



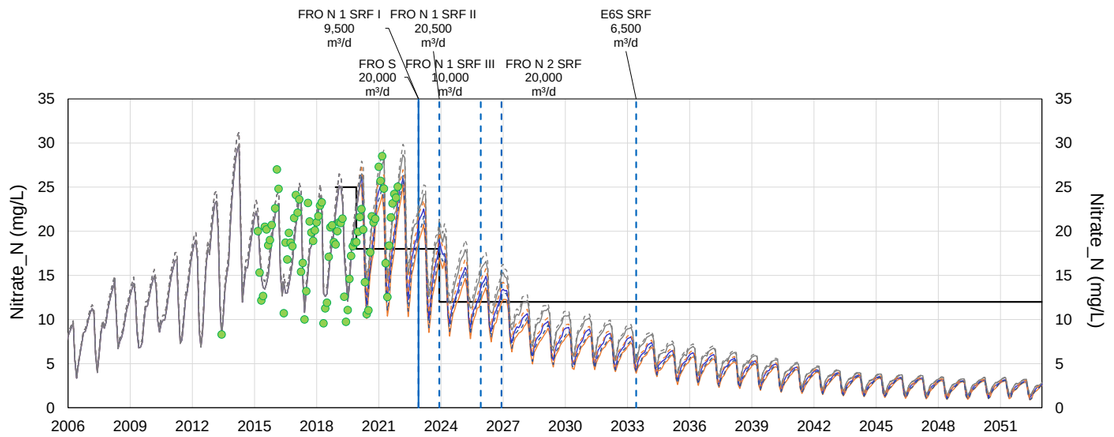
(g) Koocanusa Reservoir (RG_DSELK; E300230)



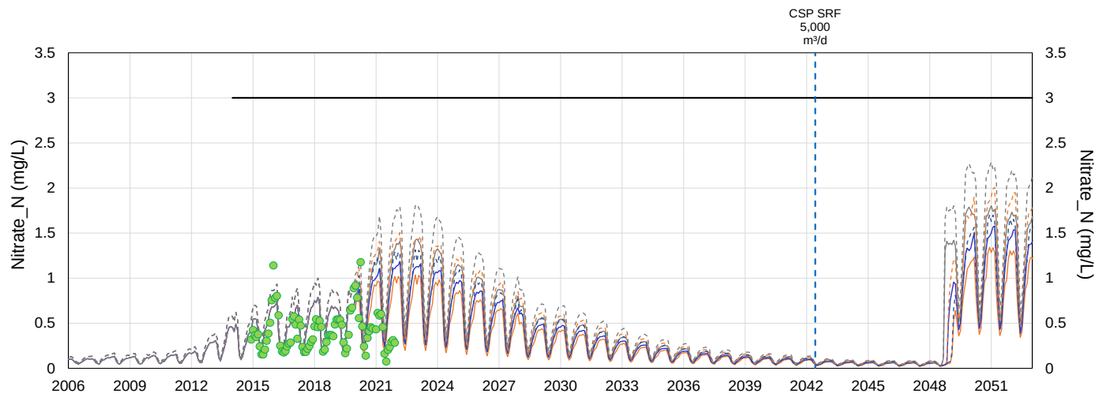
Projected P10 Monthly Average Concentrations - 2022 IPA
Projected P50 Monthly Average Concentrations - 2022 IPA
Projected P90 Monthly Average Concentrations - 2022 IPA
Projected P10 Monthly Average Concentrations - Sensitivity Analysis
Projected P50 Monthly Average Concentrations - Sensitivity Analysis
Projected P90 Monthly Average Concentrations - Sensitivity Analysis
Limit
Site Performance Objective
Monthly Average Measured Concentrations

Figure H-2: Projected Nitrate Concentrations at Selected Compliance Points with and without Changes to Instream Sinks

(a) FRO Compliance Point (FR_FRABCH; E223753)



(b) GHO Elk River Compliance Point (GH_ERC; E300090)



Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

Projected P10 Monthly Average Concentrations - 2022 IPA

Projected P50 Monthly Average Concentrations - 2022 IPA

Projected P90 Monthly Average Concentrations - 2022 IPA

Projected P10 Monthly Average Concentrations - Sensitivity Analysis

Projected P50 Monthly Average Concentrations - Sensitivity Analysis

Projected P90 Monthly Average Concentrations - Sensitivity Analysis

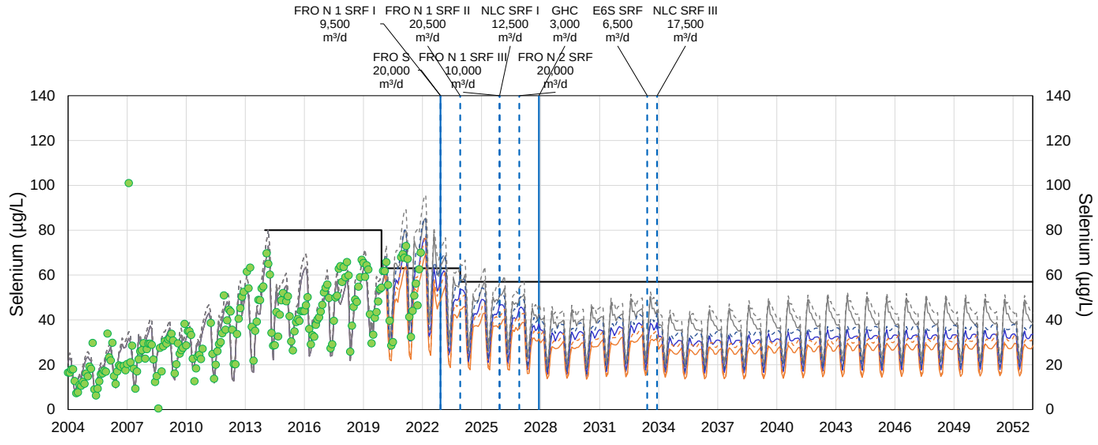
Limit

Site Performance Objective

Monthly Average Measured Concentrations

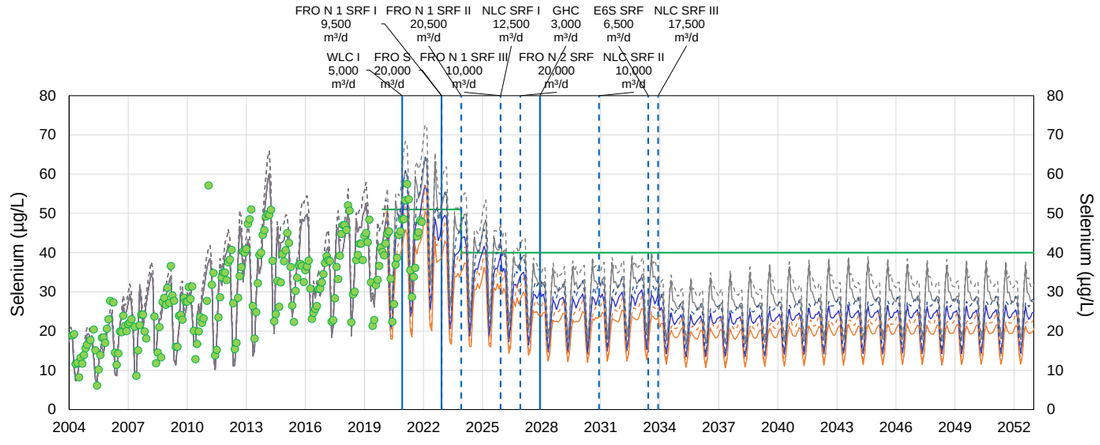
Figure H-3: Projected Selenium Concentrations at Order Stations with and without Changes to Instream Sinks

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)

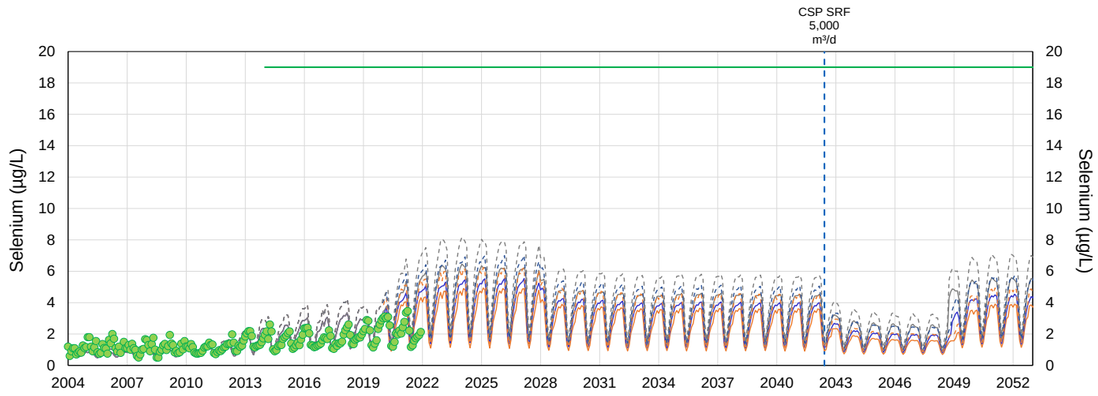


Note: This location is also the GHO Fording River Compliance Point.

(b) Fording River downstream of Line Creek (LC_LC5; 0200028)

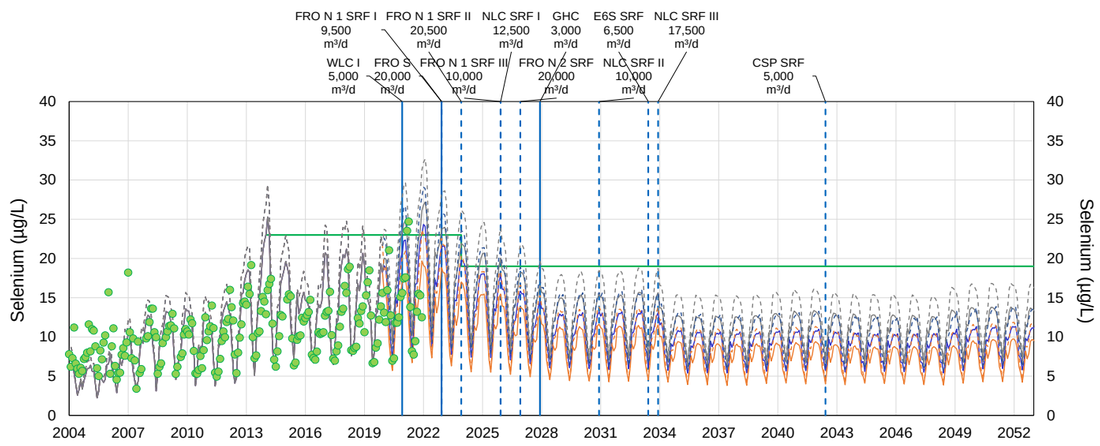


(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)

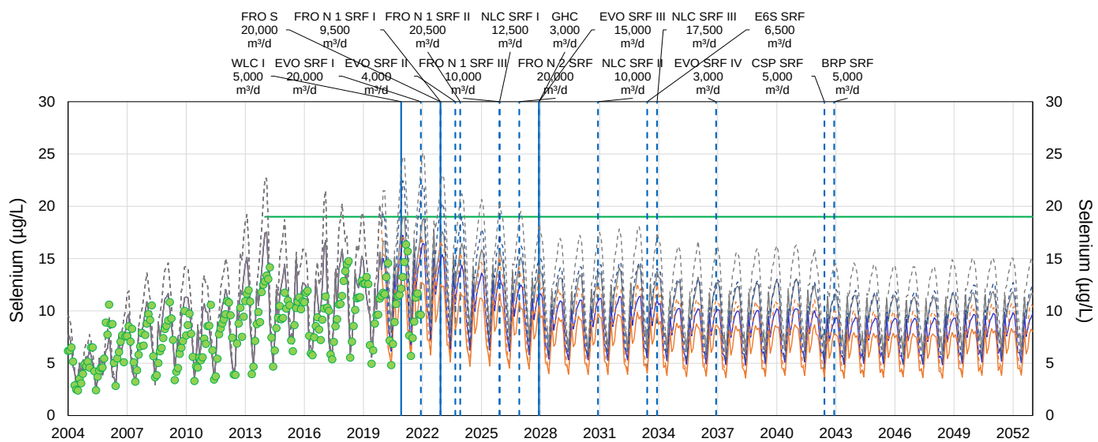


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

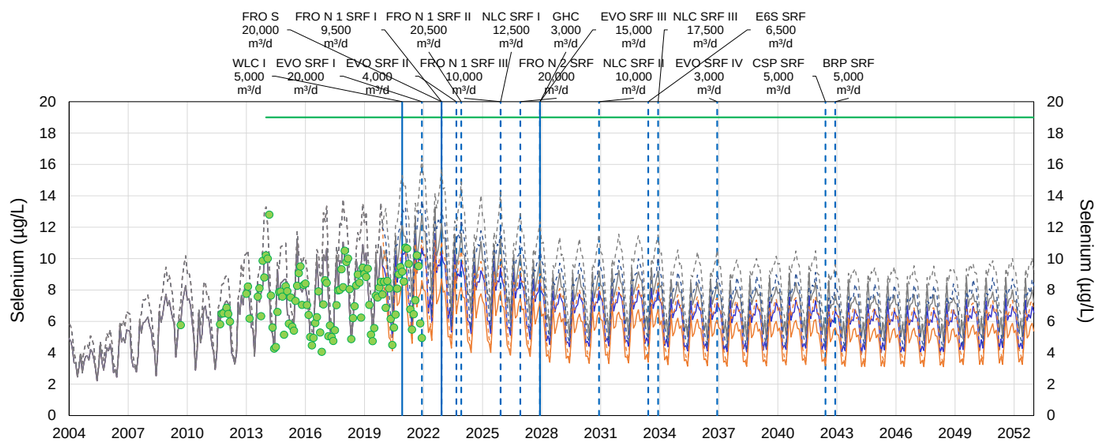
(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)



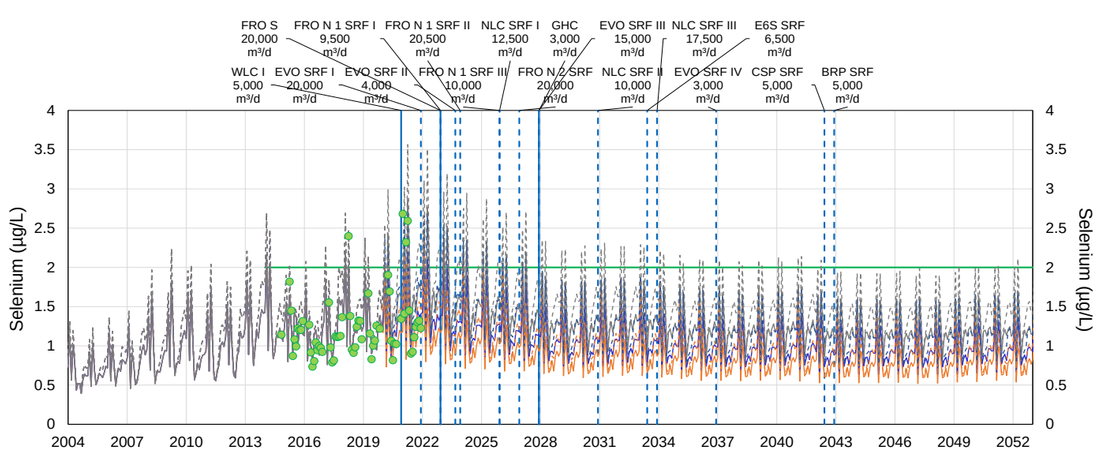
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



(g) Koocanusa Reservoir (RG_DSELK; E300230)



Projected P10 Monthly Average Concentrations - 2022 IPA

Projected P50 Monthly Average Concentrations - 2022 IPA

Projected P90 Monthly Average Concentrations - 2022 IPA

Projected P10 Monthly Average Concentrations - Sensitivity Analysis

Projected P50 Monthly Average Concentrations - Sensitivity Analysis

Projected P90 Monthly Average Concentrations - Sensitivity Analysis

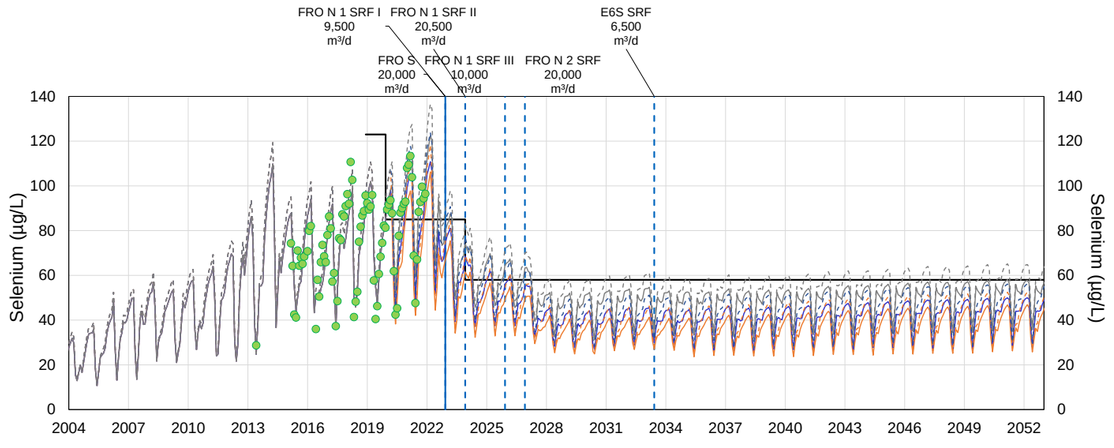
Limit

Site Performance Objective

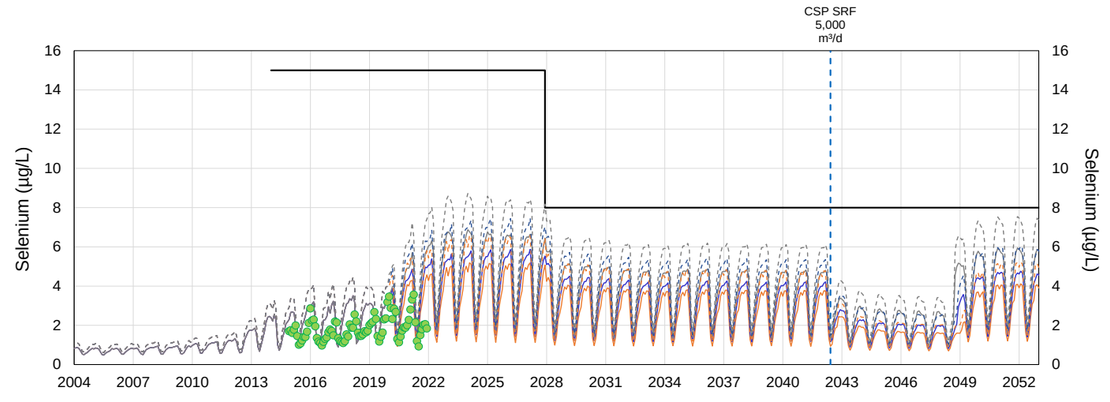
Monthly Average Measured Concentrations

Figure H-4: Projected Selenium Concentrations at Selected Compliance Points with and without Changes to Instream Sinks

(a) FRO Compliance Point (FR_FRABCH; E223753)



(b) GHO Elk River Compliance Point (GH_ERC; E300090)



Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

- Projected P10 Monthly Average Concentrations - 2022 IPA
- Projected P50 Monthly Average Concentrations - 2022 IPA
- Projected P90 Monthly Average Concentrations - 2022 IPA
- Projected P10 Monthly Average Concentrations - Sensitivity Analysis
- Projected P50 Monthly Average Concentrations - Sensitivity Analysis
- Projected P90 Monthly Average Concentrations - Sensitivity Analysis
- Limit
- Site Performance Objective
- Monthly Average Measured Concentrations

Appendix I

Projected Concentrations of Nitrate with Improvements to Blasting Practices

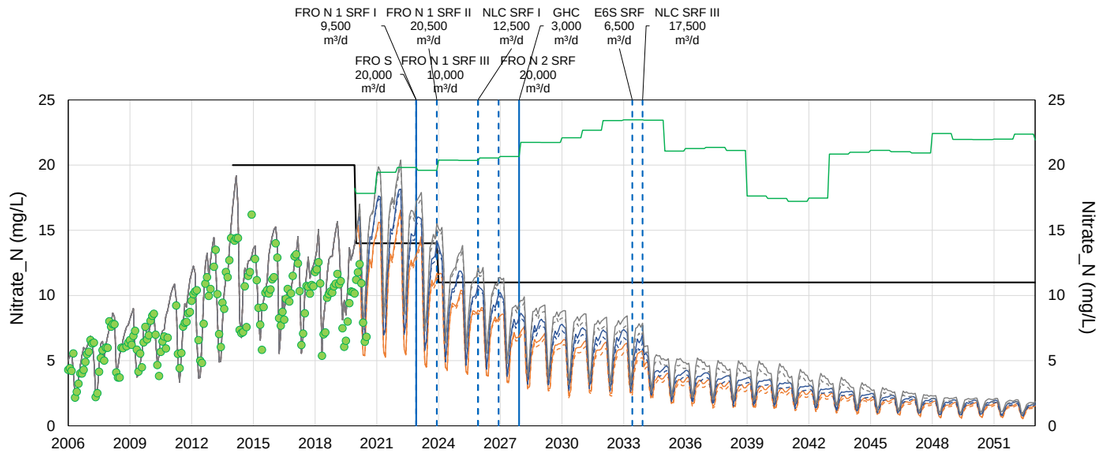
Figures

Projected concentrations of nitrate at Order Stations, compliance points, and in LCO Dry Creek, with and without changes to blasting practices are shown in Figures I-1 and I-2. The format of the figures is as follows:

- The x-axis runs from the start of 2006 to the end of 2053. The start date corresponds to the start of the calibration period for the 2020 RWQM. The end date (2053) corresponds to the modelled time period at which all permitted waste rock has been deposited and the lag associated with that rock has passed (i.e., all waste rock is contributing selenium and sulphate load).
- Projected 10^{th} percentile (P_{10}), 50^{th} percentile (P_{50}), and 90^{th} percentile (P_{90}) monthly average concentrations, without changes to blasting practices are shown as solid orange, blue and grey lines, respectively.
- Projected P_{10}, P_{50}, and P_{90} monthly average concentrations, with changes to blasting practices are shown as dashed orange, blue and grey lines, respectively.
- Measured monthly average concentrations are shown as green points.
- Modelled information shown prior to 2020 was developed based on calibrated flows. Those shown thereafter were developed using multiple climate realizations, as described in the 2020 update (Teck 2021).
- Compliance limits are shown as a solid black line, and Site Performance Objectives (SPOs) are shown as a solid green line.
- The fully effective dates for the Saturated Rock Fills (SRFs) and active water treatment facilities (AWTFs) are shown as a vertical blue line.

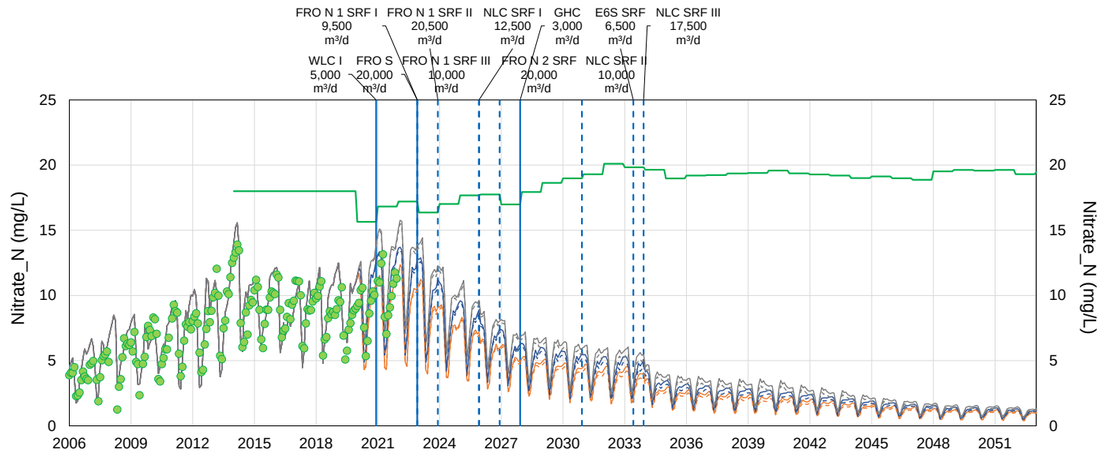
Figure I-1: Projected Nitrate Concentrations at Order Stations with and without Changes to Blasting Practices

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)



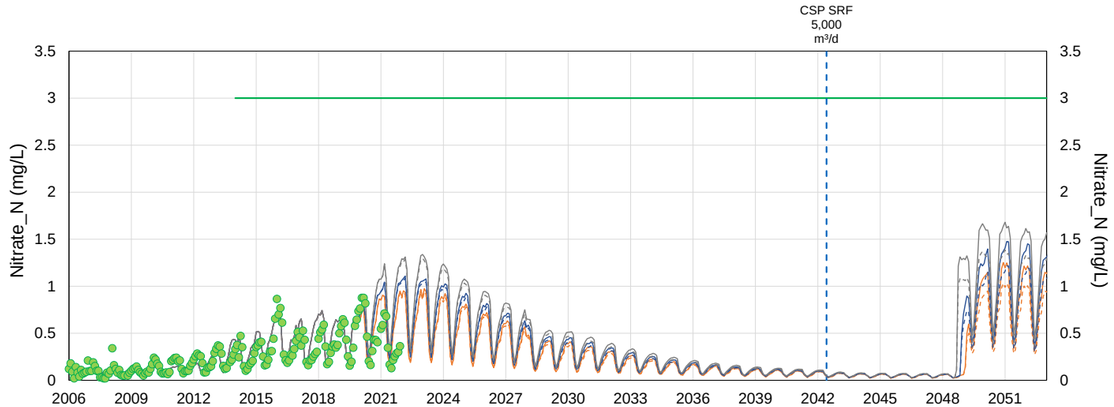
Note: This location is also the GHO Fording River Compliance Point. Site Performance Objective is hardness dependent from 2023 onward and is calculated using the following formula: N (in mg-N/L) = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$.; it varies with time to reflect projected hardness concentrations in the month when maximum monthly nitrate concentrations are projected to occur.

(b) Fording River downstream of Line Creek (LC_LC5; 0200028)



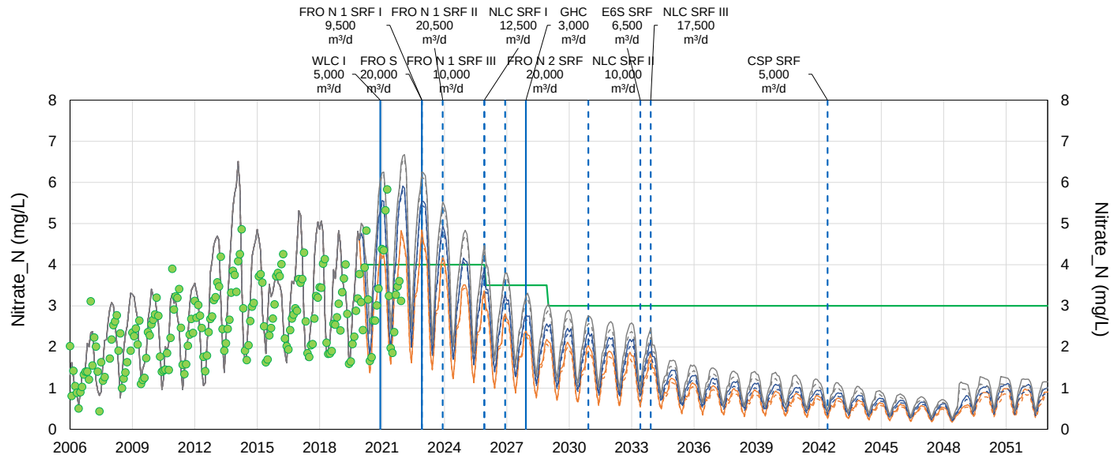
Note: Site Performance Objective is hardness dependent from 2019 onward and is calculated using the following formula: N (in mg-N/L) = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$.; it varies with time to reflect projected hardness concentrations in the month when maximum monthly nitrate concentrations are projected to occur.

(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)



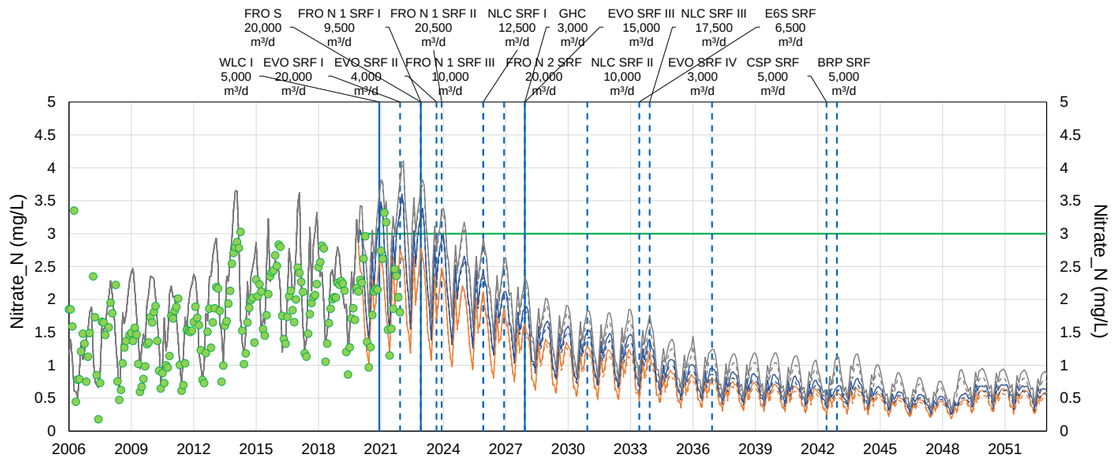
Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)

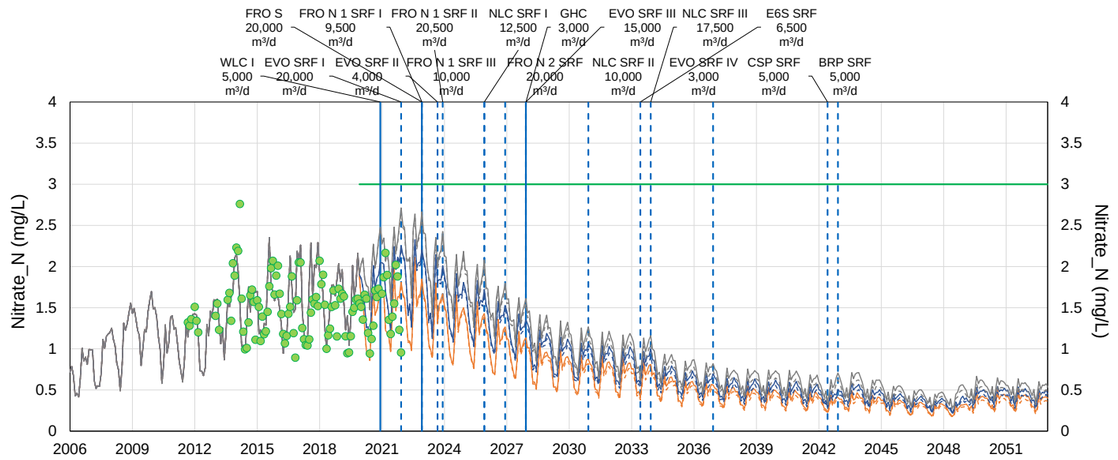


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

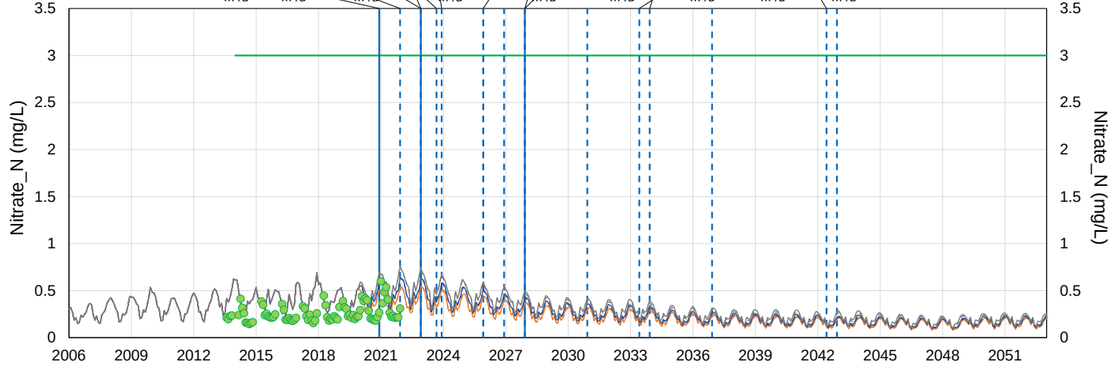
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



(g) Koocanusa Reservoir (RG_DSELK; E300230)



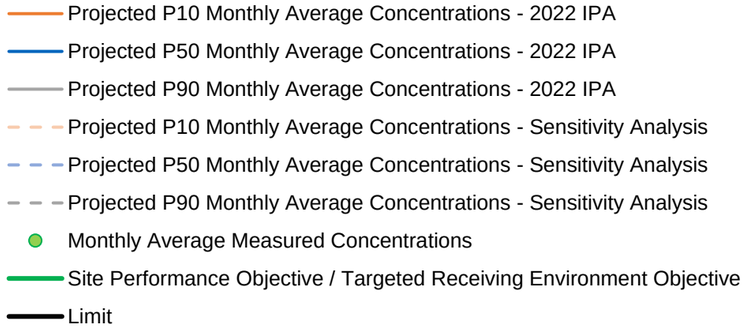
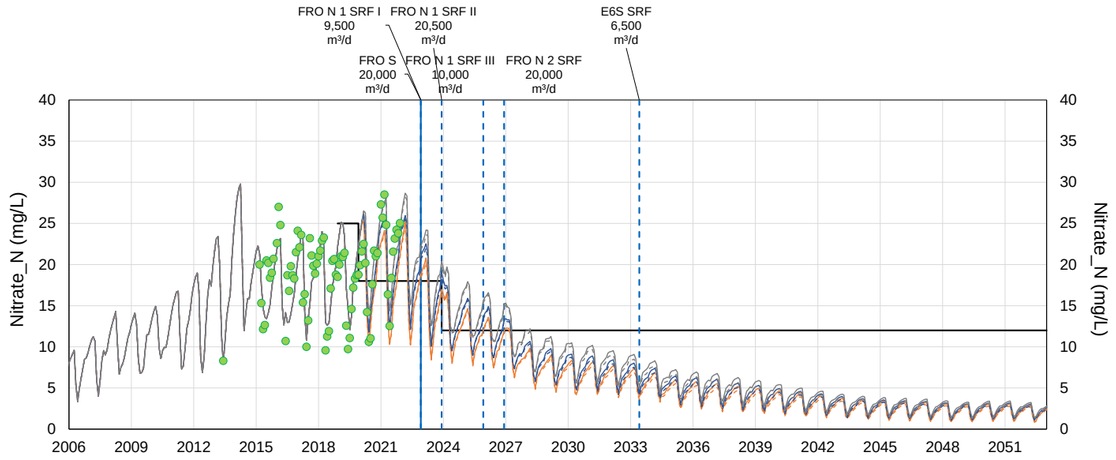
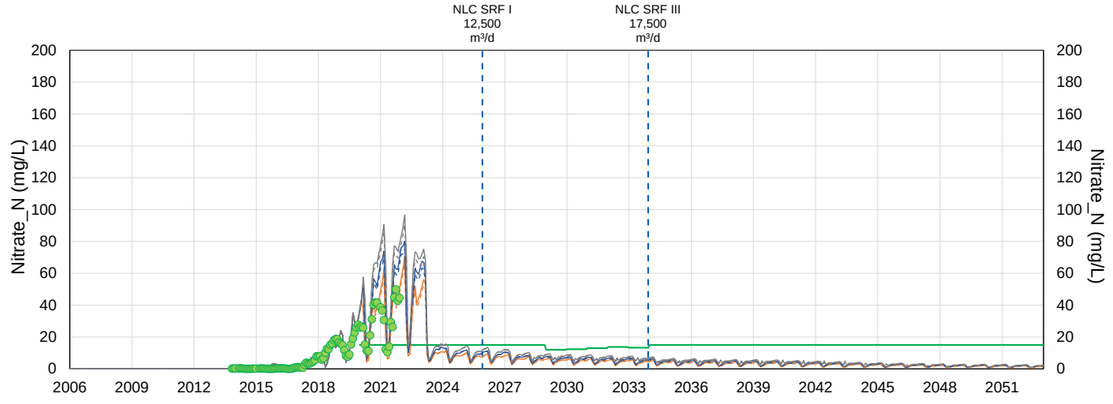


Figure I-2: Projected Nitrate Concentrations at Compliance Points and in LCO Dry Creek with and without Changes to Blasting Practices

(a) FRO Compliance Point (FR_FRABCH; E223753)

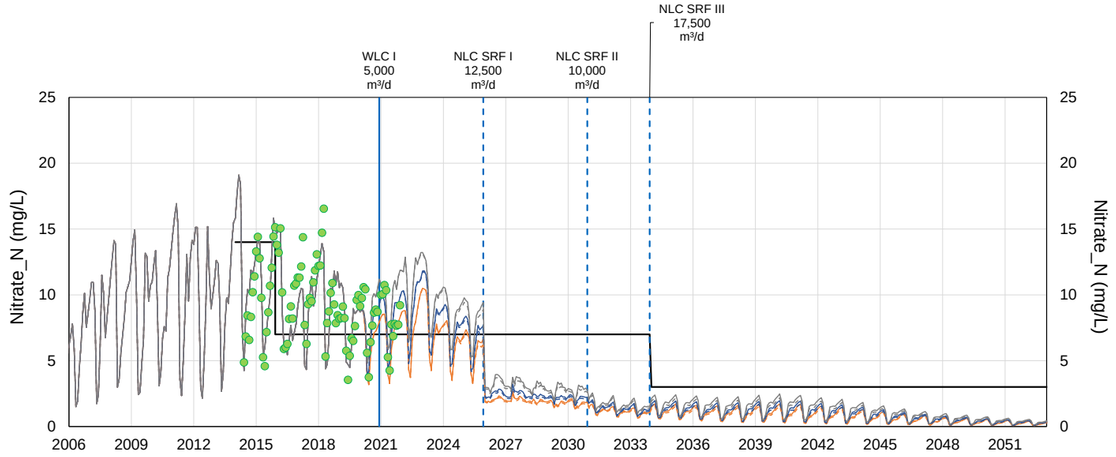


(b) Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)

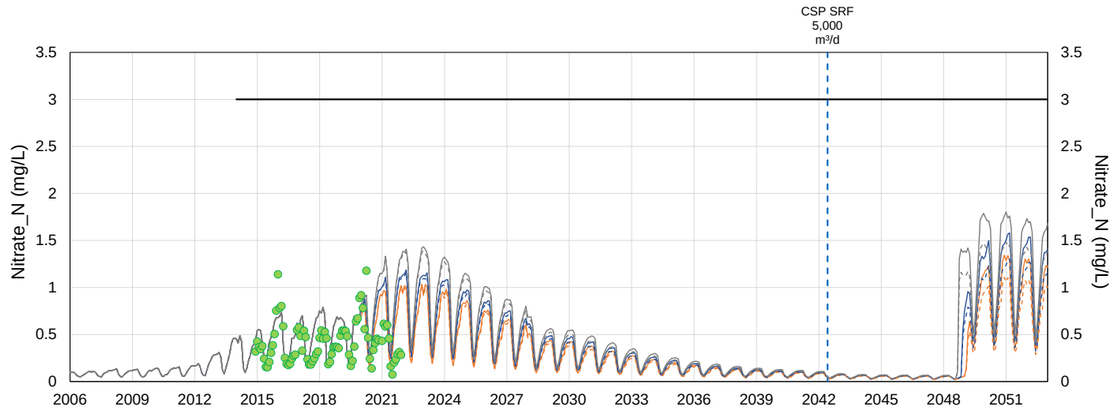


Note: Projected concentrations decrease in 2023 due to conveyance and supplementation.

(c) LCO Compliance Point (LC_LCDSSLCC; E297110)

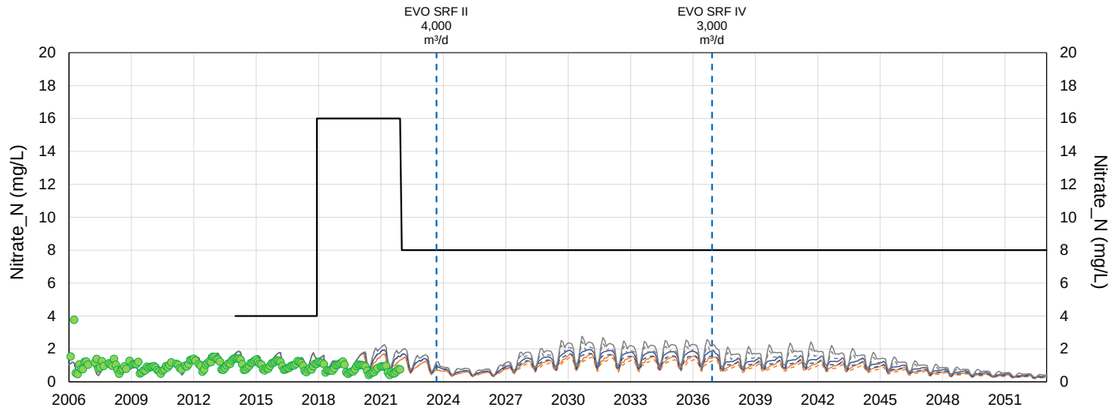


(d) GHO Elk River Compliance Point (GH_ERC; E300090)

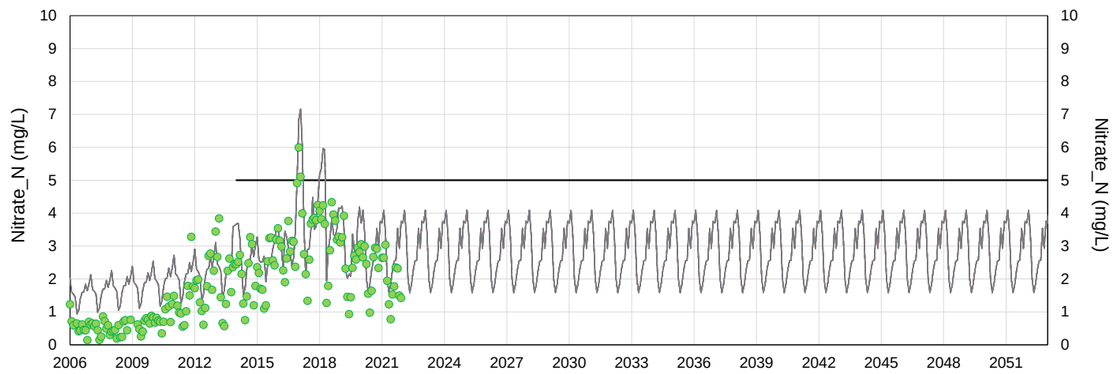


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) EVO Harmer Compliance Point (EV_HC1; E102682)

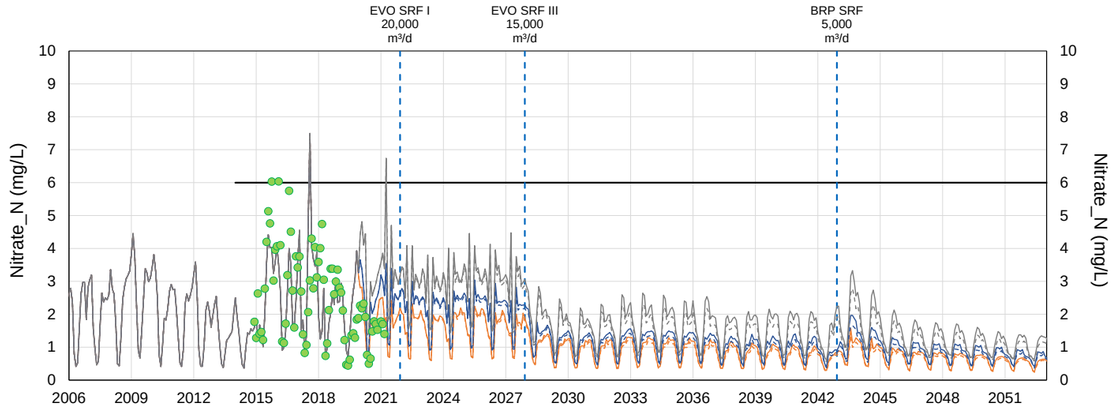


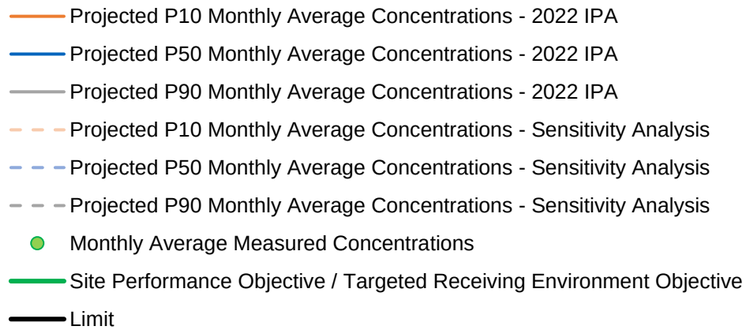
(f) CMO Compliance Point (CM_MC2; E258937)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

(g) EVO Michel Creek Compliance Point (EV_MC2; E300091)





Appendix J

Projected Concentrations of Nitrate, Selenium, and Sulphate with and without Mitigation

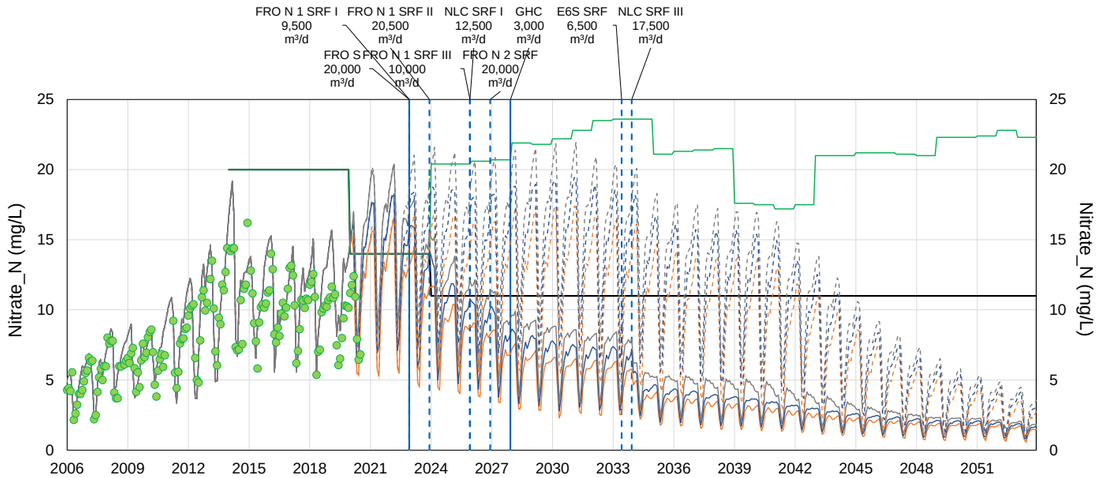
Figures

Projected concentrations of nitrate, selenium, and sulphate at Order Stations, compliance points and in LCO Dry Creek, with and without the 2022 Implementation Plan Adjustment (IPA) are shown in Figures J-1 to J-6. The format of the figures is as follows:

- The x-axis runs from the start of 2004 (for selenium and sulphate) or 2006 (for nitrate) to the end of 2053. The start date corresponds to the start of the calibration period for the 2020 RWQM. The end date (2053) corresponds to the modelled time period at which all permitted waste rock has been deposited and the lag associated with that rock has passed (i.e., all waste rock is contributing nitrate, selenium, and sulphate load).
- Projected 10th percentile (P_{10}), 50th percentile (P_{50}), and 90th percentile (P_{90}) monthly average concentrations, with the 2022 IPA are shown as solid orange, blue and grey lines, respectively.
- Projected P_{10}, P_{50}, and P_{90} monthly average concentrations, without the 2022 IPA are shown as dashed orange, blue and grey lines, respectively.
- Measured monthly average concentrations are shown as green points.
- Modelled information shown prior to 2020 was developed based on calibrated flows. Those shown thereafter were developed using multiple climate realizations, as described in the 2020 update (Teck 2021).
- Compliance limits are shown as a solid black line, and Site Performance Objectives (SPOs) and targeted receiving environment objectives are shown as a solid green line.
- The fully effective dates for the Saturated Rock Fills (SRFs) and Active Water Treatment Facilities (AWTFs) are shown as a vertical blue line.

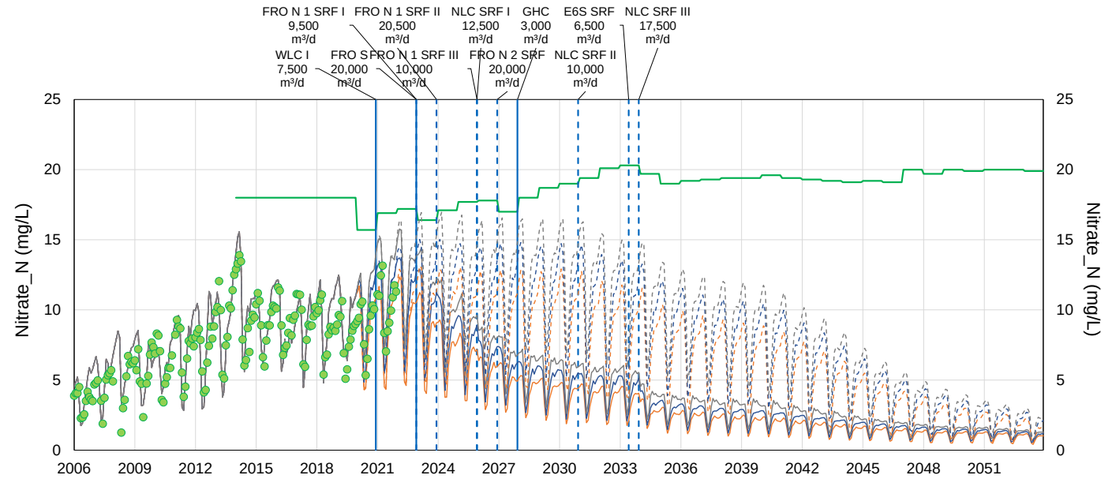
Figure J-1: Projected Monthly Average Concentrations of Nitrate at Order Stations between 2006 and 2053

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)



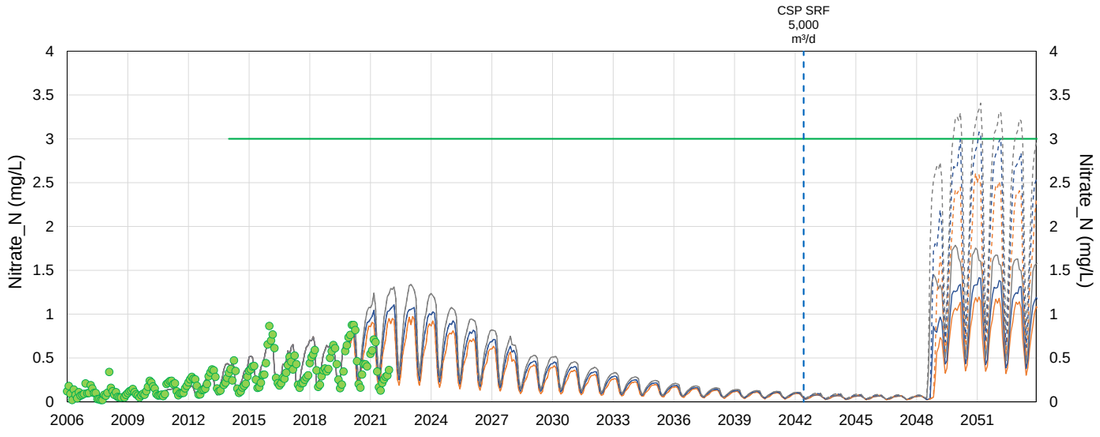
Note: This location is also the GHO Fording River Compliance Point. Site Performance Objective is hardness dependent from 2023 onward and is calculated using the following formula: N (in mg-N/L) = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$.; it varies with time to reflect projected hardness concentrations in the month when maximum monthly nitrate concentrations are projected to occur.

(b) Fording River downstream of Line Creek (LC_LC5; 0200028)



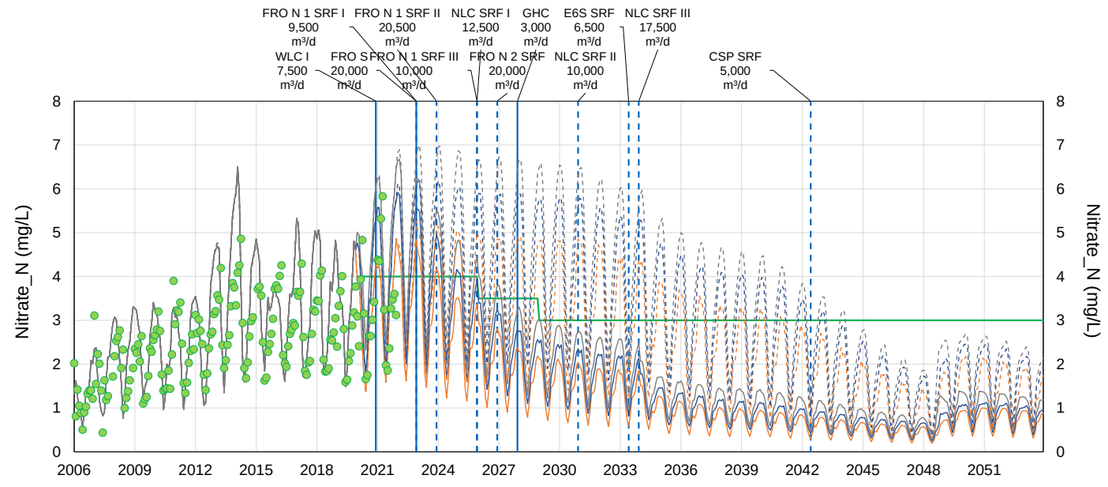
Note: Site Performance Objective is hardness dependent from 2019 onward and is calculated using the following formula: N (in mg-N/L) = $10^{1.0003\log10(\text{hardness})-1.52}$ where hardness is in mg/L of $CaCO_3$.; it varies with time to reflect projected hardness concentrations in the month when maximum monthly nitrate concentrations are projected to occur.

(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)



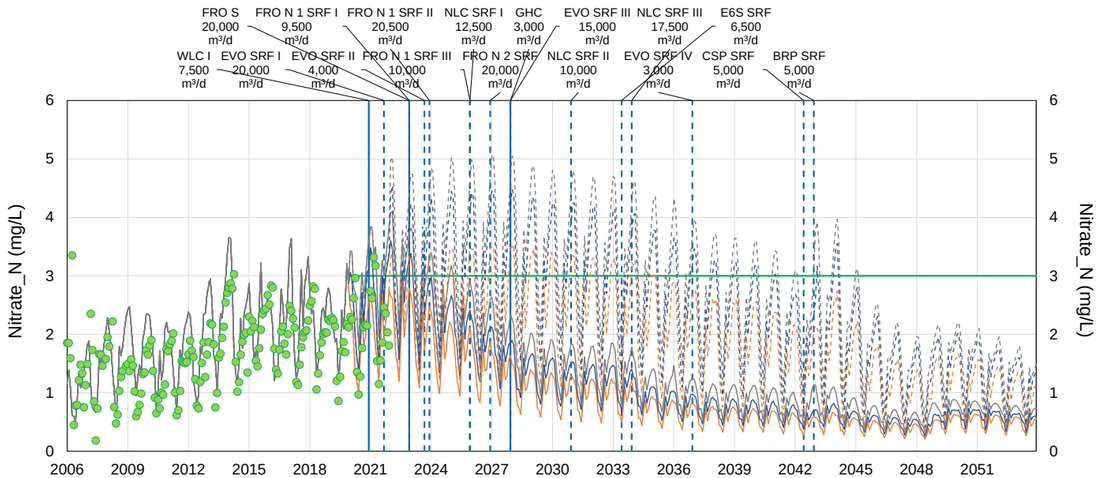
Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)

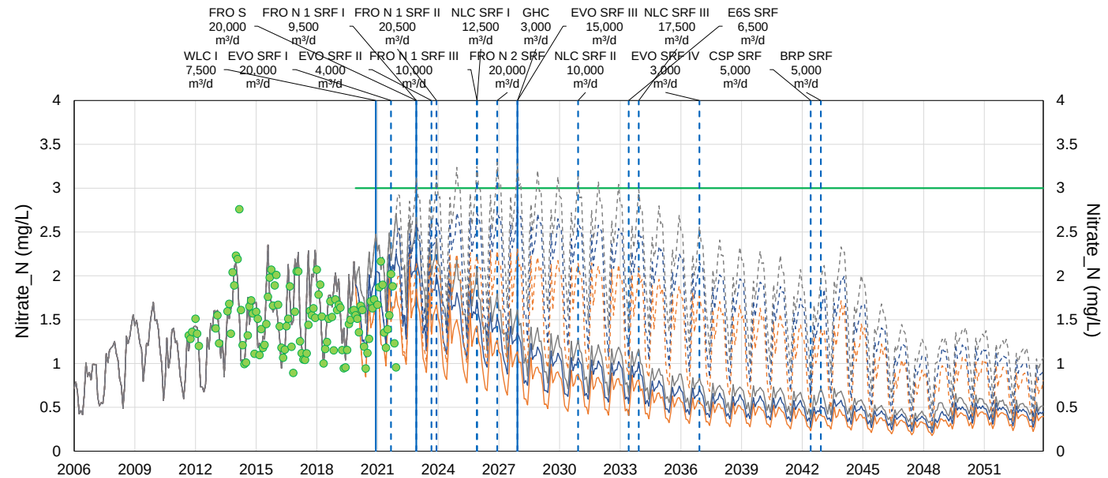


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

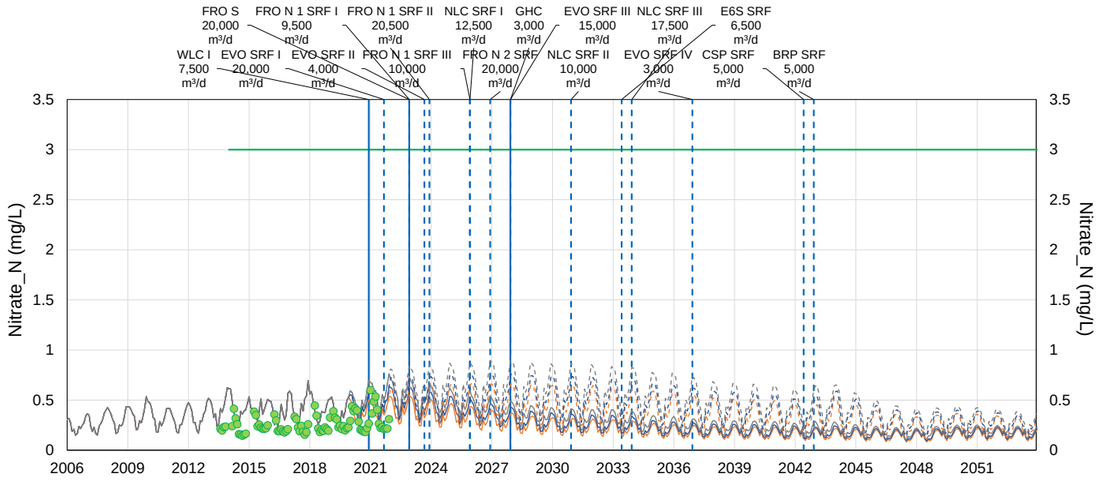
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



(g) Koocanusa Reservoir (RG_DSELK; E300230)



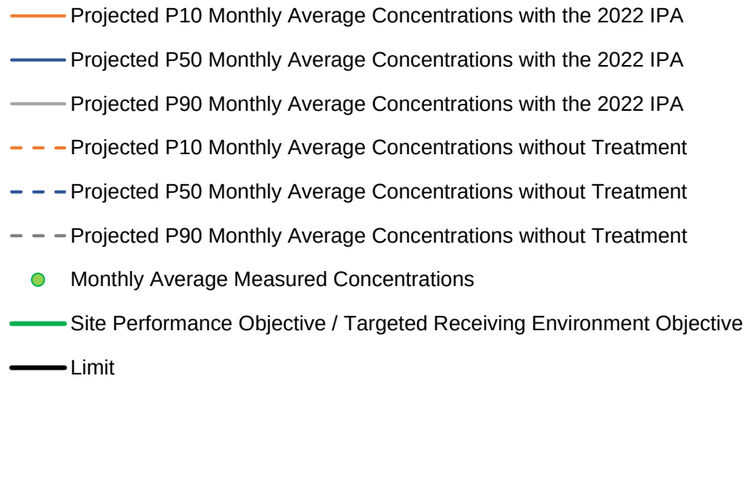
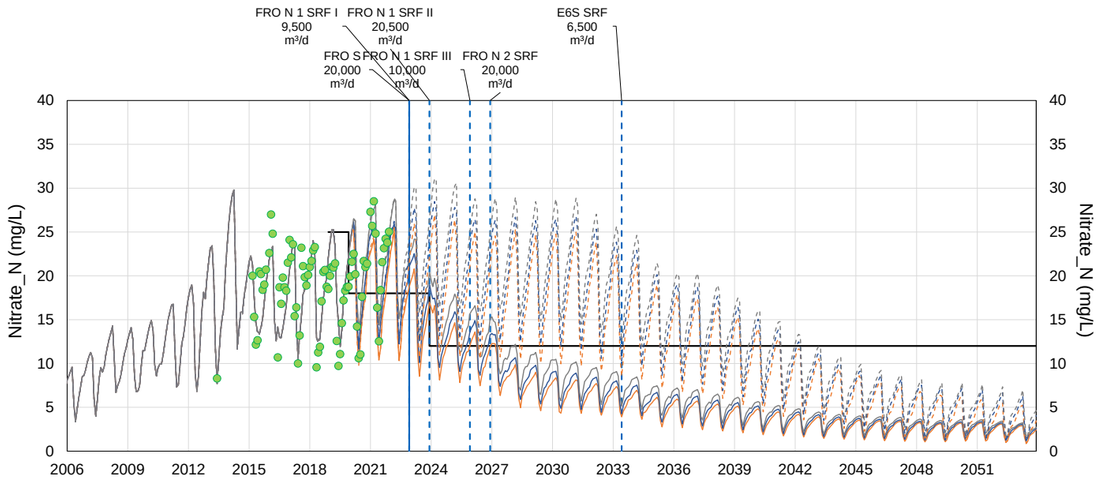
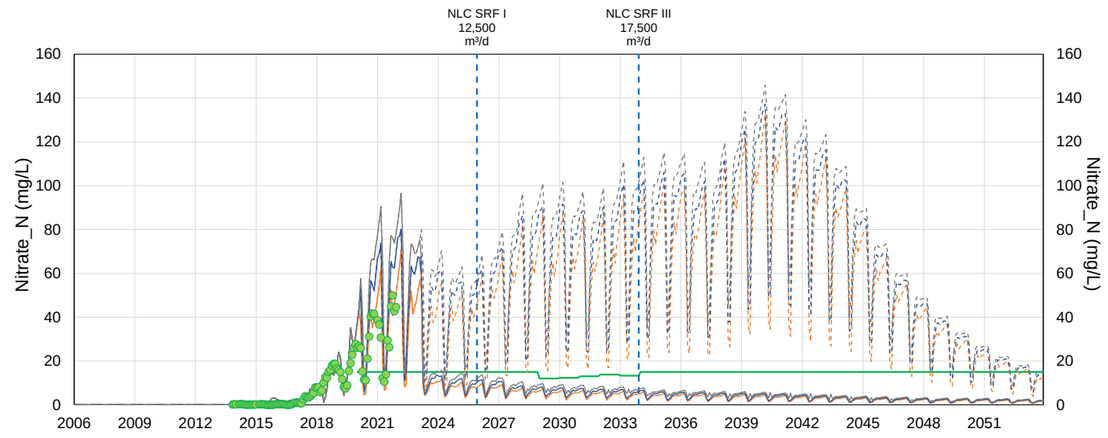


Figure J-2: Projected Monthly Average Concentrations of Nitrate at Compliance Points and in LCO Dry Creek between 2006 and 2053

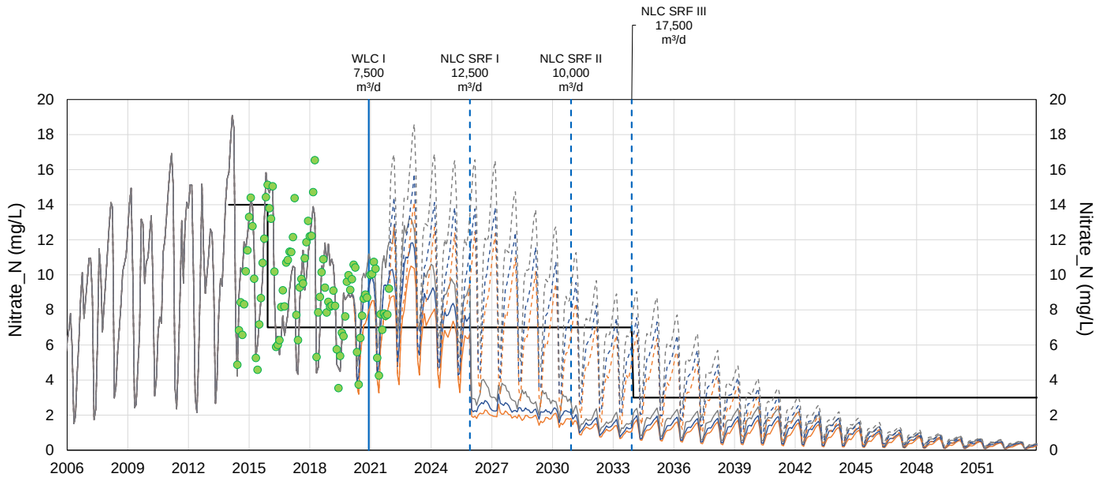
(a) FRO Compliance Point (FR_FRABCH; E223753)



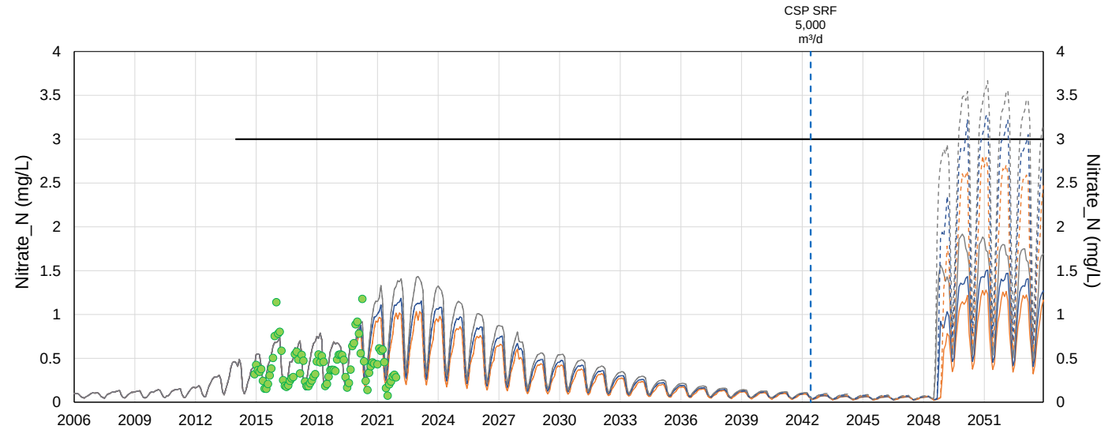
(b) Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)



(c) LCO Compliance Point (LC_LCDSSLCC; E297110)

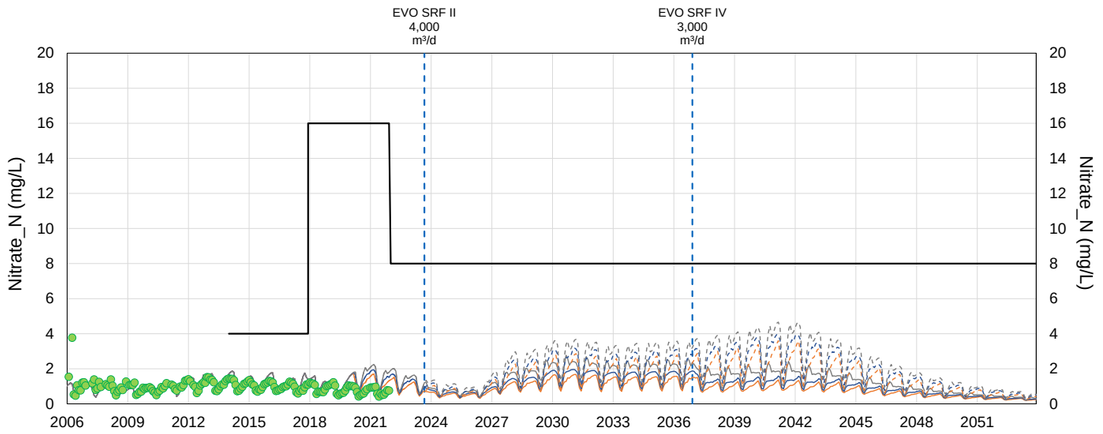


(d) GHO Elk River Compliance Point (GH_ERC; E300090)

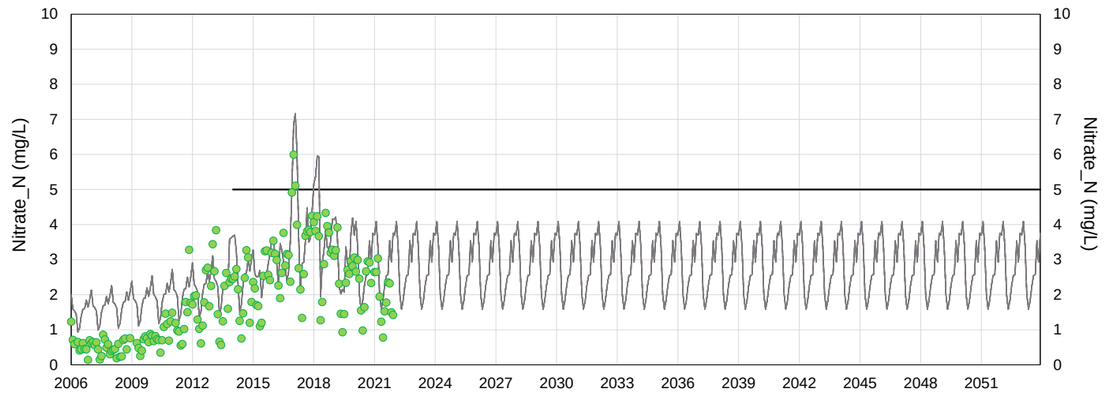


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) EVO Harmer Compliance Point (EV_HC1; E102682)

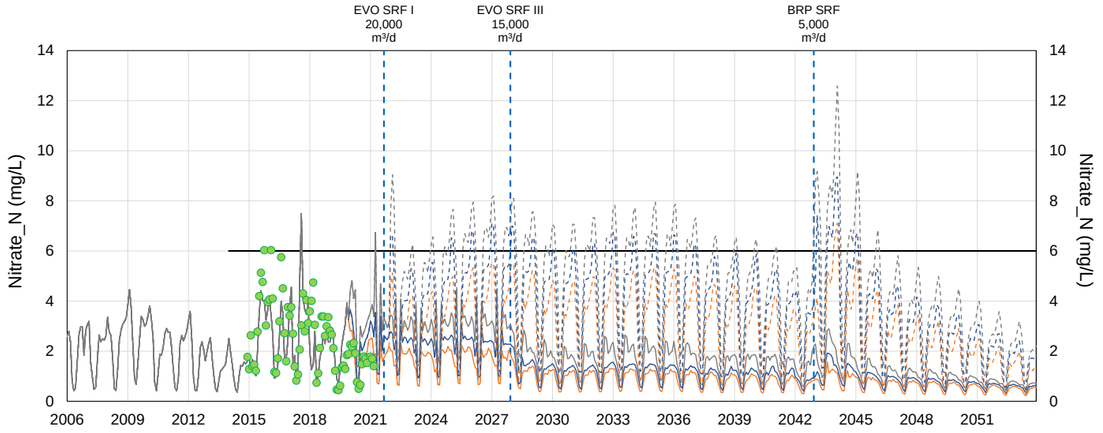


(f) CMO Compliance Point (CM_MC2; E258937)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

(g) EVO Michel Creek Compliance Point (EV_MC2; E300091)



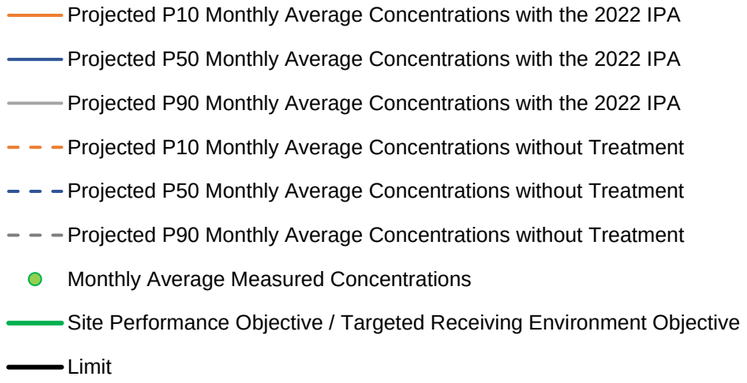
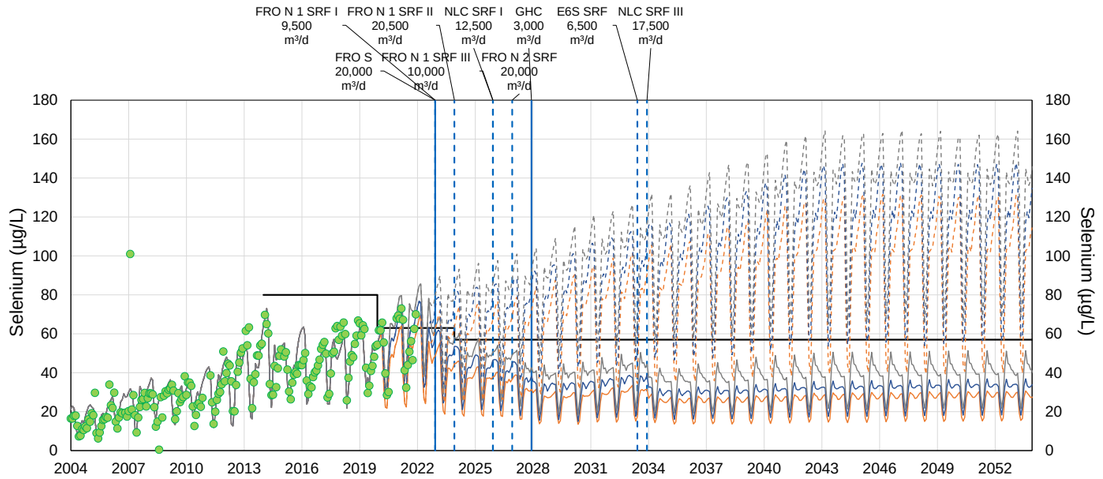


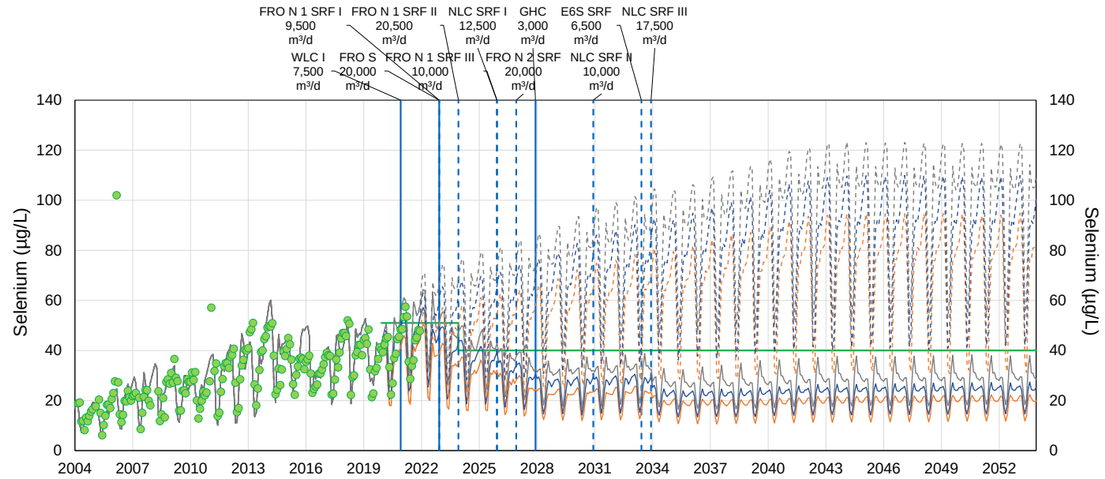
Figure J-3: Projected Monthly Average Concentrations of Selenium at Order Stations between 2004 and 2053

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)

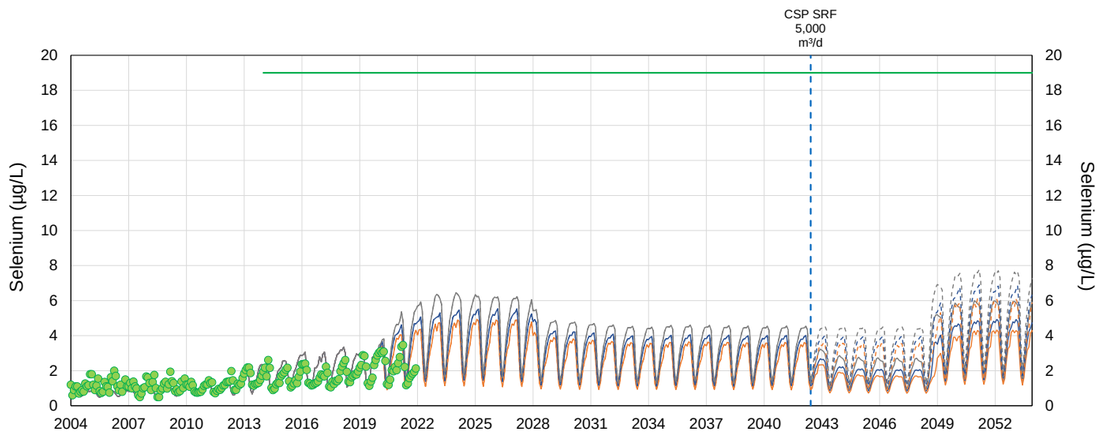


Note: This location is also the GHO Fording River Compliance Point.

(b) Fording River downstream of Line Creek (LC_LC5; 0200028)

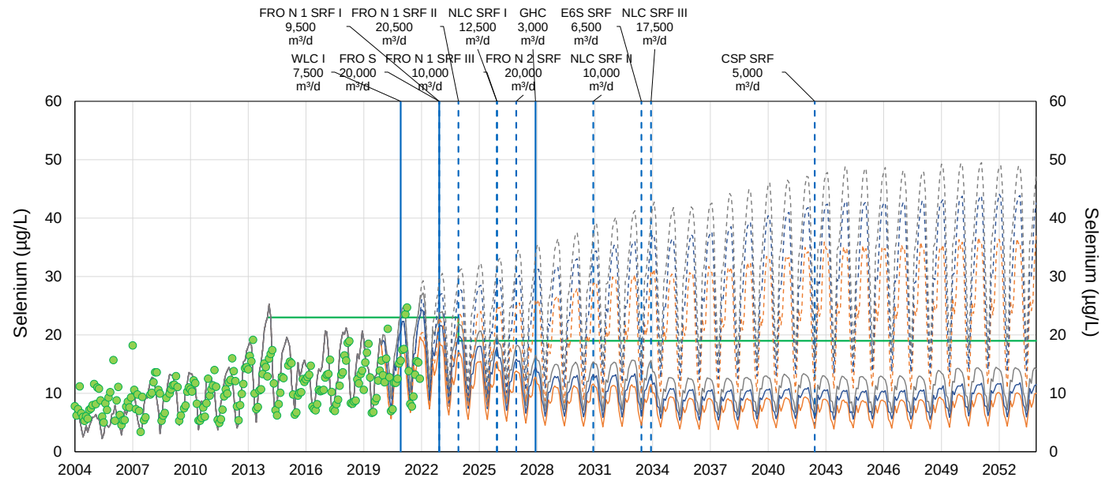


(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)

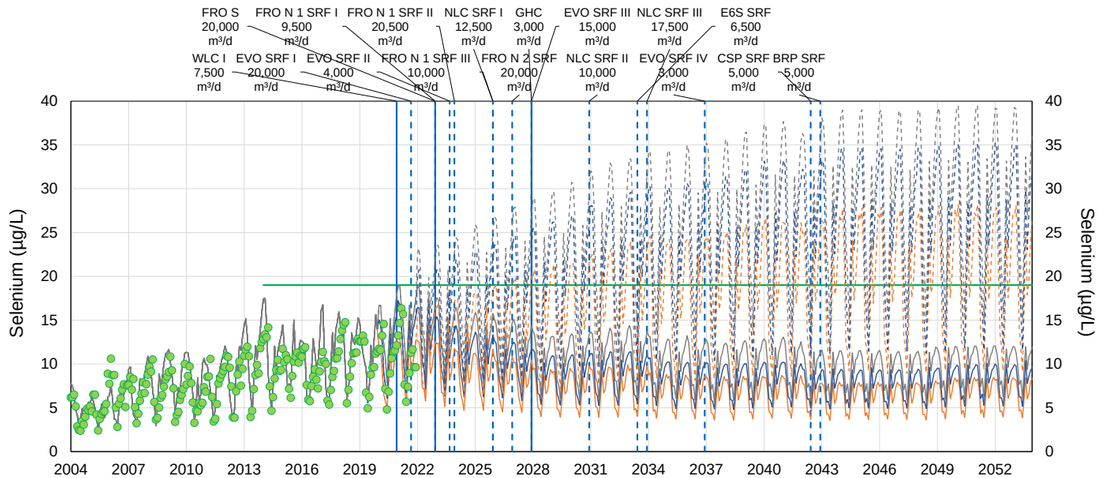


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

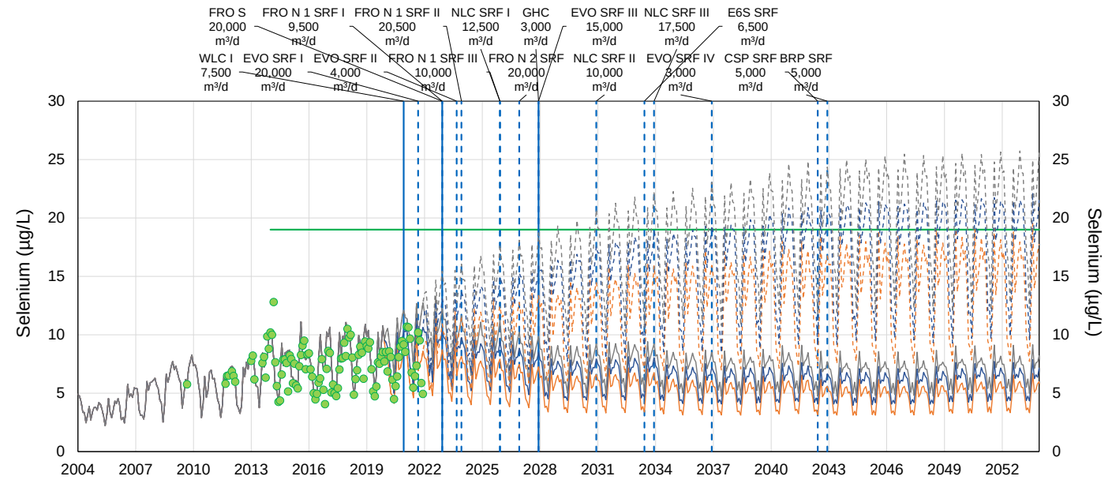
(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)



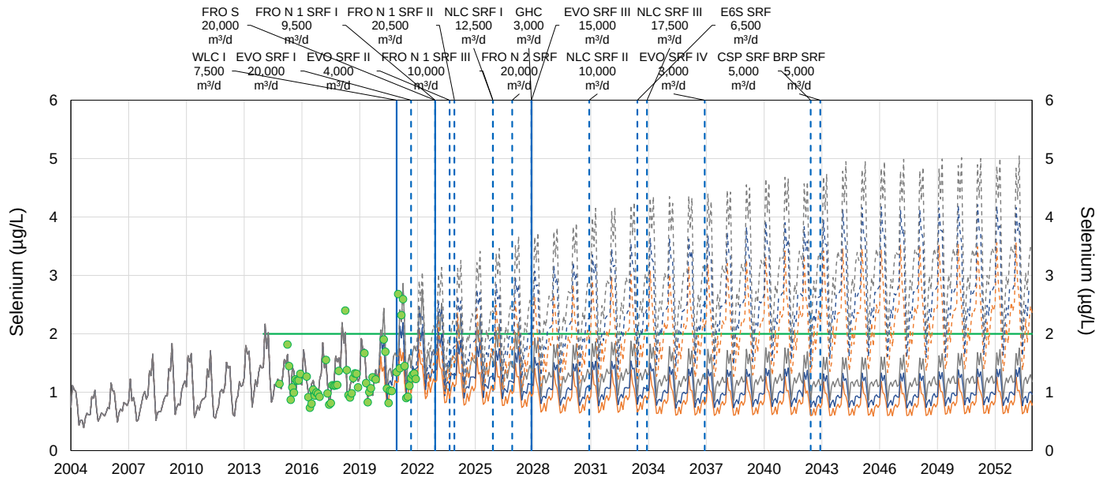
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



(g) Koocanusa Reservoir (RG_DSELK; E300230)



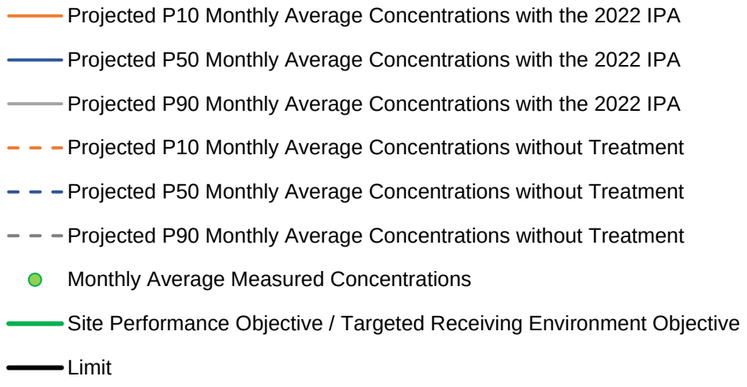
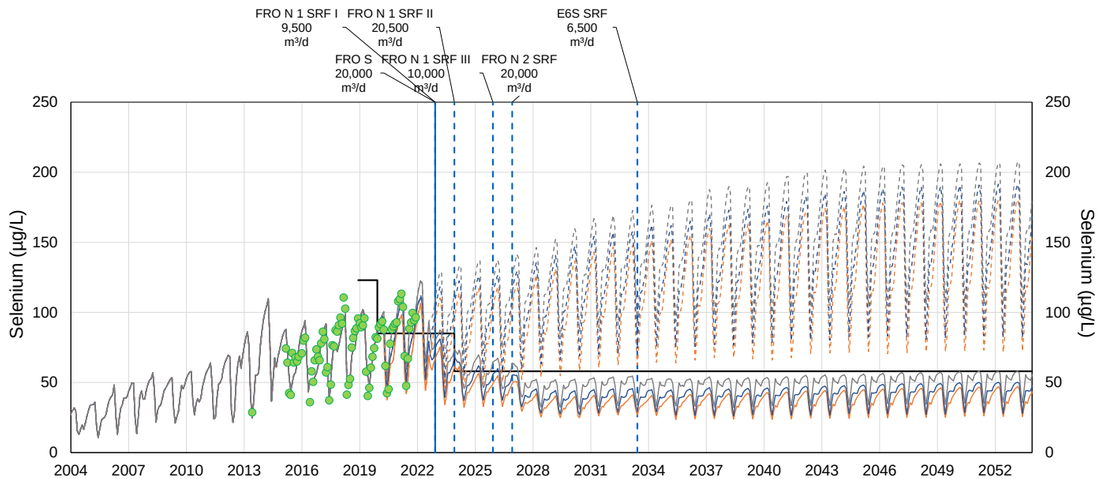
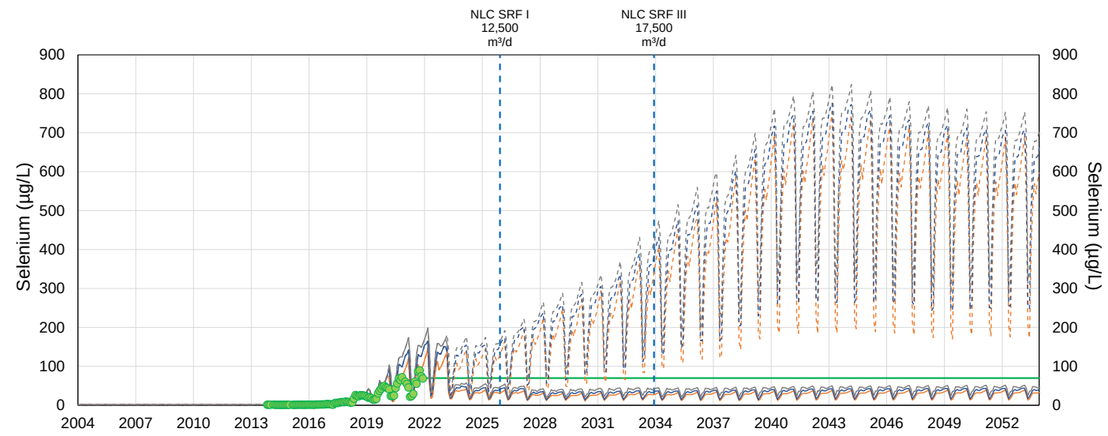


Figure J-4: Projected Monthly Average Concentrations of Selenium at Compliance Points and in LCO Dry Creek between 2004 and 2053

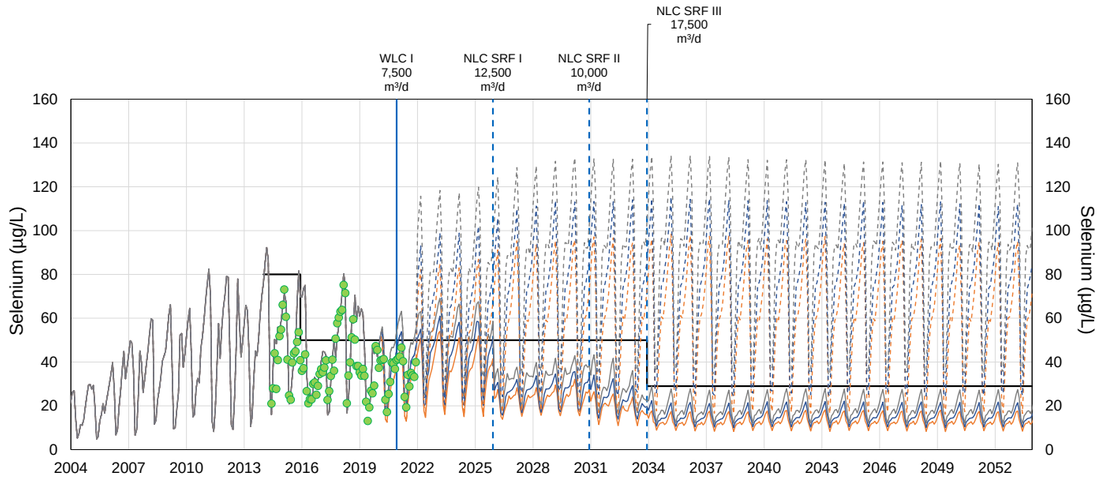
(a) FRO Compliance Point (FR_FRABCH; E223753)



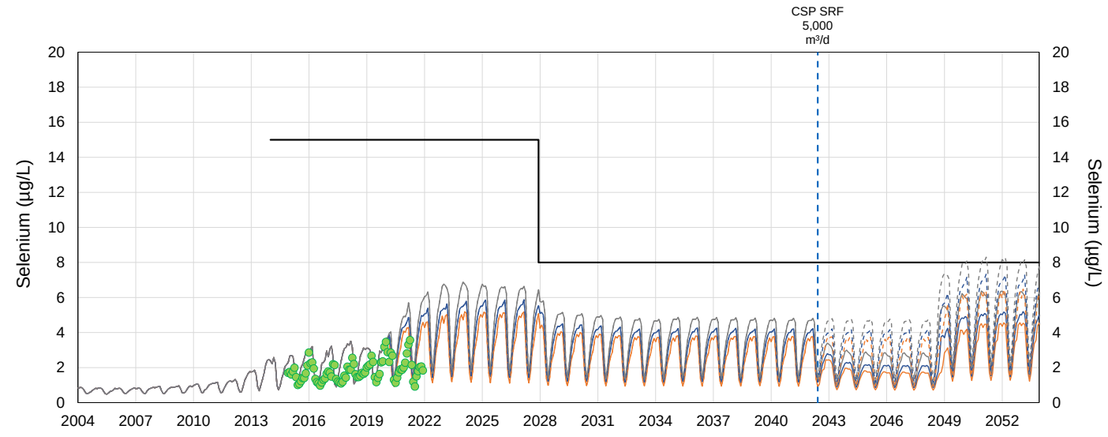
(b) Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)



(c) LCO Compliance Point (LC_LCDSSLCC; E297110)

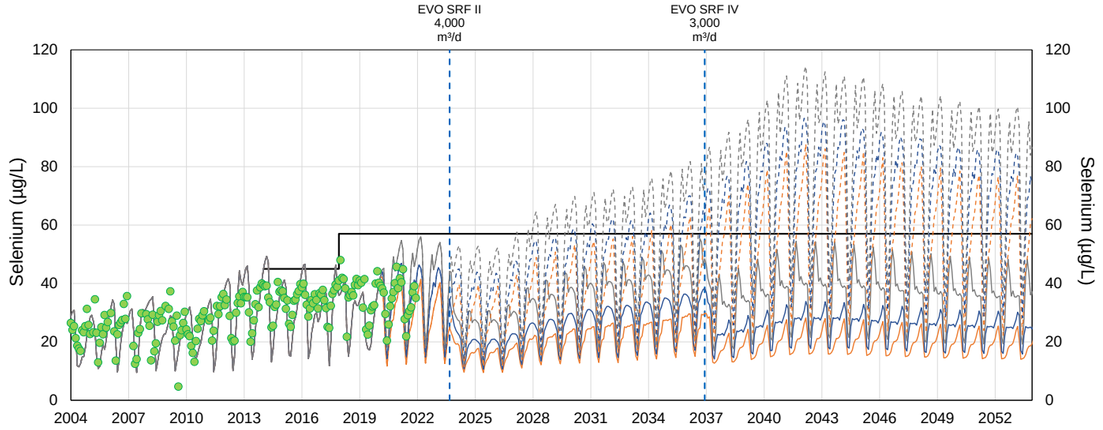


(d) GHO Elk River Compliance Point (GH_ERC; E300090)

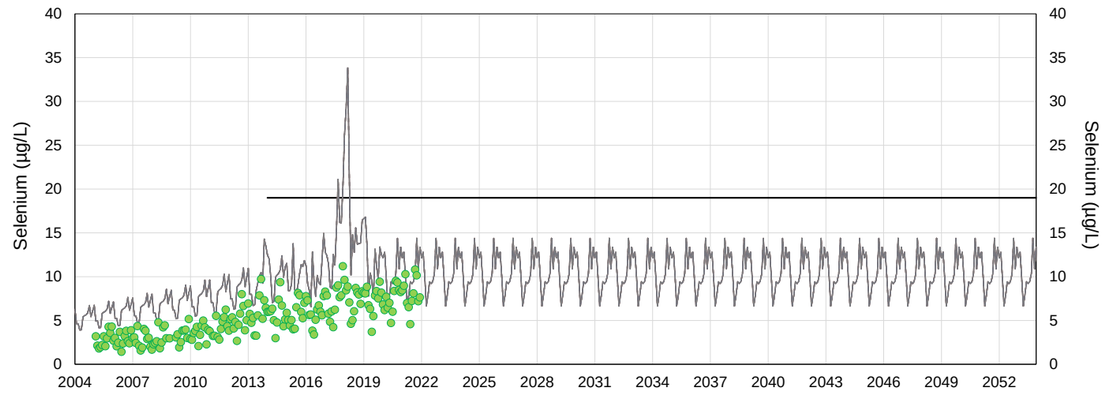


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) EVO Harmer Compliance Point (EV_HC1; E102682)

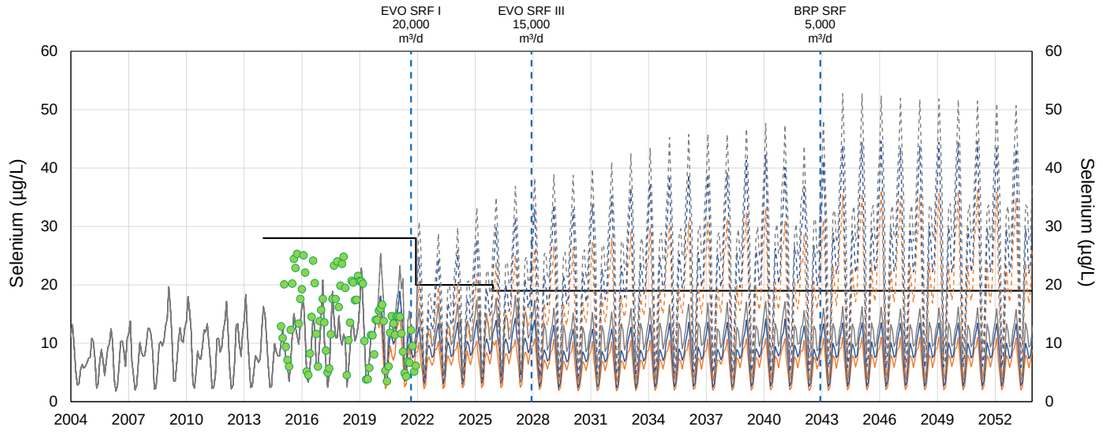


(f) CMO Compliance Point (CM_MC2; E258937)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

(g) EVO Michel Creek Compliance Point (EV_MC2; E300091)



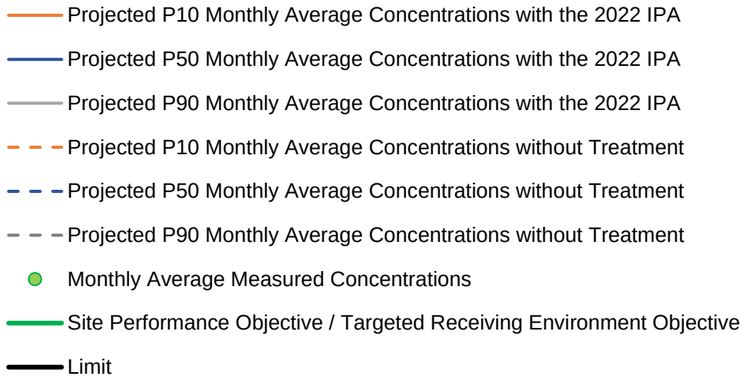
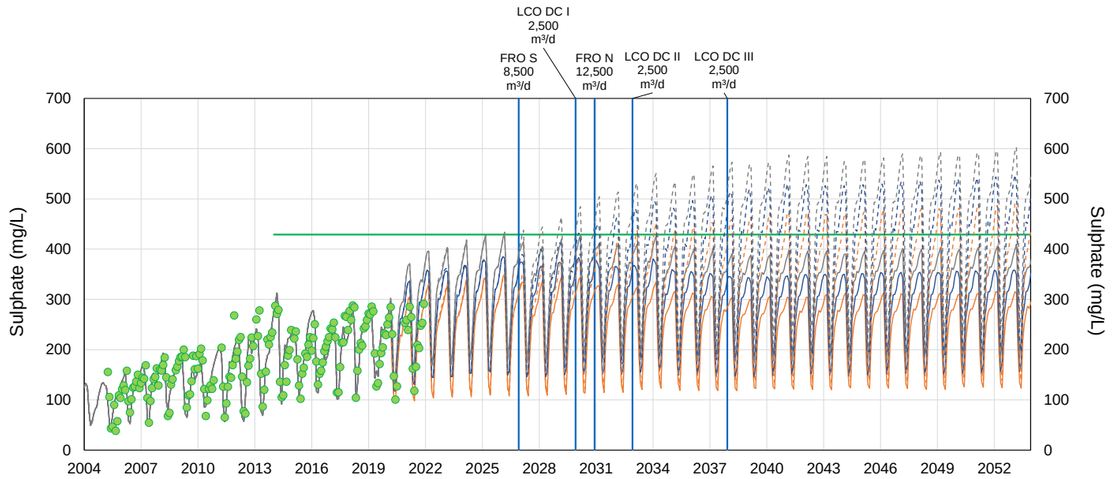
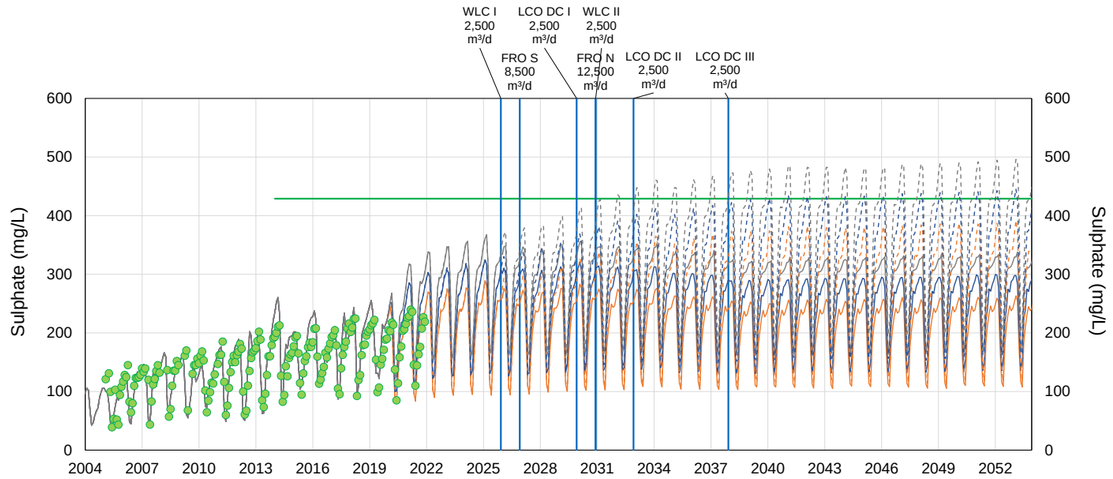


Figure J-5: Projected Monthly Average Concentrations of Sulphate at Order Stations between 2004 and 2053

(a) Fording River downstream of Greenhills Creek (GH_FR1; 0200378)

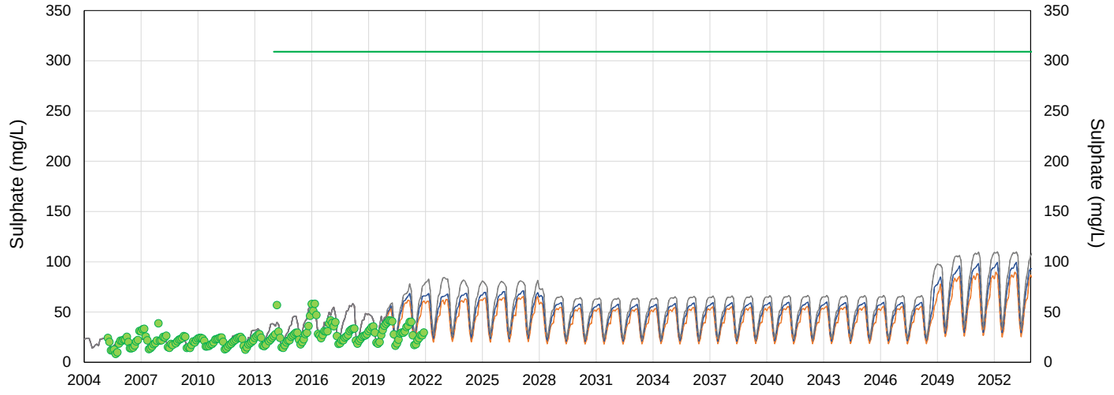


(b) Fording River downstream of Line Creek (LC_LC5; 0200028)

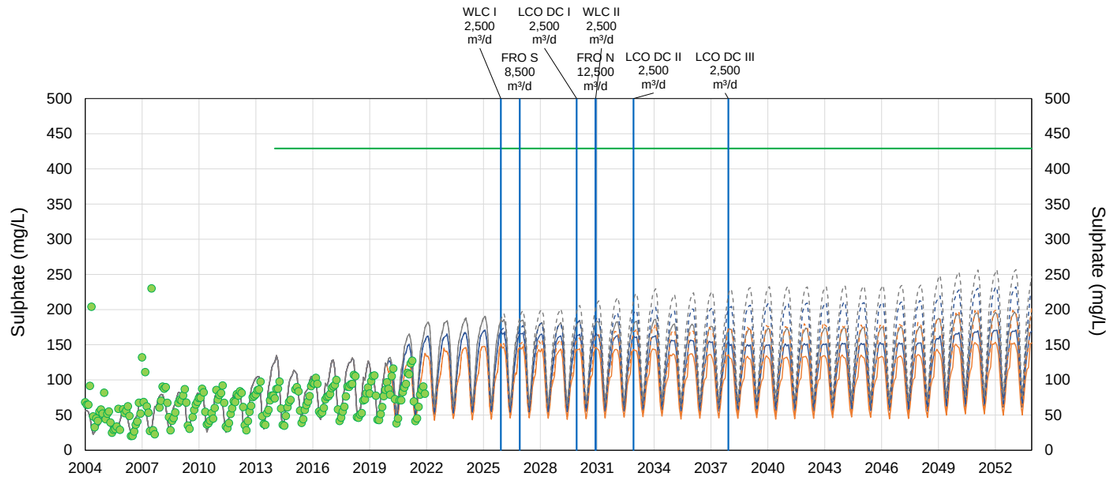


Note: This location is also the GHO Fording River Compliance Point.

(c) Elk River upstream of Boivin Creek (GH_ER1; E206661)

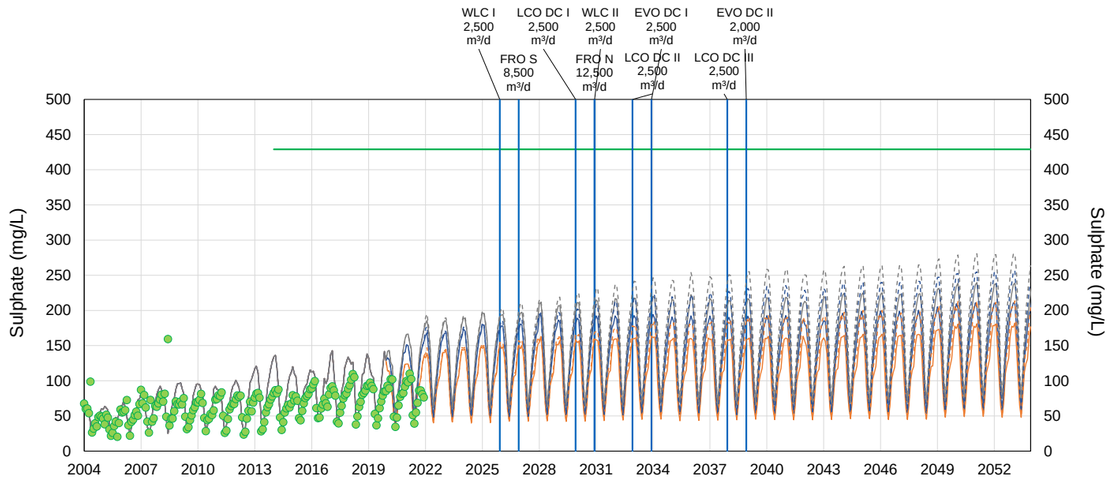


(d) Elk River upstream of Grave Creek (EV_ER4; 0200027)

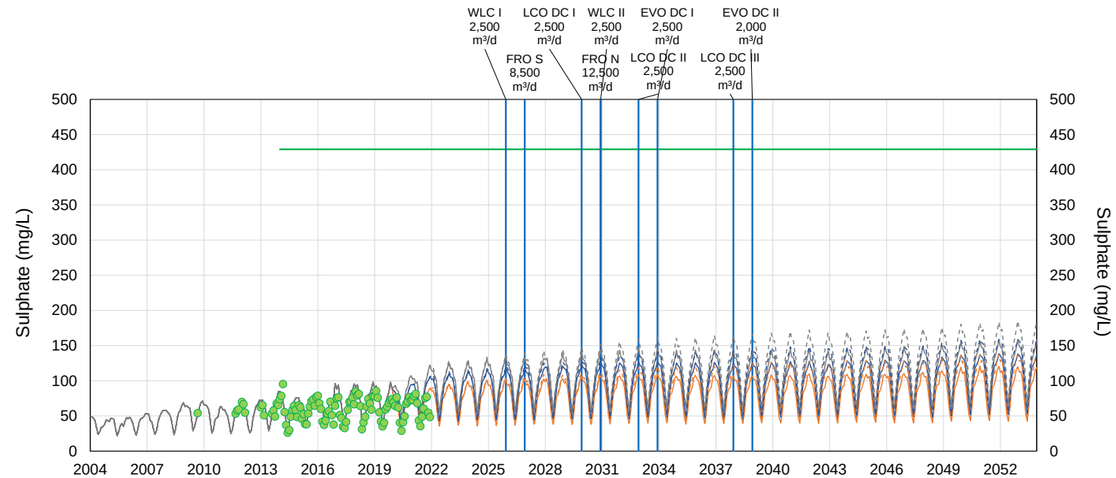


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

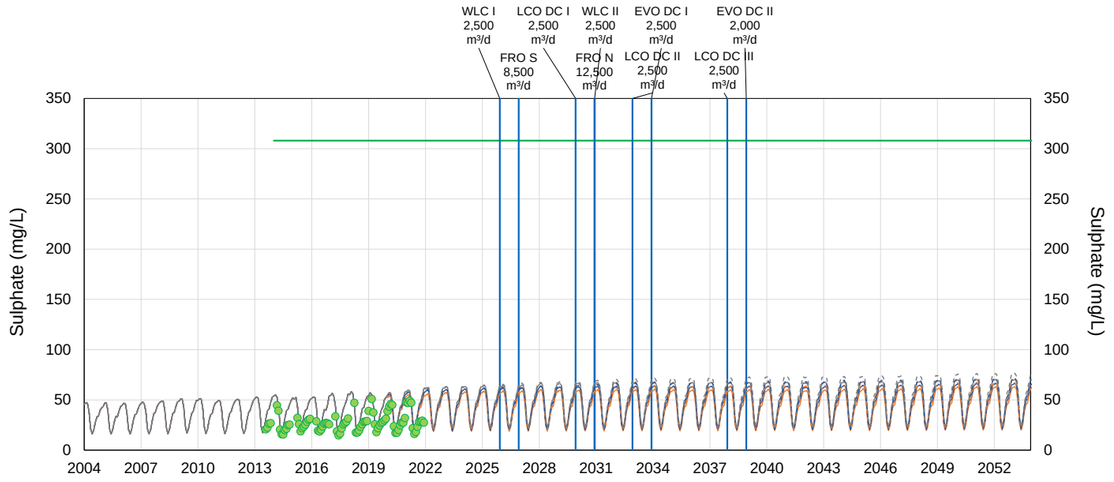
(e) Elk River downstream of Michel Creek (EV_ER1; 0200393)



(f) Elk River at Elko Reservoir (RG_ELKORES; E294312)



(g) Koocanusa Reservoir (RG_DSELK; E300230)



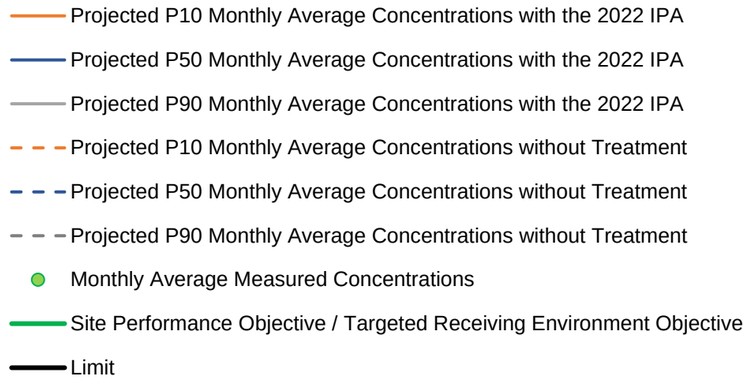
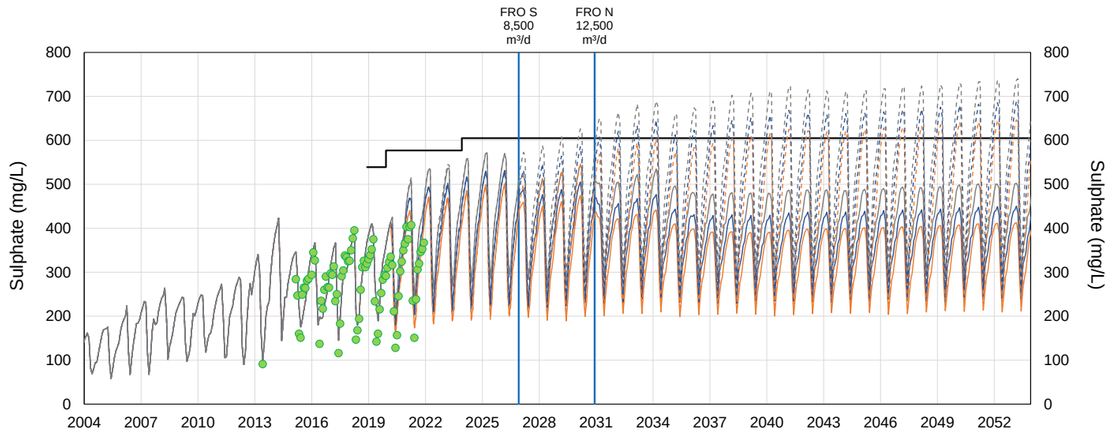
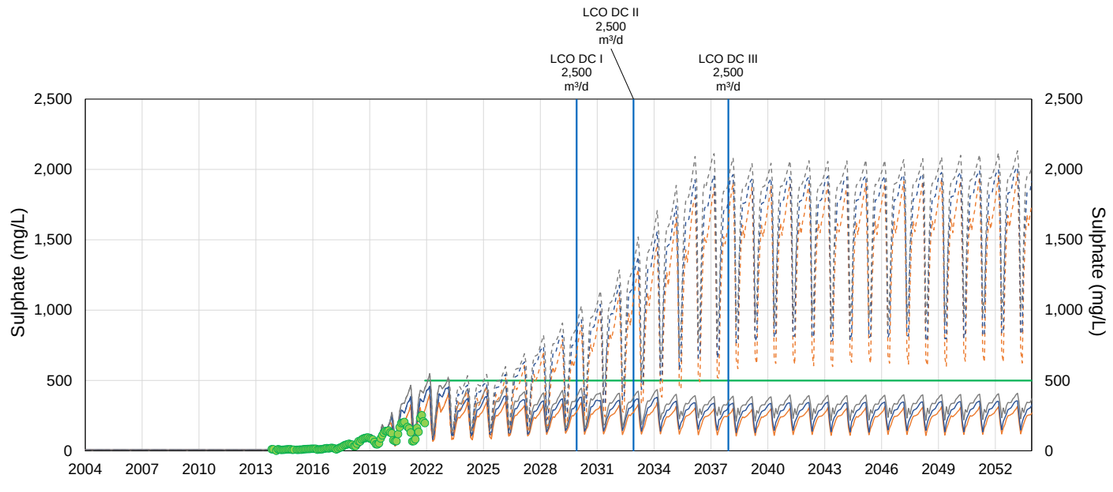


Figure J-6: Projected Monthly Average Concentrations of Sulphate at Compliance Points and in LCO Dry Creek between 2004 to 2053

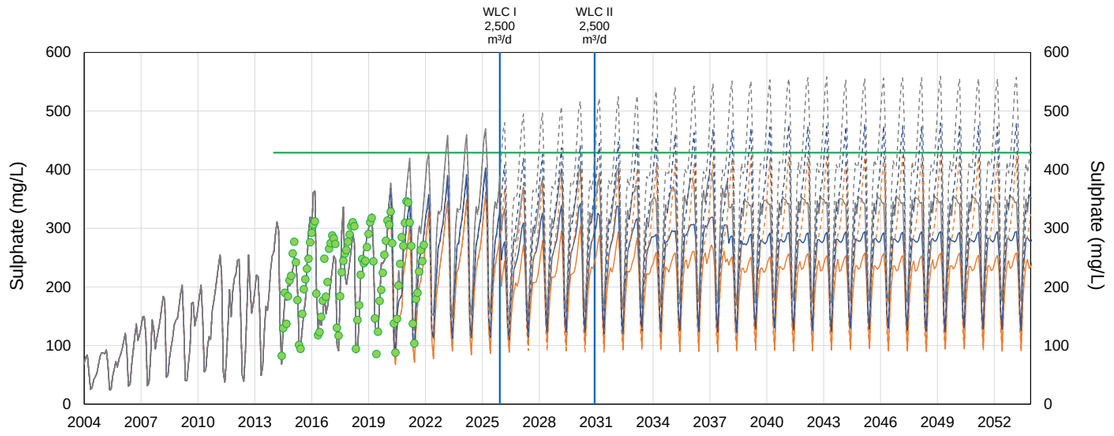
(a) FRO Compliance Point (FR_FRABCH; E223753)



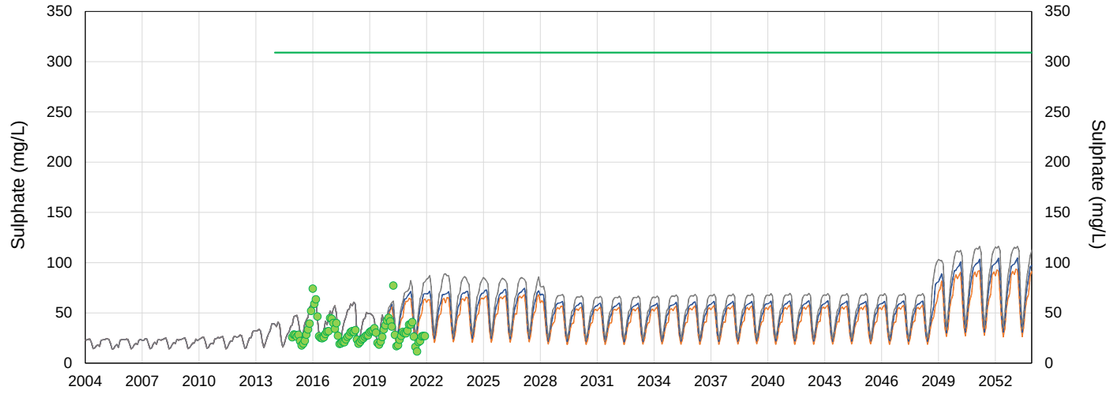
(b) Dry Creek downstream of Sedimentation Ponds (LC_DCDS; E295210)



(c) LCO Compliance Point (LC_LCDSSLCC; E297110)

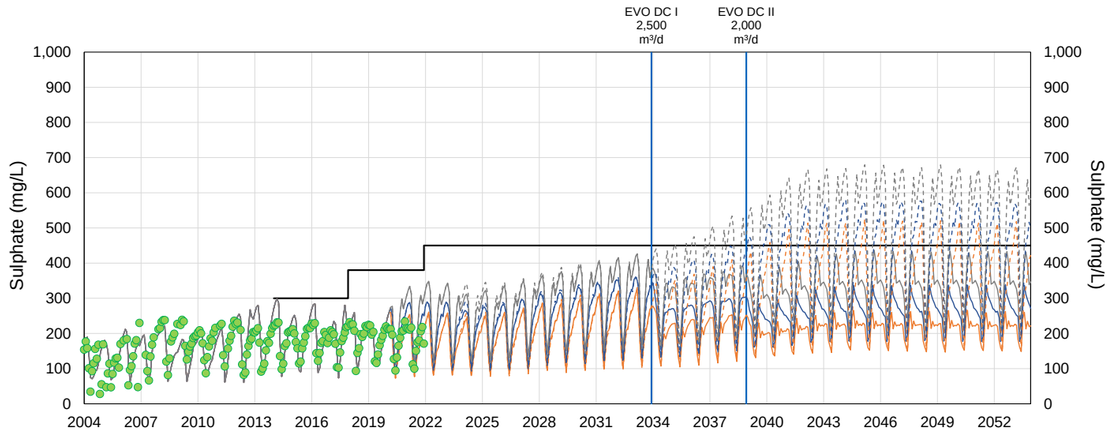


(d) GHO Elk River Compliance Point (GH_ERC; E300090)

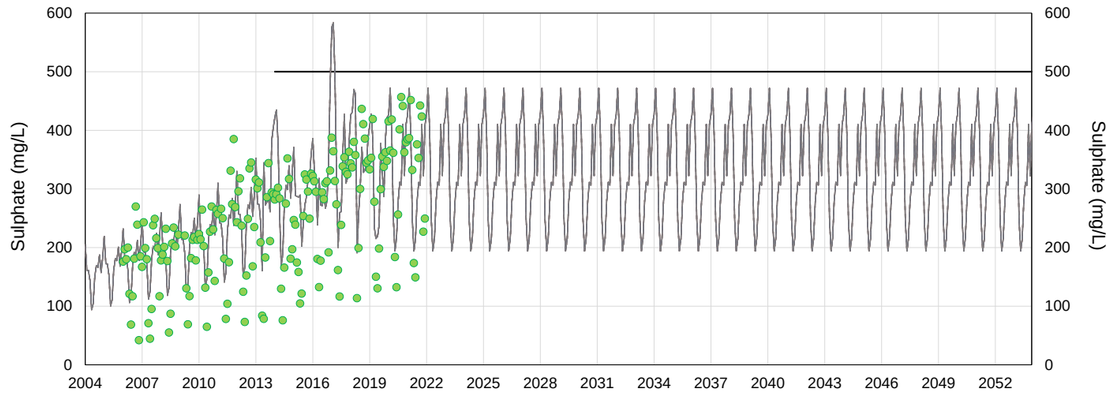


Note: Projected concentrations increase in 2050 because Cougar Pit Phase 6 at Greenhills Operations is modelled to spill.

(e) EVO Harmer Compliance Point (EV_HC1; E102682)

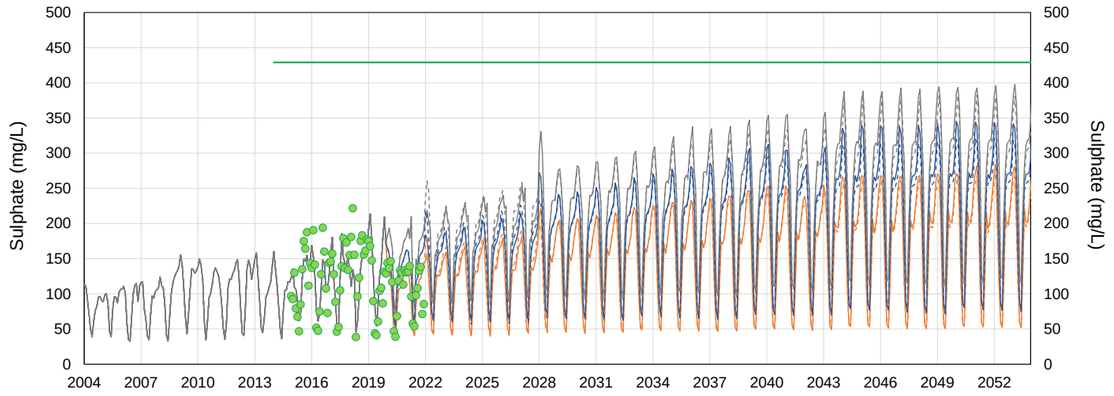


(f) CMO Compliance Point (CM_MC2; E258937)



Note: Projected concentrations are from the CMO Water and Load Balance Model.

(g) EVO Michel Creek Compliance Point (EV_MC2; E300091)



- Projected P10 Monthly Average Concentrations with the 2022 IPA
- Projected P50 Monthly Average Concentrations with the 2022 IPA
- Projected P90 Monthly Average Concentrations with the 2022 IPA
- Projected P10 Monthly Average Concentrations without Treatment
- Projected P50 Monthly Average Concentrations without Treatment
- Projected P90 Monthly Average Concentrations without Treatment
- Monthly Average Measured Concentrations
- Site Performance Objective / Targeted Receiving Environment Objective
- Limit