Implementation Guidance for the Idaho Selenium Criteria for Aquatic Life

Water Quality: Docket No. 58-0102-1701—Final Rule

State of Idaho

Department of Environmental Quality

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Acknowledgments

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Abbreviations, Acronyms, and Symbols

AU	assessment unit
BAF	bioaccumulation factor
CFR	Code of Federal Regulations
CWA	Clean Water Act
DEQ	Idaho Department of Environmental Quality
EPA	United States Environmental Protection Agency
FST	fishless stream translator
HUC	hydrologic unit code
IDAPA	numbering designation for Idaho administrative rules
IPDES	Idaho Pollutant Discharge Elimination System
L/g	liter per kilogram
µg/L	micrograms per liter
mg/L	milligrams per liter
mg/kg dw	milligrams per kilogram dry weight
NPDES	National Pollutant Discharge Elimination System
RPTE	reasonable potential to exceed
Se	selenium
TMDL	total maximum daily load
US	United States
WQBEL	water quality-based effluent limit
WQC	water quality criterion
YOY	young of year

Executive Summary

This document describes DEQ's selenium criteria and implementation procedures. The criteria discussed reflect the latest scientific knowledge, indicating that selenium toxicity to aquatic life is based primarily on organisms consuming selenium-contaminated food, rather than by being exposed only to selenium dissolved in water. DEQ's final criteria are expressed both in terms of fish tissue concentration (egg/ovary, whole body, muscle) and selenium water concentration in lentic and lotic freshwater bodies.

The Idaho Department of Environmental Quality (DEQ) will use this guidance to implement these criteria across programs. This includes, but is not limited to, providing guidance for sample collection and interpretation of results, including assessment of fishless waters and the concept of *nearest downstream waters,* as well as fish tissue sample size and monitoring requirements. The guidance cannot modify the statewide rule, the site-specific criteria, or the procedures for establishing new site-specific criteria under Idaho's "Water Quality Rules" (IDAPA 58.01.02.275).

This document provides guidance only. It does not establish or affect legal rights or obligations. It does not establish a binding norm and cannot be finally determinative of the issues addressed. Agency decisions in any situation will be made by applying the Clean Water Act and US Environmental Protection Agency (EPA) and DEQ regulations based on specific facts presented and scientific information available at the time.

In regard to the Idaho Pollutant Discharge Elimination System (IPDES) permits, DEQ acknowledges the challenges a fish tissue criterion presents in the context of water quality-based permitting. As EPA has noted, compliance with an IPDES permit is assessed against the effluent limits and other terms of the permit.

1 Introduction

Consistent with the Clean Water Act, states must develop criteria that protect designated beneficial uses and are based on sound science (CWA § 303(c)(2)(A), 40 CFR 131.11(a)). Additionally, states are required to adopt criteria for which EPA has published recommended criteria under CWA§ 304(a) (CWA § 303(c)(2)(B)). States have the discretion to adopt the EPA's criteria recommendations, the EPA's recommendations modified to reflect site-specific conditions, or criteria based on other scientifically defensible methods.

To reflect the latest science and bolster the protection of US waters in Idaho, Idaho updated its aquatic life criteria for selenium based on US Environmental Protection Agency's (EPA's) 2016 recommendation (EPA 2021a). The Idaho Department of Environmental Quality (DEQ) developed the aquatic life criteria for selenium in accordance with the Clean Water Act (CWA § 303(c)) and federal regulations (40 CFR 131). DEQ developed selenium standards after EPA's 2016 recommendations, but EPA made minor revisions to their selenium guidance in 2021. In October 2021, EPA published draft technical supporting documents, and accepted comments until January 2022.

Both EPA's recommended national criterion and DEQ's statewide criterion are based on the four most sensitive taxa in the national toxicity data set. The species most sensitive to selenium in the national toxicity data set is White Sturgeon (*Acipenser transmontanus*) (EPA 2021a). In Idaho, however, White Sturgeon historical range is limited to the main stems of the Kootenai, Snake, and Salmon Rivers. To further protect water quality where White Sturgeon may be present, DEQ also includes certain upstream waters where White Sturgeon are not expected to be found but that contribute to downstream water quality (IDFG 2008).

DEQ's statewide selenium criterion and the site-specific selenium criteria for select surface waters consists of the following: (1) fish egg-ovary; (2) fish whole-body and/or muscle; (3) water column, including one value for lentic (still water) and one value for lotic (running water) aquatic systems; and (4) water column intermittent criterion to account for potential chronic effects from short-term exposures to high concentrations in lentic and lotic aquatic systems.

1.1 Purpose

This document provides guidance to DEQ staff, the regulated community, and the general public for implementing the selenium statewide and site-specific criteria for aquatic life in Idaho. This guidance applies only to freshwater aquatic systems in Idaho and to fishless streams that feed into fish-bearing waters. The criteria reflect the latest scientific knowledge, which indicates that selenium toxicity to aquatic life is based primarily on organisms consuming selenium-contaminated food, rather than exposure to selenium dissolved in water. The final criteria are expressed both in terms of fish tissue concentration (egg/ovary, whole body, muscle) and water concentration (lentic, lotic). DEQ developed this guidance, based upon Idaho's "Water Quality Standards" (IDAPA 58.01.02).

1.2 Sources of Selenium in the Environment

Selenium is a naturally occurring element present in sedimentary rocks and soils. It is also present in the aquatic environment as methyl derivatives of selenium, naturally occurring in freshwaters through methylation by bacteria (Ranjard et.al. 2003) (EPA 2021a). Natural weathering of selenium-bearing geologic strata containing selenium can lead to leaching into ground water and surface water. Three major anthropogenic activities are known to cause increased selenium mobilization and introduction into aquatic systems: (1) mining of metals and minerals, (2) refinement and use of fossil fuels, and (3) irrigation of selenium rich soils.

Southeastern Idaho is one of the world's major phosphate ore producing regions, and phosphate mining has been an important industry since the early 20th century. Past studies in Caribou and adjacent counties have identified the waste rock dumps as sources of pollution that may pose a risk to human health and the environment. Rain and snowmelt infiltrate through the waste rock in these dumps, which transport selenium and other contaminants to the surrounding environment. As a result, these contaminants are known or suspected to be present in ground water, surface water, sediment, soils, plants, and animals in the area and can be transported beyond the former mining areas (EPA 2012). There are 13 historical mines in the Phosphate Resource Area in southeastern Idaho undergoing remedial activities under the Comprehensive, Environmental Response and Liability Act to minimize impacts of selenium and other contaminants to human health and the environment (Phosphate Resource Area Project June 2021 Fact Sheet [DEQ 2021a]).

Combustion of fossil fuels, especially coal, may be a major source of the anthropogenic introduction of selenium in the environment. Coal is enriched in selenium relative to selenium's concentration in most other rocks and relative to selenium in the Earth's crust (Coleman, et al. 1993).

Irrigation of selenium rich soils for crop production in arid and semiarid regions can mobilize selenium and move it off site in surface water runoff or via leaching into ground water. Where deposits of cretaceous marine shales occur, they can weather to produce high selenium soils; such soils are present in many areas of the western United States (Lemly 1993a). In semiarid areas of the West, irrigation water applied to soils containing soluble selenium can leach selenium. The excess water (in tile drains or irrigation return flow) containing selenium can be discharged into basins, ponds, or streams.

1.3 Effects of Selenium on Fish

Selenium is a nutritionally essential element for animals in small amounts, but toxic at higher concentrations. However, the most deleterious effects on aquatic organisms are due to its bioaccumulative properties; these chronic effects are found at lower concentrations than acute effects. Organisms exposed to selenium in aquatic environments primarily accumulate selenium through their diets, not directly through the water (Chapman et al. 2010). When selenium bioaccumulates in the aquatic food chain, it can cause chronic effects, including reproductive impairments (e.g., larval deformity or mortality) and can adversely affect juvenile growth and survival.

The most well-documented, overt, and severe toxic symptoms in fish are reproductive teratogenesis and larval mortality. Egg-laying vertebrates appear to be the most sensitive taxa, with toxicity resulting from maternal transfer to eggs. In studies involving young organisms exposed through transfer of selenium from adult female fish into their eggs, the most sensitive diagnostic indicators of selenium toxicity in vertebrates occur when developing embryos metabolize organic selenium that is present in egg albumen or yolk. It is then further metabolized by larval fish after hatching (EPA 2021a).

A variety of lethal and sublethal deformities can occur in developing fish exposed to selenium affecting both hard and soft tissues (Lemly 1993b). Developmental malformations are among the most evident and diagnostic symptoms of chronic selenium poisoning in fish. Distorted spine and fins can reduce swimming ability and overall fitness, and deformities in fish that affect feeding or respiration can be lethal shortly after hatching. Because the rate of survival of deformed young would be less than that for normal young, the percentage of deformed adults observed during biosurveys will likely understate the underlying percentage of deformed young (EPA 2021a). The toxic effect generally evaluated is the reduction in the number of normal healthy offspring compared to the starting number of eggs.

1.4 Mode of Action and Toxicity of Selenium to Fish

Selenium consumed in the diet of adult female fish is deposited in the eggs when selenium replaces sulfur in vitellogenin, which is transported to the ovary and incorporated into the developing ovarian follicle (Janz et al. 2010). The most sensitive indicators of selenium toxicity in fish larvae are effects modulated through the reproductive process and exhibited in fish larvae as teratogenic deformities such as skeletal, craniofacial, and fin deformities, and various forms of edema that result in mortality (Lemly 2002).

Although selenium has important roles in antioxidant defenses at normal dietary levels, at elevated exposure levels it can become involved in the generation of reactive oxygen species, resulting in oxidative stress with increasing exposure. Oxidative stress is a key mechanism of toxicity in vertebrate animals. More recently, oxidative stress has been proposed as the initiating event of embryo mortality and teratological effects from several chemicals (Janz et al. 2010, Chapter 6).

1.5 Bioaccumulation of Selenium in Aquatic Systems

Trace amounts of selenium are required for normal cellular function in almost all animals; however, excessive amounts of selenium can also have toxic effects. Bioaccumulation and transfer through aquatic food webs are the major biogeochemical pathways of selenium in aquatic ecosystems. Dissolved selenium oxyanions (selenate, selenite) and organic selenides are assimilated into the tissues of aquatic primary producers (trophic level 1 organisms), such as periphyton, phytoplankton, and vascular macrophytes, and are subsequently biotransformed into organo-selenium. These organisms, together with other particle-bound selenium sources, constitute the particulate selenium fraction in the water column. Selenium from this particulate fraction is then transferred to aquatic primary consumers such as zooplankton, insect larvae, larval fish, and bivalves (trophic level 2), and then to predators such as fish and birds (trophic level 3 and above) (EPA 2021a). In addition to the water concentration of selenium, the process of selenium bioaccumulation in aquatic life residing in freshwater systems depends on several factors specific to each aquatic system. These factors include the water residence time, distribution of selenium between particulate and dissolved forms, species of selenium in water, bioaccumulation in prey, and trophic transfer to higher trophic-level consumers.

2 Aquatic Life Criteria for Selenium

Idaho's numeric selenium criteria for aquatic life are found in IDAPA 58.01.02.210. The standards have been summarized in Table 1. There is no specific acute criterion for aquatic life; however, the aquatic life criterion is based on chronic effects of the selenium on aquatic life and is expected to adequately protect against acute effects.

IDAPA 58.01.02.287.05 provides a site-specific selenium criterion for portions of Idaho that applies to all waters of the state except the main stems of the Kootenai, Salmon, and Snake Rivers within the historic range of White Sturgeon, as well as subbasins flowing directly into these rivers and those designated as critical salmonid habitat or Bull Trout habitat. This site-specific criterion applies in the hydrologic unit code (HUC) subbasins in IDAPA 58.01.02.287.05(a).

There is no specific selenium acute criterion for aquatic life; however, the selenium aquatic life criterion is based on chronic effects of selenium on aquatic life and is expected to adequately protect against acute effects to aquatic organisms.

Table 1. Selenium criteria for aquatic life.

Chronic					**Short-Term**
Egg-Ovary (mg/kg dw)	**Fish Tissue (mg/kg dw)**		**Water Column (µg/L)**		**Water Column (µg/L)**
Egg-Ovary	Whole-Body	Muscle	Water Lentic	Water Lotic	Water
15.1[a]	8.5[b]	11.3[b]	1.5 (30-day average)[c]	3.1 (30-day average)[c]	Intermittent Exposure Equation[c,d]
mg/kg dw – milligrams per kilogram dry weight, µg/L – micrograms per liter					

a. Egg-ovary supersedes any whole-body, muscle, or water column element when fish egg-ovary concentrations are measured. Single measurement of an average or composite sample of at least five individuals of the same species. Not to be exceeded; DEQ will evaluate all representative egg-ovary data to determine compliance with this criterion element.

b. Fish whole-body or muscle tissue supersedes water column element when both fish tissue and water concentrations are measured. Single measurement of an average or composite sample of at least five individuals of the same species where the smallest individual is no less than 75% of the total length (size) of the largest individual. Not to be exceeded; DEQ will evaluate all representative whole body or muscle data to determine compliance with this criterion element.

c. Water column values are based on dissolved total selenium in water and are derived from fish tissue values via bioaccumulation modeling. Water column values are the applicable criterion element in the absence of steady-state condition fish tissue data. In fishless waters, selenium concentrations in fish from the nearest downstream waters may be used to assess compliance using methods provided in *Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater,* EPA-822-R-16-0, Appendix K: Translation of a Selenium Fish Tissue Criterion Element to a Site-Specific Water Column Value (EPA 2016b).

d. Intermittent Exposure Equation =

$$\text{Intermittent Exposure Equation} = \frac{WQC - C_{bkgrnd}\,(1 - f_{int})}{f_{int}}$$

Where WQC is the applicable water column element, for either lentic or lotic waters; C_{bkgrnd} is the average background selenium concentration, and f_{int} is the fraction of any 30-day period during which elevated selenium concentrations occur, with f_{int} assigned a value ≥ 0.033 (corresponding to 1 day).

3 Site-Specific Aquatic Life Criteria for Selenium

Site-specific selenium criteria apply to upper Blackfoot River and Georgetown Creek watersheds, and Hoopes Spring, Sage Creek, and Crow Creek near the Smoky Canyon Mine. Site-specific selenium criteria are included for nonsturgeon waters. Nonsturgeon waters are defined as all waters of the state except the main stems of the Kootenai, Salmon, and Snake Rivers within the historic range of White Sturgeon, and subbasins flowing directly into these rivers and those designated as critical salmonid habitat or Bull Trout habitat. Information about the site-specific selenium criteria is provided in DEQ's Justification for Site-Specific Selenium Criterion for Non-Sturgeon Waters (Docket 58-0102-1701, 2018).

Site-specific water column values (30-day average) are based on dissolved total selenium in water and are derived using a performance-based approach from fish tissue values via either the mechanistic modeling or empirical bioaccumulation factor (BAF) method in *Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater,* EPA-822-R-16-006, Appendix K: Translation of a Selenium Fish Tissue Criterion Element to a Site-Specific Water Column Value (EPA 2016b).

Site-specific egg-ovary, whole-body, and muscle criterion elements for these water bodies are provided in Table 2. The lentic and short-term exposure water column criterion elements, provided in section 2, Table 1 also apply to the water bodies identified in this section (Figure 1).

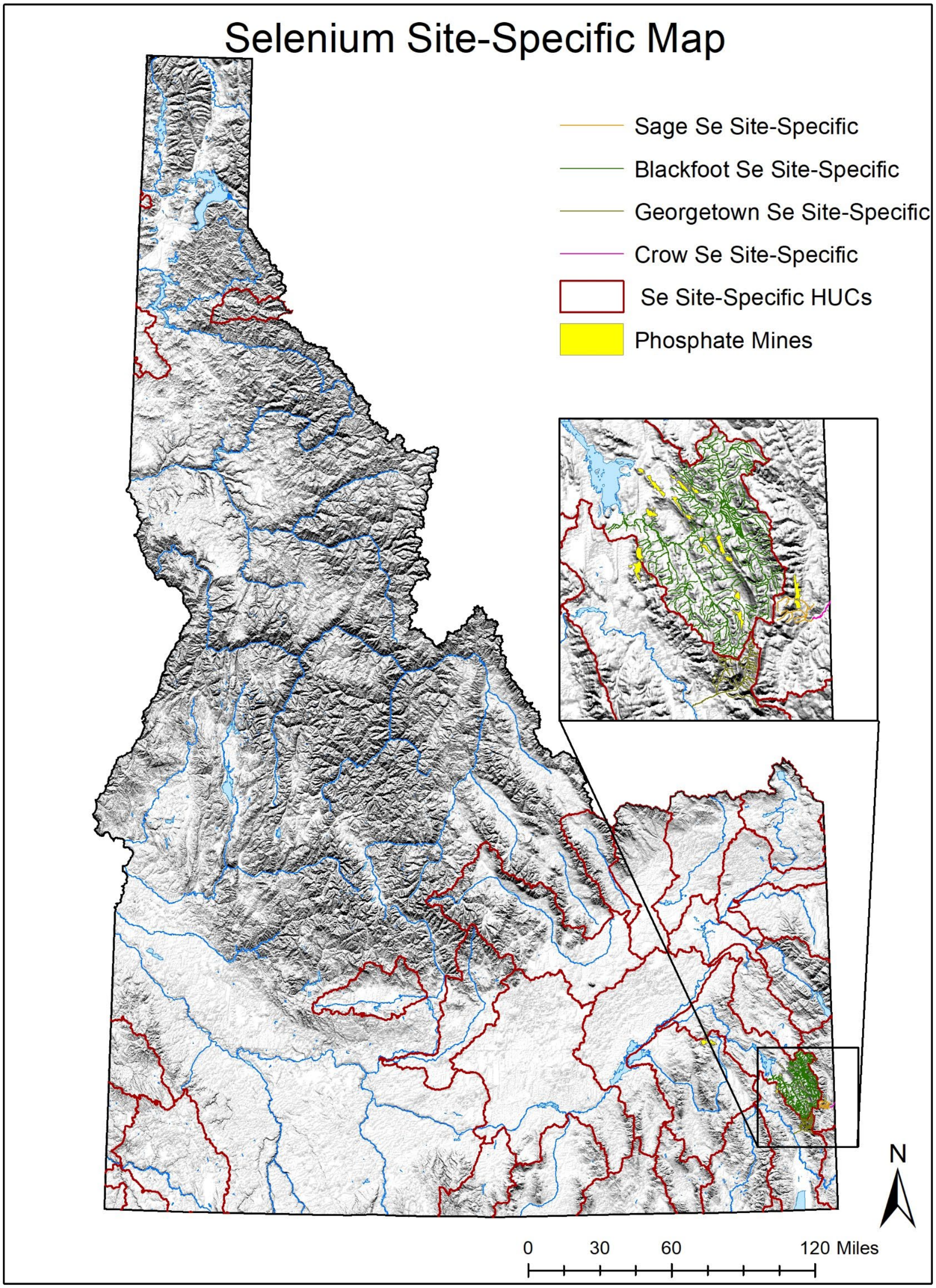


Figure 1. Selenium site-specific map.

Table 2. Selenium criteria for HUCs listed in Table 3.

Chronic		
Egg-Ovary (mg/kg dw)	**Fish Tissue (mg/kg dw)**	
Egg-Ovary	Whole-Body	Muscle
19.0[a]	9.5[b]	13.1[b]

a. Egg-ovary supersedes any whole-body, muscle, or water column element when fish egg-ovary concentrations are measured. Single measurement of an average or composite sample of at least five individuals of the same species. Not to be exceeded; DEQ will evaluate all representative egg-ovary data to determine compliance with this criterion element.
b. Fish whole-body or muscle tissue supersedes water column element when both fish tissue and water concentrations are measured. Single measurement of an average or composite sample of at least five individuals of the same species where the smallest individual is no less than 75% of the total length (size) of the largest individual. Not to be exceeded; DEQ will evaluate all representative whole-body or muscle data to determine compliance with this criterion element.

Table 3. HUC subbasins where site-specific criteria applies.

HUC	Subbasin	HUC	Subbasin
16010102	Central Bear	17040207	Blackfoot
16010201	Bear Lake	17040208	Portneuf
16010202	Middle Bear	17040209	Lake Walcott
16010203	Little Bear-Logan	17040210	Raft
16010204	Lower Bear-Malad	17040211	Goose
16020309	Curlew Valley	17040214	Beaver-Camas
17010302	South Fork Coeur d Alene	17040215	Medicine Lodge
17010306	Hangman	17040216	Birch
17010308	Little Spokane	17040218	Big Lost
17040104	Palisades	17040220	Camas
17040105	Salt	17040221	Little Wood
17040201	Idaho Falls	17050104	Upper Owyhee
17040202	Upper Henrys	17050105	South Fork Owyhee
17040203	Lower Henrys	17050106	East Little Owyhee
17040204	Teton	17050107	Middle Owyhee
17040205	Willow	17050108	Jordan
17040206	American Falls	17060109	Rock

3.1 Blackfoot River Subbasin

The Blackfoot River subbasin includes the upper Blackfoot River, confluence of Lanes and Diamond Creeks to Blackfoot Reservoir, and all tributaries, including named and unnamed tributaries, draining into unit US-10 (IDAPA 58.01.02.287.01) (Figure 2):

Site-specific egg-ovary, whole-body, and muscle criterion elements for these water bodies are provided in Table 4. The lentic and short-term exposure water column criterion elements in section 2, Table 1 also apply to the water bodies identified in this section.

Rainbow Trout is the most sensitive resident species for the tissue elements (egg ovary, whole body, and muscle) in the upper Blackfoot River and all its associated tributaries (Nu-West. 2017).

Table 4. Site-specific criteria for Blackfoot River subbasins.

Chronic			
Egg-Ovary (mg/kg dw)	**Fish Tissue (mg/kg dw)**		**Water Column (µg/L)**
Egg-Ovary	Whole-Body	Muscle	Water Lotic
24.5[a]	12.5[b]	12.8[b]	11.9[c, d, e]
mg/kg dw – milligrams per kilogram dry weight, µg/L – micrograms per liter			

a. Egg-ovary supersedes any whole-body, muscle, or water column element when fish egg-ovary concentrations are measured. Single measurement of an average or composite sample of at least five individuals of the same species. Not to be exceeded; DEQ will evaluate all representative egg-ovary data to determine compliance with this criterion element.

b. Fish whole-body or muscle tissue supersedes water column element when both fish tissue and water concentrations are measured. Single measurement of an average or composite sample of at least five individuals of the same species where the smallest individual is no less than 75% of the total length (size) of the largest individual. Not to be exceeded; DEQ will evaluate all representative whole body or muscle data to determine compliance with this criterion element.

c. Water column values are derived using the empirical BAF method. For comparative purposes only, the example value displayed in this table represents the lotic water column value for Sheep Creek based on the average BAF for Cutthroat Trout among all sampling locations and years.

d. Lotic Water Column Equation =

$$\frac{Tissue_{criterion}}{BAF}$$

Where tissue criterion is the fish tissue element (whole-body), and BAF is the bioaccumulation factor derived by diving site-specific field-collected samples of fish tissue (whole-body) by site-specific field-collected samples of water.

e. Water column values are the applicable criterion element in the absence of steady-state condition fish tissue data. In fishless waters, surface water from the fishless waters and fish tissue from the nearest downstream waters are used for bioaccumulation modeling. Fish tissue supersedes and site-specific water column values when fish are sampled downstream of fishless waters.

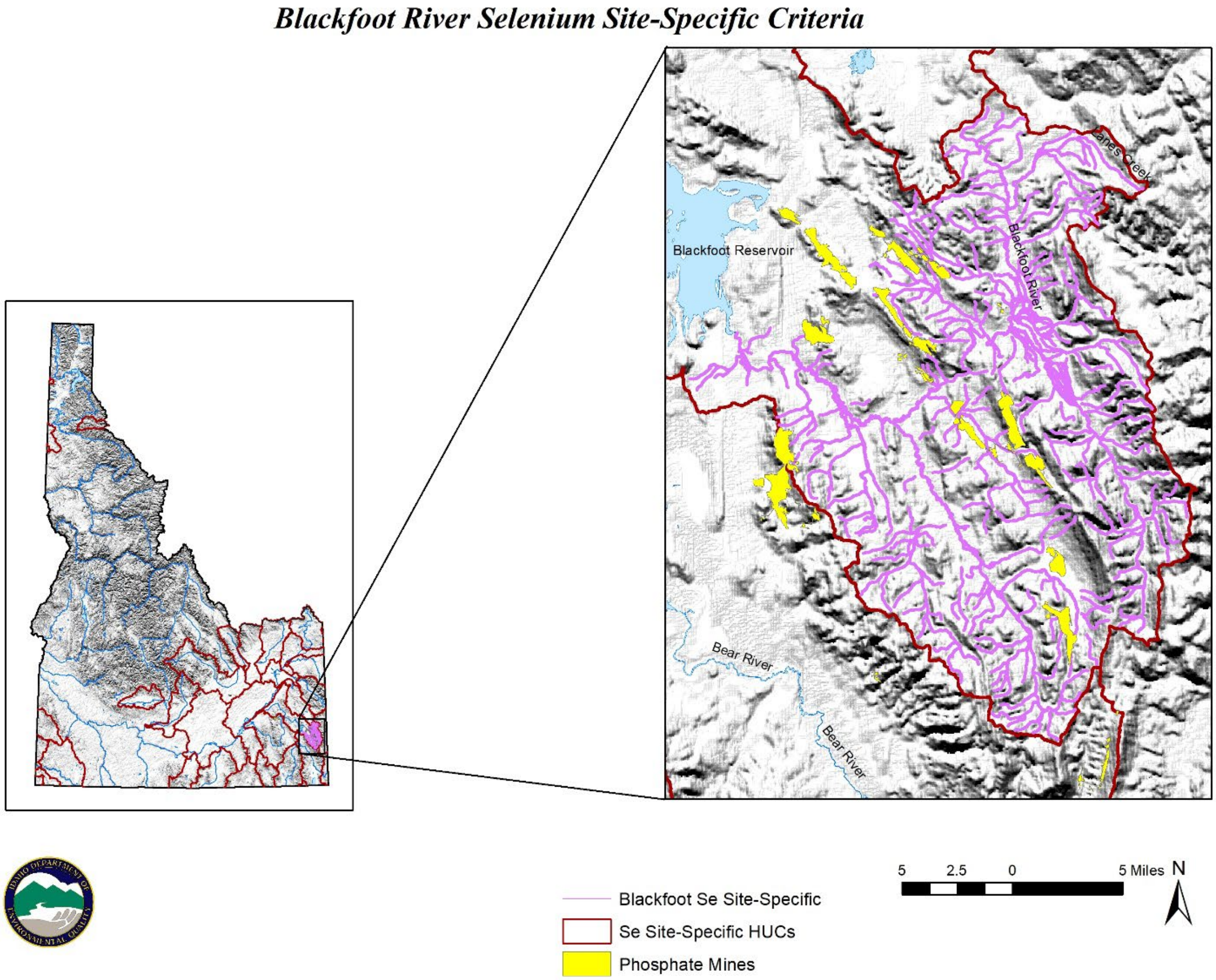


Figure 2. Blackfoot River subbasin selenium site-specific criteria.

3.2 Bear Lake Subbasin—Georgetown Creek

The Bear Lake subbasin includes Georgetown Creek, source to mouth, and all the tributaries draining into unit B-22 (IDAPA 58.01.02.287.02) (Figure 3).

Site-specific egg-ovary, whole-body, and muscle criterion elements for these water bodies are provided in Table 5. The lentic and short-term water column criterion elements in section 2, Table 1 also apply to the water bodies identified in this section.

Information such as fish survey results demonstrates that Brown Trout is the most sensitive species for the egg ovary tissue element, and Rainbow Trout is the most sensitive species for the whole body and muscle tissue elements in Georgetown Creek (EPA 2019).

Site-specific egg-ovary and whole-body criterion elements for this water body are provided in IDAPA 58.01.02.287.02.

Table 5. Site-specific criteria for Bear Lake subbasin—Georgetown Creek.

Chronic			
Egg-Ovary (mg/kg dw)	**Fish Tissue (mg/kg dw)**		**Water Column (µg/L)**
Egg-Ovary	Whole-Body	Muscle	Water Lotic
21.0[a]	12.5[b]	12.8[b]	3.8[c, d, e]
Mg/kg dw – milligrams per kilogram dry weight, µg/L – micrograms per liter			

a. Egg-ovary supersedes any whole-body, muscle, or water column element when fish egg-ovary concentrations are measured. Single measurement of an average or composite sample of at least five individuals of the same species. Not to be exceeded; DEQ will evaluate all representative egg-ovary data to determine compliance with this criterion element.

b. Fish whole-body or muscle tissue supersedes water column element when both fish tissue and water concentrations are measured. Single measurement of an average or composite sample of at least five individuals of the same species where the smallest individual is no less than 75% of the total length (size) of the largest individual. Not to be exceeded; DEQ will evaluate all representative whole-body and muscle data to determine compliance with this criterion element.

c. Water column values are derived using the empirical BAF method. For comparative purposes only, the example displayed in this table represents the lotic water column value for Georgetown Creek, upstream of the intermittent reach, based on the average BAF for Brook Trout in all sampling locations and years.

d. Lotic Water Equation =

$$\frac{Tissue_{criterion}}{BAF}$$

Where tissue criterion is the fish tissue element (whole-body), and BAF is the bioaccumulation factor derived by dividing site-specific field-collected samples of fish tissue (whole-body) by site-specific field- collected samples of water.

e. Water column values are the applicable criterion element in the absence of steady-state condition fish tissue data. In fishless waters, surface water from the fishless waters and fish tissue from the nearest downstream waters are used for bioaccumulation modeling. Fish tissue supersedes any site-specific water column values when fish are samples downstream of fishless waters.

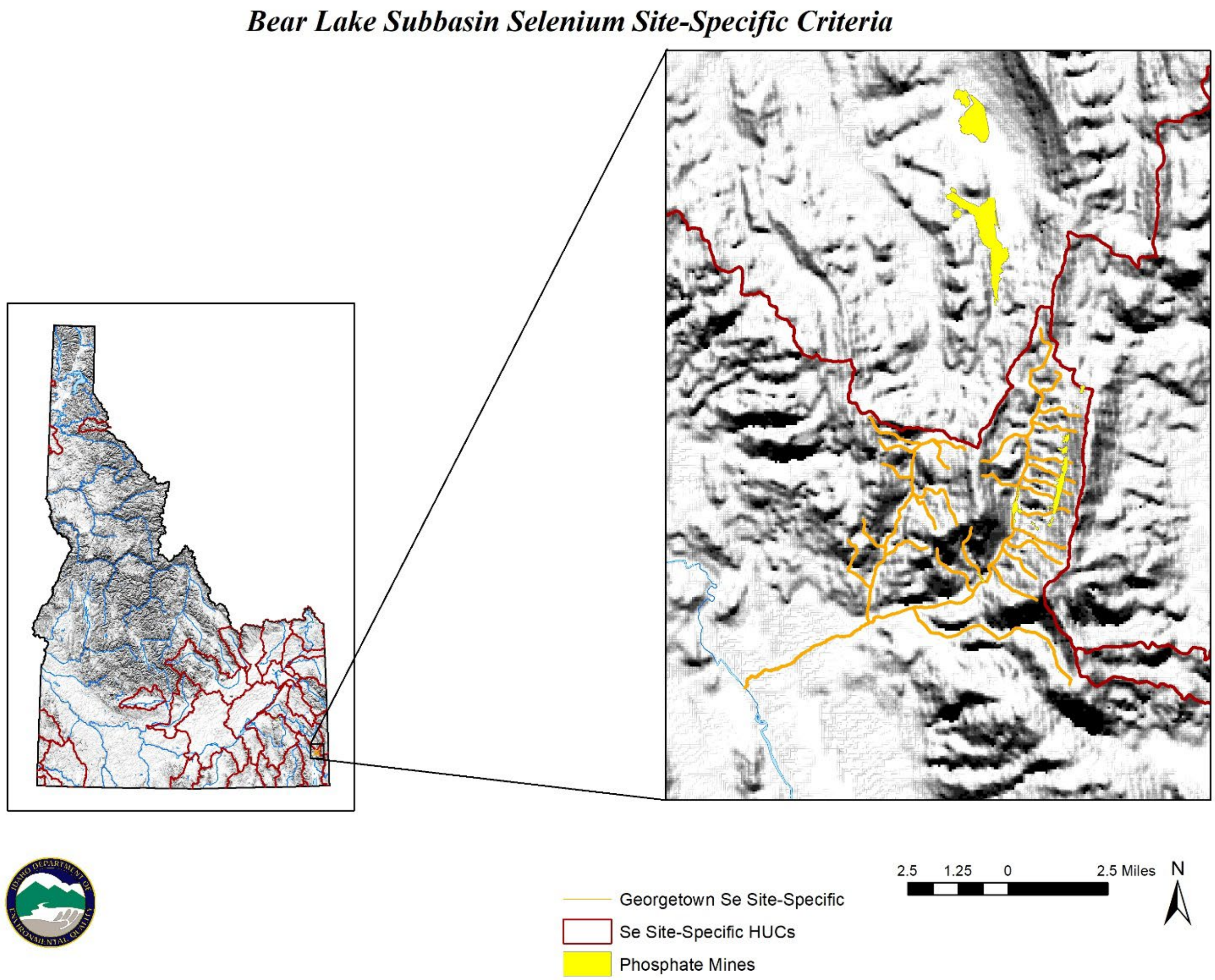


Figure 3. Bear Lake subbasin selenium site-specific criteria.

3.3 Salt River Subbasin——Sage Creek

The Salt River subbasin includes Sage Creek, source to mouth (unit US-9), including Hoopes Spring channel downstream of the spring complex; South Fork Sage Creek downstream of the spring complex; Sage Creek downstream of the confluence of Hoopes Spring with Sage Creek to its confluence with Crow Creek; and tributaries (excluding North Fork Sage Creek, Pole Canyon Creek, and their tributaries) (IDAPA 58.01.02.287.03).

Site-specific egg-ovary, whole-body, and muscle criterion elements for these water bodies are provided in IDAPA 58.01.02.287.03 and Table 6. The muscle, lentic water column, and short-term water column criterion elements in section 2, Table 1 also apply to the water bodies identified in this section.

Information and data available demonstrate that Brown Trout is the most sensitive resident species for the egg-ovary and whole-body tissue elements in Sage Creek (Simplot 2017).

Sage Creek and its tributaries include the following stream segments:

- ID17040105SK009_02e: South Fork Sage Creek (7.95 miles); applied to South Fork Sage Creek below the spring complex.
- ID17040105SK009_03: Sage Creek—confluence with North Fork Sage Creek to mouth (3.22 miles); applied to the entire segment.
- Hoopes Springs—no specific segment is identified; it falls within the larger segment identified above for Sage Creek.

Table 6. Site-specific criteria for Salt River subbasin—Sage Creek.

Chronic		
Egg-Ovary (mg/kg dw)	**Fish Tissue (mg/kg dw)**	**Water Column (µg/L)**
Egg-Ovary	Whole-Body	Water Lotic
20.5[a]	13.6[b]	16.7[c]
mg/kg dw – milligrams per kilogram dry weight, µg/L – micrograms per liter		

a. Egg-ovary supersedes any whole-body, muscle, or water column element when fish egg-ovary concentrations are measured. Single measurement of an average or composite sample of at least five individuals of the same species. Not to be exceeded; DEQ will evaluate all representative egg-ovary data to determine compliance with this criterion element.
b. Fish whole-body or muscle tissue supersedes water column element when both fish tissue and water concentrations are measured. Single measurement of an average or composite sample of at least five individuals of the same species where the smallest individual is no less than 75% of the total length (size) of the largest individual. Not to be exceeded; DEQ will evaluate all representative whole-body and muscle data to determine compliance with this criterion element.
c. Water column values are derived using the empirical BAF method. Water column values are the applicable criterion element in the absence of steady-state condition fish tissue data. In fishless waters, selenium concentrations in fish from the nearest downstream waters may be used to assess compliance.

3.4 Salt River Subbasin—Crow Creek

The Salt River subbasin (ID17040105SK008_04) includes Crow Creek; Sage Creek downstream of the confluence of Hoopes Springs to its confluence with Crow Creek; and Crow Creek downstream of its confluence with Sage Creek to the Wyoming border (IDAPA 58.01.02.287.04) (Figure 4).

Site-specific egg-ovary and whole-body criterion elements for these water bodies are provided in Table 7. The muscle, lentic water column, and short-term water column criterion elements in section 2, Table 1 also apply to the water bodies identified in this section.

Table 7. Site-specific criteria for Salt River subbasin—Crow Creek.

Chronic		
Egg-Ovary (mg/kg dw)	**Fish Tissue (mg/kg dw)**	**Water Column (µg/L)**
Egg-Ovary	Whole-Body	Water Lotic
20.5[a]	12.5[b]	4.2[c]
mg/kg dw – milligrams per kilogram dry weight, µg/L – micrograms per liter		

a. Egg-ovary supersedes any whole-body, muscle, or water column element when fish egg-ovary concentrations are measured. Single measurement of an average or composite sample of at least five individuals of the same species. Not to be exceeded; DEQ will evaluate all representative egg-ovary data to determine compliance with this criterion element.
b. Fish tissue supersedes water column element when both fish tissue (whole-body) and water concentrations are measured. Fish tissue elements are expressed as a single arithmetic average of tissue concentrations from at least five individuals of the same species where the smallest individual is no less than 75% of the total length (size) of the largest individual. Not to be exceeded; DEQ will evaluate all representative whole-body data to determine compliance with this criterion element.
c. Water column values are derived using the empirical BAF method. Water column values are the applicable criterion element in the absence of steady-state condition fish tissue data. In fishless waters, selenium concentrations in fish from the nearest downstream waters may be used to assess compliance.

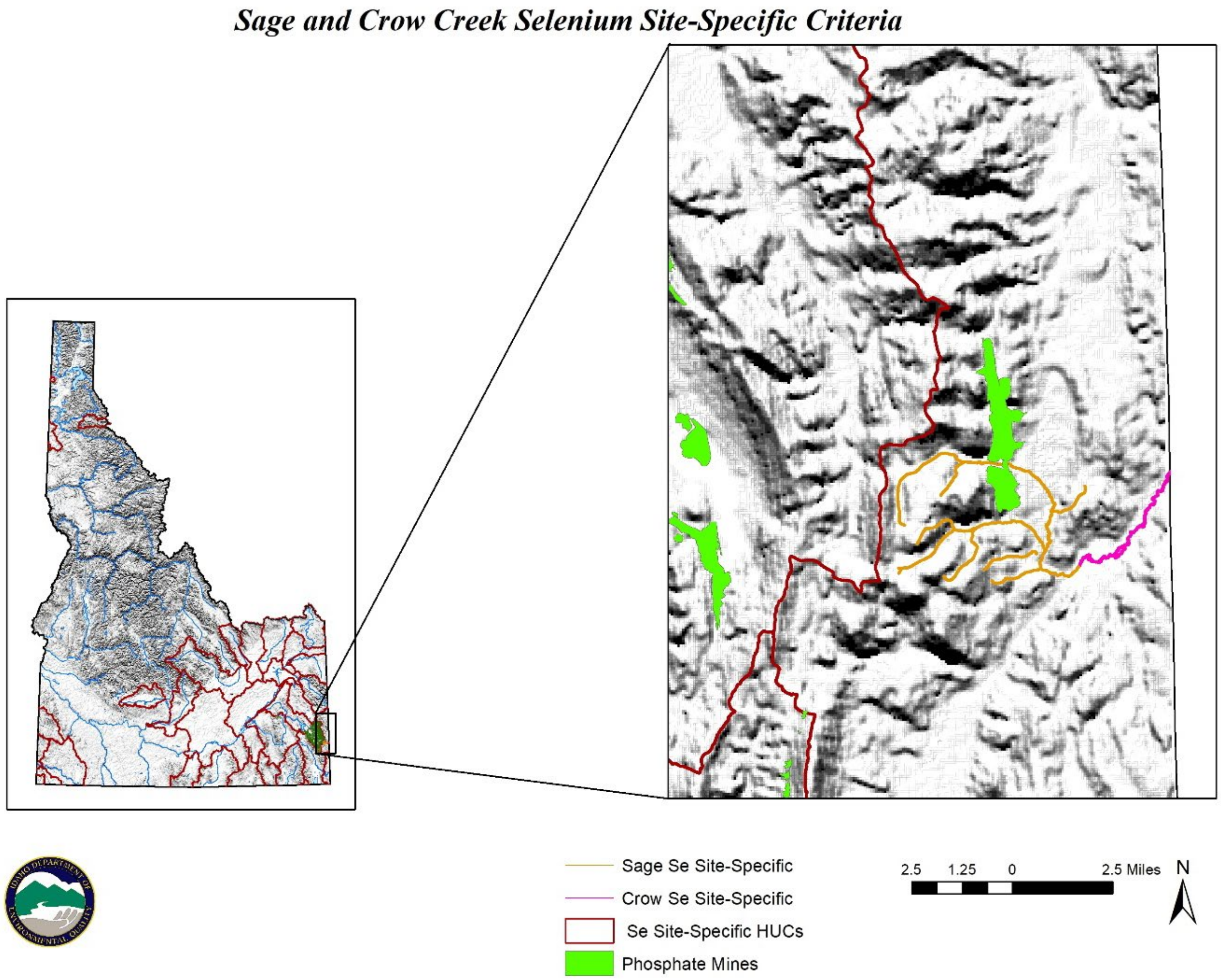


Figure 4. Sage and Crow Creeks selenium site-specific criteria.

3.5 Sturgeon Water/Most Sensitive Species

DEQ's statewide criterion (section 2) is based on the four most sensitive taxa in the national toxicity data set (Table 8). The species most sensitive to selenium in the data set is White Sturgeon (*Acipenser transmontanus*) (EPA 2021a). In Idaho, White Sturgeon has a limited range and is present only in select main stem rivers (IDFG 2008). White Sturgeon presence and historical range is limited to the main stems of the Kootenai, Snake, and Salmon Rivers. To further protect water quality where White Sturgeon may be present, certain upstream waters where White Sturgeon are not expected to be found but that contribute to downstream water quality are included (Figure 5).

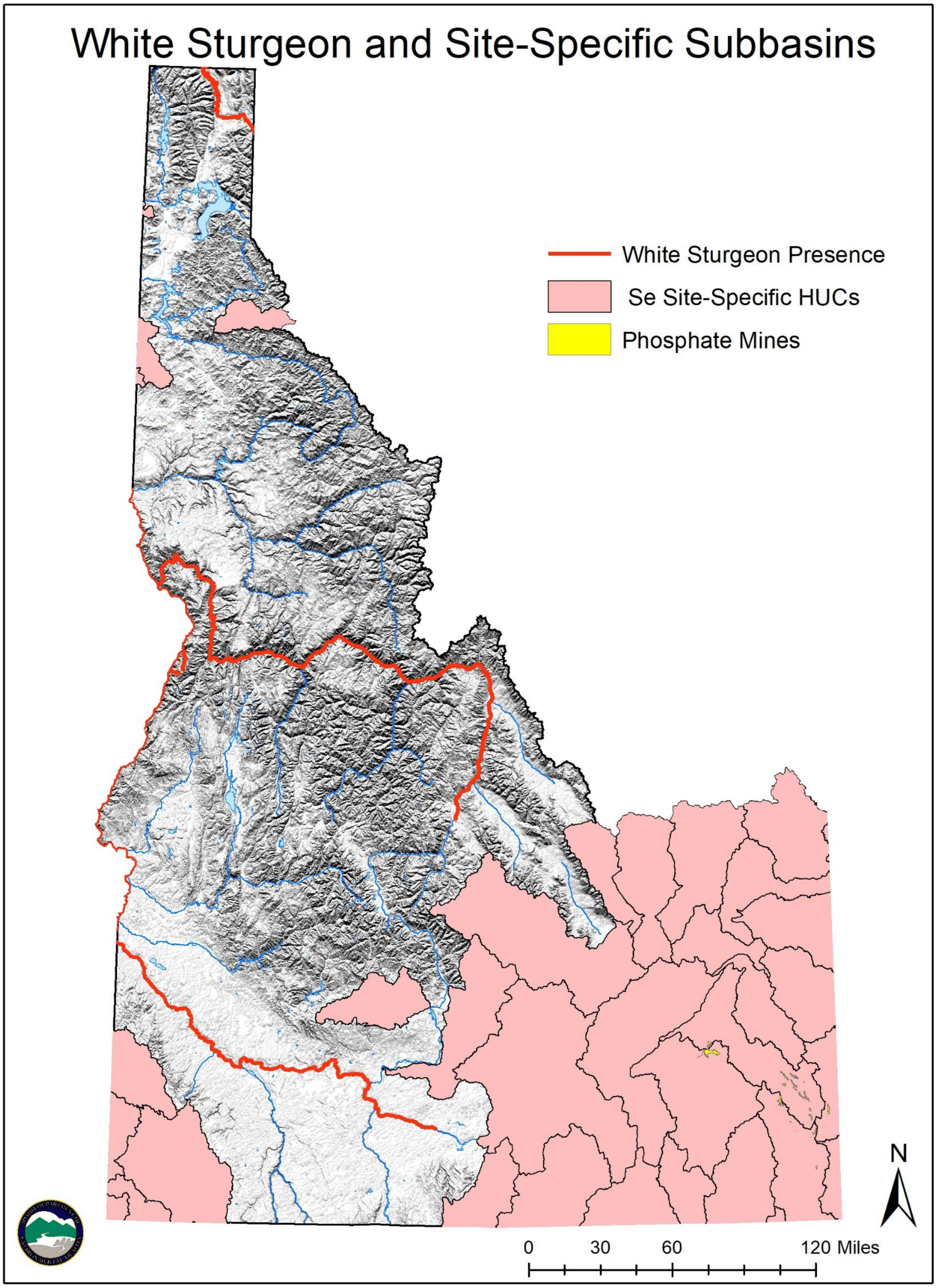


Figure 5. Sturgeon waters.

Table 8. Summary of criterion comparisons.

Selenium Criterion	Chronic					Short-Term
	Fish Tissue (mg/kg dw)			Water Column (µg/L) (30-Day Average)		Water Column (µg/L)
	Egg-Ovary	Whole Body	Muscle	Water (Lentic)	Water (Lotic)	Water
Statewide	15.1	8.5	11.3	1.5	3.1	Intermittent exposure equation
Site-Specific Waters	19.0	9.5	13.1	a	a	a
Upper Blackfoot River	24.5	12.5	12.8	a	$\frac{Tissue_{criterion}}{BAF}$	a
Bear Lake	21.0	12.5	12.8	a	$\frac{Tissue_{criterion}}{BAF}$	a
Sage Creek	20.5	13.6	a	a	16.7	a
Crow Creek	20.5	12.5	a	a	4.2	a

a. Statewide rule applies (section 2, Table 1).

4 General Implementation for Aquatic Life Criteria

The following general implementation requirements for aquatic life criteria, found in IDAPA 58.01.02.287, apply when implementing the selenium criteria for aquatic life:

- When utilizing fish tissue to determine compliance with criteria, egg-ovary (ripe ovaries collected from gravid females as defined in section 5.4) supersedes any whole-body, muscle, or water column data. An average of egg-ovary tissue or composite sample of at least five individuals of the same species may be used. When utilizing egg ovary tissue to for the determination of criteria, DEQ will evaluate all representative data to determine compliance.
- When utilizing fish whole-body or muscle tissue to determine selenium concentration at a site, it supersedes the water column element. An average or composite whole-body sample of at least five individuals of the same species where the smallest individual is no less than 75% of the total length (size) of the largest individual may be used. When using whole-body criteria, DEQ will evaluate all representative whole body or muscle data to determine compliance with this criterion element.
- When utilizing water column criteria, the values are based on dissolved total selenium in water.
- In the absence of a steady-state condition (defined in section 7), water column values are the applicable criterion element. In fishless waters, selenium concentrations in fish from the nearest downstream waters may be used to assess compliance. If available, evaluate and utilize data about the condition of the macroinvertebrate community present in the fishless waters.

- There is no specific acute criterion for aquatic life; however, the aquatic life criterion is based on chronic effects of selenium on aquatic life and is expected to adequately protect against acute effects from selenium exposure.
- For short-term exposure, the criterion will be based on the Intermittent Exposure Equation = (C_{bkgrnd} (1-f))/f_{int}, where C_{bkgrnd} is the average background selenium concentration, and f_{int} is the fraction of any 30-day period during which elevated selenium concentrations occur with f_{int} assigned a value ≥ 0.033 (corresponding to 1 day). IDAPA 58.01.02.210.01.a.

5 Fish-Tissue Monitoring and Assessment

5.1 Fish-Tissue Sampling

It is recommended to engage very early with DEQ when developing a sampling and analysis plan and submit for review and approval prior to undertaking any sampling or monitoring plans. This is very important when sampling egg or fish tissue data.

DEQ recommends using composite samples as the most cost-effective way to represent average selenium tissue concentrations in target species populations. Composite samples are homogeneous mixtures of one type of tissue (e.g., egg-ovary sample, whole-body, or muscle) from five or more individual organisms of the same species collected at a particular site and analyzed as a single sample. Composite samples of fish tissue are recommended for selenium analysis to help identify those sites where selenium concentrations are elevated. Since composites represent a physical averaging of the samples, they avoid the issue of how nondetection in a single fish sample would be factored into averaging individual sample results.

A composite fish tissue sample of at least five individuals will be collected and analyzed (IDAPA 58.01.02.210). Organisms used in a composite sample are required to meet the following recommendations (IDAPA 58.01.02.210):

- All the same species.
- Of similar size so that the smallest individual in a composite is no less than 75% of the total length (size) of the largest individual (the *75% rule* does not apply to egg-ovary samples).
- Samples should be collected at the same time (i.e., collected as close to the same time as possible, but all samples should be collected within a week of each other[1]).

An individual sample is a discrete sample from a single fish and can be an egg-ovary sample, a whole body, or a muscle (fillet) sample. There are no circumstances where DEQ would consider analysis of a single fish useful or sufficient for determining compliance with the selenium

[1] L. Macchio, USEPA, email to M. Dale, DEQ. "Question about paired sampling for Selenium." October 23, 2020.

criterion. However, there are some instances where collecting individual fish may be desirable. For example, in water bodies or segments that are known to be impacted by selenium, individual samples may better estimate the magnitude of the impact and may provide information about selenium source-exposure relationships in large water bodies. Individual samples may also allow for the identification of fish that are migrant or transient in a population because that fish may have a higher or lower concentration of selenium than other fish in the area.

Individual fish tissue samples may provide site replicate data needed to make statistical comparisons, as well as provide information on the variability of fish tissue selenium concentrations for a site. If the resources are available to collect individual fish tissue samples, results from the individual analysis may be used for statistical comparisons, but a composite of the results will be used to compare to the criteria.

5.2 Recommended Species

Recommended fish for tissue collection in Idaho are salmonids, preferably from the predominant species of trout or char (i.e., Yellowstone Cutthroat Trout, Rainbow Trout, Brook Trout, or Brown Trout) (DEQ 2021b). Resident fish should be determined from available fisheries data and other biological surveys. Different fish species have varying sensitivity and bioaccumulation to potential to selenium exposure. DEQ recommends that fish tissue sampling plans consider species sensitivity, bioaccumulation potential, availability (e.g., presence), mobility (e.g., resident or nonresident), and species management goals when selecting a target species for fish tissue analyses to ensure that a representative species will be selected.

Ongoing research and data results showing species bioaccumulation and sensitivity is important for better understanding of the appropriate species to target in a given watershed. For example, some species of sculpin are more sensitive than salmonids to metal enrichment in the field and may prove to be effective target organisms for biological assessments of anthropogenic impacts over small areas because they are often abundant, tend to be sensitive to a variety of perturbations, and often occupy relatively small areas throughout their lives (Zaroban 2018)

In addition, through years of internal sampling, DEQ determined the preferred size of salmonids that directly relates to species fidelity is young of year (YOY), which at the time of sampling (i.e., late summer, early fall) is considered fish less than 4 inches in length. If enough YOY are not available, then fish that have obviously spent most of their life history in the stream (up to 6 inches) should be collected. If more information is needed on migratory salmonids, for example, then fish larger than YOY will be collected. The preferred size of sculpin and other species of fish will be less than 6 inches (DEQ 2021b).

IDAPA 58.01.02.287.01–05 provides site-specific criteria for selenium to protect the most sensitive resident fish species determined previously in those specific surface waters. Recommended species for the implementation of these site-specific criteria should be the most sensitive resident species (i.e., species in the *Salmo* or *Oncorhynchus* genera), or taxonomically related species in the Salmonid family (i.e., species in the *Salvelinus* genus) (DEQ 2017b).

5.3 Spatial Considerations

The spatial extent of a sampling or monitoring plan will need to be defined and factors that may affect selenium variability throughout the site need to be identified so they can be considered in the design of the sampling plan (EPA 2021b). When sampling a site, Global Positioning System coordinate locations should be taken for the downstream and upstream limits of the site, or the beginning and end of where the samples were taken. Confluence areas should be avoided whenever possible (DEQ 2021). The physical and chemical parameters can be highly spatially variable, hydrology and geology may cause certain areas to be prone to selenium bioaccumulation resulting in elevated concentrations of selenium (Beatty and Russo 2014). Additionally, some fish species (e.g., salmonids) migrate to upstream areas to spawn. These areas may be harder to access than larger order downstream segments that are inhabited during on-spawning seasons (EPA 2018). When sampling fish, considerations should be given to the different flow characteristics of the site that is being sampled, along with the locations where fish are feeding and obtaining their selenium body burdens. When sampling sites, attempts should be made to sample all habitat types to appropriately characterize the range and distribution of selenium concentrations at a site (EPA 2021b).

It may still be possible to sample such species on their way up stream; or it may be necessary to monitor smaller order stream segments of a larger stream network to get closer to selenium inputs. Monitoring plans may need to be adjusted to consider the species of fish found in the small stream segment, and it is important to consider the relationship of upstream sources to downstream habitats (EPA 2018).

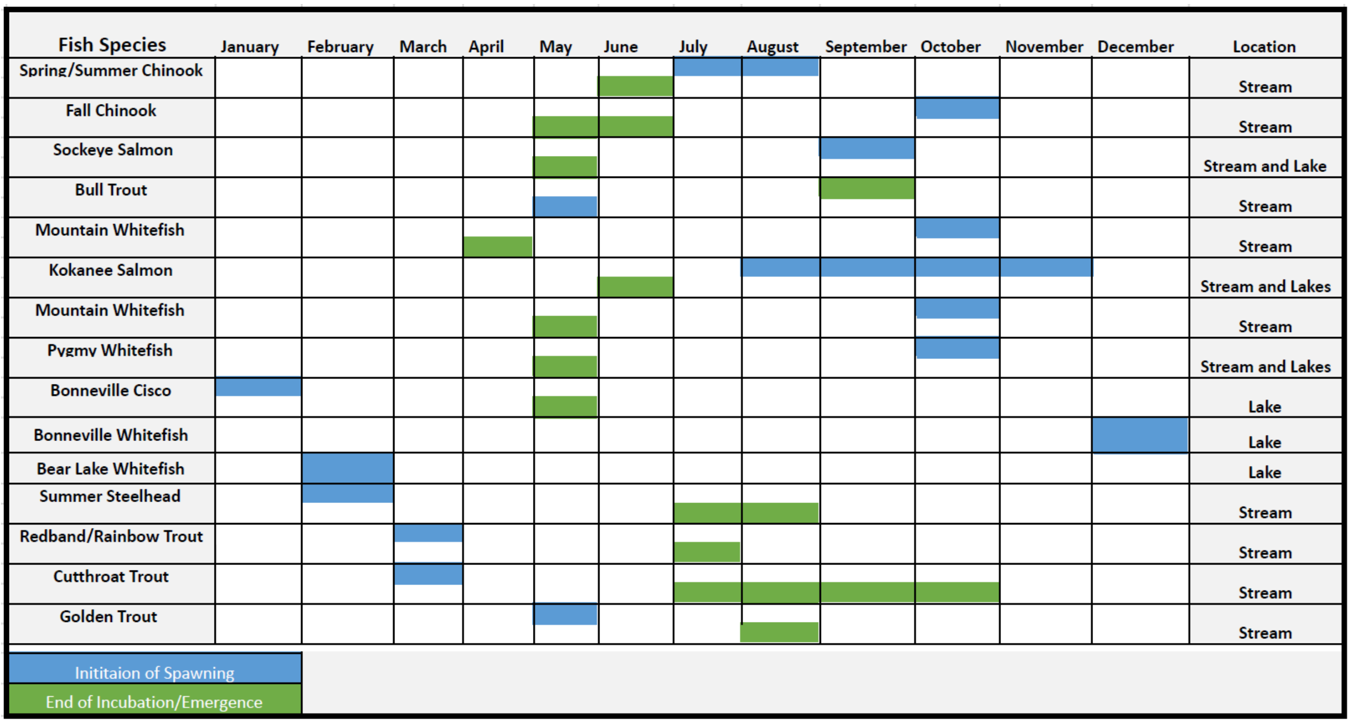
When implementing site-specific water column criteria that are based on site-specific conditions, any single sample location will be considered representative of a larger stream segment and need to be sampled within the same assessment unit (AU). Interpreting spatial representation to implement the selenium criteria for aquatic life depends on how the data are to be used—whether monitoring results will determine compliance with water quality standards for the Integrated Report and total maximum daily load (TMDL) development, or for development of effluent limits and determining compliance with IPDES permits. In flowing waters, spatial representation is generally ensured by sampling well-mixed portions of the stream (i.e., sampling from the thalweg and avoiding confluences or other obvious lateral inputs) (DEQ 2020).

5.4 Temporal Considerations

The only appropriate time to collect egg-ovary tissue from suitable species is when the female is gravid in the prespawn stage, just prior to mating and spawning. This time frame is typically small for most synchronous species and may occur in the spring to early summer, or in the fall to early winter. Egg tissue samples for use to determine if the criterion is met, must be from five gravid females, not five different eggs within one gravid female.

It is important to consider the difficulty in timing egg-ovary sampling with spawning periods. Timing errors related to fish reproduction may result in data that falsely indicate the selenium criterion is being met. Most spawning by salmonids takes place quickly over a couple of weeks and may depend on many environmental factors. Removing gravid females from an at-risk population (e.g., Yellowstone Cutthroat Trout in the Blackfoot River) may be contradictory to other agency (such as the Idaho Department of Fish and Game) activities aimed at restoring those populations. Table 9 can be used to determine monitoring times for targeting egg-ovary samples. Spawning periods for native salmonids in Idaho are found in the *Geography and Timing of Salmonid Spawning in Idaho* (DEQ 2014). EPA published guidance for egg and ovary collection from freshwater fish in Appendix B of the *Technical Support for Fish Tissue Monitoring for Implementation of EPA's 2016 Selenium Criterion Draft* (2021b) and provides spawning windows for different species in various regions across the United States. Other resources for salmonid spawning periods include but are not limited to the Idaho Department of Fish and Game's *2019-24 Fishery Management Plan*, TMDLs, DEQ's ARCGIS map for salmonid spawning, and DEQ's (2016a) *Water Body Assessment Guidance.*

Table 9. Spawning and incubation/emergence periods for native salmonids in Idaho (DEQ 2014).



While egg-ovary remains the preferable tissue type, whole-body or muscle samples can be used as an alternative (EPA 2016a). For egg/ovary sample preparation, see EPA's *Technical Support for Fish Tissue Monitoring for Implementation of EPA's 2016 Selenium Criterion* (EPA 2021b). Whole-body and muscle tissue samples are relatively easy to collect and do not have the same spatial considerations and temporal restrictions as egg-ovary tissue. Summer and fall may be prime periods for whole-body and muscle tissue collection due to the engorgement of populations to replenish fat and energy reserves postspawn. For whole-body tissue collection, fish should be collected from late August to early October, preferably in September (DEQ 2021).

> The available scientific evidence indicates that for selenium, critical assessment endpoints for aquatic species are offspring mortality and severe development abnormalities that affect the ability of fish to swim, feed, and successfully avoid predation, resulting in impaired recruitment of individuals into fish populations.

5.5 Fish-Tissue Sample Assessment

Federal and state criteria are designed to protect most aquatic animal species in an aquatic community (i.e., approximately 95th percentile of tested aquatic animals representing the aquatic community). For the CWA, aquatic life criteria for toxic pollutants are typically determined based on the results of toxicity tests with aquatic organisms in which unacceptable effects on growth, reproduction, or survival occur. Fish are the most sensitive aquatic taxon to the toxicological effects of selenium, more specifically the survival and development of young fish exposed in ovo; therefore, the criterion is expressed in terms of fish tissue, using eggs or ovarian tissue as the most representative element related to selenium toxicity.

Selenium criteria are based on the premise that selenium toxicity occurs primarily through transfer to the eggs, reducing reproductive success and survival. Egg-ovary concentrations supersede other fish tissue or water column concentrations when measured This is also why it is important in determining resident fish populations for both the statewide and site-specific selenium criteria (DEQ 2018).

Because the most sensitive adverse effects of selenium are reproductive effects on the offspring of exposed fish, chronic effects from long-term exposure are the focus of selenium assessment. In addition to continuous discharges, shorter-term intermittent or pulsed exposures to elevated levels of selenium may also result in bioaccumulation through the aquatic food web and may adversely affect fish reproduction.

5.5.1 Frequency Component for Fish-Tissue Criteria

The bioaccumulative nature of selenium means recovery of an aquatic system from exposure can take many years, particularly where selenium levels have built up in sediments. DEQ adopted frequency to exceed language stating: “Not to be exceeded; DEQ will evaluate all representative fish tissue data to determine compliance with the applicable criterion element” (DEQ 2018). Once measured levels of tissue selenium return to meeting the criterion, and the system has demonstrably recovered, DEQ would likely deem such a water body as no longer impaired by selenium regardless of prior measurements showing exceedances of the criteria. However, if there were a long history of tissue levels (egg/ovary, muscle, or whole body) exceeding criteria, DEQ might want to see multiple recent (within 3 to 5 years) sampling events demonstrating tissue levels are now meeting criteria before declaring a system no longer impaired (section 5.5.2) In a steady state waterbody, once fish tissue concentrations meet the criterion, the aquatic system should no longer be negatively impacted by selenium or present any adverse effects resulting from selenium exposure. Regardless of depuration rates, be they hours, years, or decades, once the fish tissue is below the criterion, the fish are no longer impaired (DEQ 2017a)In addition, other lines of evidence should be provided in cases where treatment systems or remedial activities have been implemented to minimize selenium concentrations in a particular water body. Selenium concentrations in fish tissue are generally expected to change only gradually over time in response to environmental fluctuations (EPA 2021a).

5.5.2 Frequency of Exceedance

To protect aquatic life, the frequency of exceedance for selenium in egg-ovary, whole-body, and muscle is “Not to be exceeded[2],” and the frequency of exceedance for the water column monthly average exposure and intermittent exposure is “Not more than once in three years on average.” (IDAPA 58.01.02.210). The duration or averaging period, for the monthly average exposure and intermittent exposure criterion elements is 30 days. Therefore, water column values cannot be averaged over a period greater than 30 days to assess compliance with the water column element and the monthly average should not exceed the water column criterion more than once in a three-year period.

6 Water Column Values

Water column criterion values established for the statewide selenium rule in IDAPA 58.01.02.210.01 and for nonsturgeon, critical salmonid, or Bull Trout waters in IDAPA 58.01.02.287.05 are consistent with EPA’s § 304(a) national, recommended selenium criteria for both lentic and lotic waters. For more information on the EPA’s (2021a) approach to derive the § 304(a) water column criterion, see section 3.2 of EPA’s *Aquatic Life Ambient Water Quality Criterion for Selenium –Freshwater 2016*.

[2] Tissue data is single measurement of an average or composite sample of at least five individuals of the same species. DEQ will evaluate all representative whole body or muscle data to determine compliance with this criterion element (section 10).

When monitoring surface water selenium concentrations, if the water-criterion value is not exceeded, then it may be concluded that the egg-criterion element is not exceeded, and, correspondingly, that the selenium concentrations will not have adverse effects on fish populations. If an exceedance of the water criterion occurs, tissue monitoring could occur as a follow up, if fish are present. In the event no fish are present in a water body, the nearest downstream location where fish are present would be examined to assess if the tissue data indicate an exceedance (Section 9, “Fishless Waters”). Although surface water selenium measurement is an effective monitoring tool, the ultimate decision on compliance will depend on the tissue data.

The methods used to derive the statewide water column criteria and for all water column criteria are based on the national 304 (a) recommendations and the methods described in EPAs Aquatic Life Ambient Water Quality Criterion For Selenium (EPA 2021ab). Appendix K of this same document referenced in the rule clarifies which bioaccumulation modeling approaches are permissible and refers to the specific approaches used in the § 304(a) recommendation. This section provides justification for the water column derivation for all site-specific criteria and for using methods in Appendix K to assess compliance in fishless streams using fish tissue data from the nearest downstream fish-bearing water.

6.1 Lentic Versus Lotic Waters

Selenium concentrations and bioaccumulation patterns are different in lotic (flowing water) versus lentic (very slow moving or still water) environments, and this difference is reflected in Idaho’s water quality standards (Table 10).

Surface water selenium concentration is the preferred method of routine monitoring because it allows for a less destructive form of evaluating compliance with site-specific selenium criteria. Because EPA derived all water column criterion from the egg/ovary element representing a protective selenium concentration for fish populations, the water column criterion also represents protective selenium concentrations for fish populations.

Water bodies with a mean detention time of 15 days or greater are considered nonflowing waters. Detention time is calculated as the mean annual storage volume divided by the mean annual flow rate out of the reservoir for the same time period (IDAPA 58.060.01.h.iv).

Table 10. Chronic lentic and lotic criteria for selenium.

Water Column (ug/L) 30-day average		
	Water Lentic	**Water Lotic**
State waters	1.5	3.1
Site-specific water[a]	1.5	3.1
Blackfoot River subbasin	1.5	$\frac{Tissue_{criterion}}{BAF}$
Bear Lake subbasin	1.5	$\frac{Tissue_{criterion}}{BAF}$
Salt River subbasin—Sage Creek	1.5	16.7
Salt River subbasin—Creek	1.5	4.2

a. Refer to Table 3; HUC subbasins where site-specific criterion applies.

6.2 Intermittent (Short-Term) Water Column

Selenium criterion includes an intermittent water column exposure to address situations where pulsed exposures of selenium could result in bioaccumulation in the ecosystem (Equation 1). It is intended to limit cumulative exposure to selenium and potential chronic effects in fish.

Water column values are based on dissolved total selenium in water and are derived from fish tissue values via bioaccumulation modeling. Water column values are the applicable criterion the absence of steady-state condition fish tissue data (Section 7, “Steady-State Conditions”).

$$\frac{\boldsymbol{WQC - C_{background(1-f_{int})}}}{\boldsymbol{f_{int}}}$$

Equation 1. Intermittent exposure equation.

Where:

WQC = the applicable water column element, for either lentic or lotic waters.

C_{bkgrnd} = the average background selenium concentration.

f_{int} = the fraction of any 30-day period during which elevated selenium concentrations occur, with f_{int} assigned a value ≥ 0.033 (corresponding to 1 day).

Idaho’s intermittent water column equation is found at IDAPA 58.01.02.210.01.

7 Steady-State Conditions and Areas with New Selenium Inputs

Steady-state is the condition where an organism’s rates of chemical uptake and depuration are equal and tissue concentrations remain relatively constant over time. Steady state is achieved when sufficient time has passed after the introduction of new or increased discharge of selenium into a water body so that fish tissue concentration of selenium is no longer increasing, and the aquatic community has reached equilibrium with the concentration of selenium in the water column.

DEQ defines *new inputs* as new activities resulting in the release of selenium into a lentic or lotic aquatic system. New inputs will likely result in greater concentrations of selenium in the food web and a relatively slow increase of selenium concentration in fish until the new selenium release achieves a steady-state balance in the aquatic system.

- To show that an aquatic system is at steady-state, an analysis of a trend of fish tissue concentrations must demonstrate that selenium in fish tissue is no longer increasing. The time needed to achieve steady-state with new or increased selenium inputs is expected to be site specific. Natural seasonal variability of selenium concentrations in surface waters may occur during spring runoff and/or snow melt causing annual pulses. These seasonal pulses do not preclude a steady state condition if a weight of evidence demonstrates that fish tissue and water column data trends are changing in a manner consistent with these natural climatic activities and not due to anthropogenic activities.

It is estimated that the concentration of selenium in fish tissue will not reach steady-state for several months in lotic systems and longer time periods (e.g., 2 to 3 years) in lentic systems (EPA 2021a).

Fish tissue criterion should take precedence over the water column criterion only when the aquatic system achieves steady state. In the interim, sampling and site-specific data can be used to determine steady state in the receiving water and to gain a better understanding of the selenium bioaccumulation dynamics in a given system (Figure 6).

Water column values are based on dissolved total selenium in water and are derived from fish tissue values via bioaccumulation modeling. The values are the applicable criterion element in the absence of steady-state condition fish tissue data. In streams or stream reaches where fish are naturally absent due to low flow conditions, surface water from the fishless stream or stream reaches and the associated fish tissue measured downstream at the first occurrence of a continuous fish population may be used to assess compliance (Section 9, “Fishless Waters”).

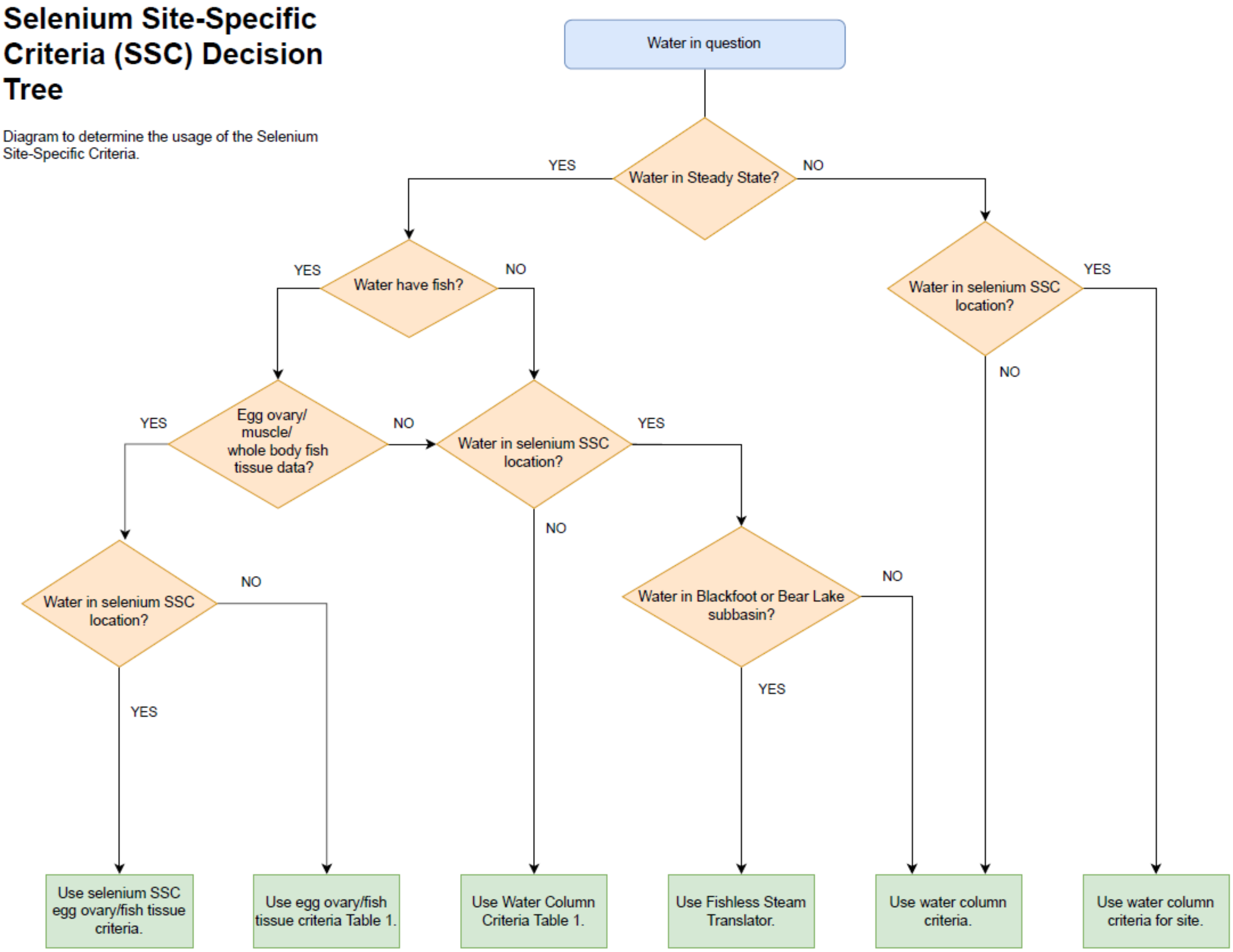


Figure 6. Selenium criteria decision tree.

8 Bioaccumulation Factor Approach

The goal in deriving a site-specific BAF is to determine the most accurate estimates of bioaccumulation feasible for each site. The empirical BAF modeling approach establishes a relationship between concentrations of selenium in fish tissue and ambient water. This is done by measuring selenium concentrations in both media and calculating the ratio of the two concentrations. A BAF is the ratio of the concentration of a chemical in the tissue of an aquatic organism (in milligrams per kilogram) to the concentration of the chemical dissolved in ambient water at the site of sampling (in milligrams per liter) (EPA 2016a). BAFs are used to relate chemical concentrations in aquatic organisms to concentrations in the ambient media of aquatic ecosystems where both the organism and its food are exposed.

Detailed information about how to derive a site-specific, field-measured BAF is provided in EPA's Aquatic Life Ambient Water Quality Criterion For Selenium (EPA 2021ab), at Appendix K: *Translation of a Selenium Fish Tissue Criterion Element to a Site-Specific Water Column Value.*

8.1 Considerations for Developing Site-Specific BAFs

BAF measurements should be based on water column concentrations that are averaged over a sufficient period of time (e.g., a duration comparable to the time required for the chemical to reach steady state). In addition, BAF measurements should be based on adequate spatial averaging of both fish tissue and water column concentrations for use in deriving § 304(a) criteria for the protection of human health (EPA 2000).

The most important aspect of conducting a successful field study to measure site-specific BAFs is collecting representative samples of the biota and water. The home range of the target species will dictate the spatial scale of the sampling effort. Chemical temporal and spatial distributions, organism life history, and duration of exposure, among other factors, all contribute to BAF uncertainty and should be addressed by the field sampling plan (EPA 2000). The goal for BAFs is to collect fish and water column data at or close to the same time as possible, no longer than a year apart.

8.2 Equations for BAF and C_{target}

The BAF is expressed mathematically as (EPA 2009) (Equation 2):

$$BAF = \frac{C_{tissue}}{C_{water}}$$

Equation 2. BAF equation.

Where:

BAF = bioaccumulation factor derived from site-specific field-collected samples of tissue and water (L/kg).

C_{tissue} = concentration of chemical in fish tissue (mg/kg).

C_{water} = ambient concentration of chemical in water (mg/L).

The site-specific BAF can then be applied to the tissue criterion to solve for a target site-specific water column criterion (C_{target}) (Equation 3):

$$C_{target} = \frac{C_{egg-ovary\ criterion}}{BAF}$$

Equation 3. Site-specific Water Column Value.

Where:

C_{target} = site-specific water criterion concentration (mg/L).

$C_{egg\text{-}ovary}$ criterion = egg-ovary tissue criterion (15.1 mg Se/kg dw).

BAF = bioaccumulation factor derived from site-specific field-collected samples of tissue and water (L/kg).

9 Fishless Waters

In stream reaches where fish are naturally absent due to low flow conditions, surface water from the fishless stream or stream reaches and the associated fish tissue measured downstream at the first occurrence of a continuous fish population may be used for bioaccumulation modeling if sampling is conducted in a manner that reflects bioaccumulation processes affected by the upstream water.

The following factors will be considered in any sampling plans aimed at understanding bioaccumulation dynamics in a downstream water affected by upstream sources:

- Variation (e.g., low-to-high exposure depending on location and time) in fish selenium exposure from other waters in addition to the upstream fishless water.
- Variability, both spatial and seasonal, of selenium concentrations in surface waters and fish tissue.
- Timing and location of sampling of water and fish to be representative of this variability.

The condition of an upstream water source in a fishless stream and a downstream water with fish is rare in the areas covered by site-specific criteria, and DEQ anticipates applying this provision to a very small number of fishless streams in the sections of subbasins covered by the site-specific criteria (DEQ letter 2019[3]).

- For this document, and Idaho's selenium aquatic life criterion, fishless streams are defined as the streams, or stream reaches:
    - with insufficient instream habitat and/or flow to support a population of one or more fish species on a continuing basis, or;
    - where fish are naturally absent due to ephemeral, intermittent or persistent low flows, or;
    - streams that lack a permanent connection to downstream fish-bearing waters; specifically, ephemeral streams that only flow briefly during and after a period of rainfall or precipitation.

This criterion also includes streams that lack habitat to support fish, such as lack of gravel for spawning, barriers, or lack a food source. If a water body does not support fish because of unnatural conditions, such as presence of pollutants, then the water column criteria will need to be used.

[3] J. Pappani, DEQ, letter to Mr. Dan Opalski, EPA. "Application of 'Fishless Water Translator' to Derive Selenium Criteria for Aquatic Life in Fishless Waters; DEQ Rulemaking Docket No. 58-0102-1701" July 9, 2019.

To determine that a water body is fishless, the site should have accompanying research and field data that is less than 5 years old. It is recommended using either environmental DNA or electrofishing the site to collect comprehensive data for all species (DEQ 2022).

The selenium aquatic life criteria were developed to protect not only fish, but all aquatic life in fishless streams. Fish are most susceptible to selenium exposure in the early stages of development; however, it is important to protect all aquatic assemblages in fishless streams in addition to protecting downstream waters. Except as otherwise provided in the rule or this guidance, when fish tissue samples are not available, water column criterion must be met.

Appendix K in EPA's Aquatic Life Ambient Water Quality Criterion for Selenium-Freshwater 2016 (EPA 2016) may be used to create a procedure that will translate fish tissue criterion concentration values to site-specific water concentration values to assess criterion compliance. The purpose of the procedure is to ensure that the criterion set through fish issue translation is protective of the fish community downstream. For example, users may choose to evaluate upstream waters without fish by measuring the selenium concentration in water, biotic and/or abiotic particulate material, and/or the tissues of invertebrate aquatic organisms that reside there. Because selenium associated with particulate material and invertebrate organisms can be transported downstream during intermittent high flows, elevated concentrations of selenium in the tissues of downstream fish could indicate upstream sources of selenium that require a more detailed evaluation of upstream conditions (EPA 2021a).

In a fishless steady-state water body, fish-tissue samples from the most sensitive fish species (sections 5.5 and 8) inhabiting nearby, most proximate downstream waters, at the first occurrence of a continuous fish population may be used to assess compliance with the selenium criterion. Case-by-case analysis will need to be conducted if the lotic site is not intermittent and if the most proximate fish population is more than 3 miles downstream. If considering this method, DEQ suggests using the most current data from DEQ and Idaho Fish and Game to determine which downstream water body closest to the site supports fish communities.

Although the upper reaches of some aquatic systems may not support fish communities, the invertebrate organisms that reside there may tolerate high concentrations of selenium and pose a selenium risk to predator fish if transported downstream. Data from downstream may help inform a listing decision, but readily available data from the stream segment in question should be the primary consideration for a listing decision. For this reason, fish tissue downstream of the fishless streams provides the most direct and sensitive method to ensure the fishless stream is protective to downstream fish. However, DEQ recommends collecting invertebrate samples in the nearest water body to the project site, and directly downstream in lotic waters, to ensure the fishless stream is protected for its designated uses.

When fish tissue samples from the nearest downstream water are not available, water column criterion must be met to protect all aquatic assemblages in fishless streams.

9.1 Fishless Stream Translator

The fishless stream translator (FST) approach adopted for the Blackfoot River subbasin (IDAPA 58.01.01.287.01) and Bear Lake subbasin (IDAPA 58.01.02.287.02) was developed to establish surface-water selenium concentrations in upstream fishless waters that are expected to be protective of sensitive resident fish in the most proximate downstream waters (Nu-West 2017b). Outside of these specific subbasins, any new water column criterion derived using this, or a similar process, would need to be reviewed and approved by Idaho Legislature and EPA.

In this approach, surface-water selenium is measured in the fishless stream at, or as close as possible to, the confluence with a downstream water containing a continuous fish population within the same water body unit (e.g., *nearest downstream water*; section 9.1) while fish-tissue selenium is measured in the downstream surface water as close as possible to the fishless stream. A fishless stream translator (Nu-West 2017b) was derived according to procedures established in IDAPA 58.01.02.275.01.h. and can be calculated as follows (Equation 4):

$$\boldsymbol{FST = \frac{C_{tissue}}{C_{water}}}$$

Equation 4. Fishless stream translator.

Where:

FST = fishless stream translator derived from site-specific field-collected samples of fish tissue and water (L/kg).

C_{tissue} = concentration of selenium in fish tissue measured in the nearest downstream water.

C_{water} = total dissolved selenium in surface water from the fishless water.

Using a site-specific FST, a site-specific selenium concentration (C_{target}) for the fishless stream is calculated as follows (Equation 5):

$$\boldsymbol{C_{target} = \frac{Tissue_{criterion}}{FST}}$$

Equation 5. Site-specific fishless stream translator.

Where:

C_{target} = site-specific selenium water target (mg Se/L).

FST = fishless stream translator derived from site-specific field-collected samples of fish tissue and surface water.

To implement the FST approach, surface water selenium in the fishless stream is monitored in a spatial and temporal manner consistent with FST development. Specifically, surface water selenium in the fishless stream, when present, is measured and assessed against an FST-derived water-column value at, or as close as possible to, the confluence with a nearest downstream water. This approach will ensure monitoring of surface-water selenium from the fishless stream is most representative of potential selenium exposure to downstream fish.

In fishless waters outside of these subbasins, the water column criterion applies. However, if the site is in a steady-state condition, and downstream fish tissue data show no impairment based on the criteria for that site, then the fishless water is not impaired regardless of water column concentration.

DEQ will evaluate all representative data used in an FST approach to ensure water column criteria are sufficiently protective of both downstream fish and aquatic assemblages in fishless streams, considering temporal and spatial variability described above.

9.2 Protection of Aquatic Life in Fishless Waters

When downstream fish tissue samples are available and meet the selenium criterion, DEQ will also consider readily available data from the fishless stream segment in question (e.g., instream benthic assessments) to ensure resident aquatic assemblages are protected and to determine the aquatic life use support status of the fishless stream segment is consistent with IDAPA 58.01.02.054. If benthic monitoring indicates potential problems to resident aquatic assemblages or is inconsistent with aquatic life use support status, site-specific water column values where site-specific water column values have been adopted, may need to be reevaluated and adjusted to protect instream and downstream assemblages. If only water column data are available for a site, this data must be used for implementation of the criterion and implementation decision should not be delayed allowing time for tissue collections.

If a situation arises where the water column criterion in the fishless water body is exceeded, but fish tissue from the nearest downstream water body continues to meet criterion, and the aquatic assemblages are protected, then the fish tissue criterion takes precedence, and the fishless water body is meeting criterion. For this to be true, there must be a site-specific water column value for comparison. DEQ will not accept blanket assumptions that water column criteria in upstream fishless water bodies are met if historic downstream fish tissue concentrations do not exceed the criterion. Assessments of waterbodies should consider all existing and readily available water quality-related data and information in order to develop an impaired waters list. DEQ will find data older than the lifetime of the fish being protected to be irrelevant for the assessment of current conditions.

10 Identifying Impairments for the Integrated Report

The process of assessing whether a water body fully supports designated, presumed, and existing beneficial uses is governed by IDAPA 58.01.02.054. DEQ uses the *Water Body Assessment Guidance* (DEQ 2016) as a guide in making assessment decisions. Under IDAPA 58.01.02.054, data used for developing selenium criteria in the Integrated Report should represent the AU being assessed. DEQ recommends basing selenium assessments on the chronic effects from long-term exposure. When evaluating selenium data to determine compliance with criteria in the Integrated Report, DEQ assessors will use the following hierarchical approach:

1. If fish egg-ovary data from at least five individuals of the same species are available, compare results of the egg-ovary data to the egg-ovary criterion element. If the average egg-ovary value is less than the criterion, the AU will not be listed as impaired. If egg-ovary data are not available, proceed to step 2.
2. If fish tissue data from at least five individuals of the same species are available, where the smallest individual is no less than 75% of the total length (size) of the largest individual, compare the fish tissue data results to the tissue criterion element. If the average tissue value is less than the criterion, the AU will not be listed as impaired.
3. If fish tissue data are not available, compare water column data to either: (a) site-specific water column criteria, if one has been derived for the water body or (b) the statewide water column criterion found at IDAPA 58.01.02.210.01.
4. Water column values are the applicable criterion in the absence of steady-state condition fish tissue data. In fishless waters, surface water from the fishless waters and fish tissue from the nearest downstream waters are used for bioaccumulation modeling. Fish tissue supersedes any site-specific water column values when fish are sampled downstream of fishless waters. In fishless waters, selenium concentrations in fish from the nearest downstream waters should be used to assess using methods provided in *Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater, EPA-822-R-16-006, Appendix K: Translation of a Selenium Fish Tissue Criterion Element to a Site-Specific Water Column Value* (EPA 2016) to determine is if the criterion is protective of the fish in the downstream community.

11 Idaho Pollutant Discharge Elimination System Permits

To meet the state's EPA-approved standards as required in the CWA § 301(b)(1)(C) and Idaho Pollutant Discharge Elimination System (IPDES) regulations at IDAPA 58.01.25, permit writers must develop water quality-based effluent limits (WQBELs) if a reasonable potential to exceed (RPTE) standards has been demonstrated.

Any of the elements of a four-part criterion for selenium can be used to assess the need for effluent limits. The flowchart provided in EPA's *Frequently Asked Questions: Implementing Water Quality Standards Based on EPA's 2016 Recommended Selenium Criterion in Clean Water Act Section 402 NPDES Permit* (EPA 2020) presents an approach that considers both the fish tissue and water column elements of the criterion. Specific questions about using the four-part criterion to assess RPTE and WQBEL development are provided in sections 3 and 4 of EPA's *Frequently Asked Questions (FAQs): Implementing WQS that Include Elements Similar or Identical to EPA's 2016 Selenium Criterion in Clean Water Act Section 402 NPDES Programs, Draft*, listed in Appendix B, "Additional Resources."

Effluent data requirements recommended for toxics or hazardous pollutants in section 3.3 of EPA's *Technical Support Document for Water Quality-based Toxics Control* (EPA 1991) and other IPDES monitoring guidance should be used to identify appropriate monitoring requirements for RPTE determinations and IPDES permitting. These resources can be used to assess whether the discharge causes, has the RPTE to cause, or contributes to an instream excursion above the water column element for selenium criterion. The flowchart presented in EPA's FAQ document referenced above summarizes the options to assess RPTE based on the different elements of EPA's 2016 selenium criterion and data availability.

In Idaho's water quality standards, the selenium criterion water column concentration element for lentic waters is lower than it is for lotic waters. Therefore, if an IPDES discharge is located in lotic waters upstream of lentic waters, the permit writer will need to ensure that the lentic downstream water quality criterion is protected when conducting RPTE analysis and developing WQBELs for selenium (40 CFR 122.4(d)).

WQBELs for selenium should be expressed as total recoverable selenium; however, the selenium criterion water column elements are expressed as dissolved selenium. Given that particulate as well as dissolved selenium can have deleterious effects on aquatic life in the absence of site-specific data, it may be appropriate to use a total recoverable-to-dissolved selenium ratio of 1.00 in determining RPTE and calculating permit WQBELs. EPA provided previous guidance on procedures for translating a dissolved criterion to total recoverable permit limits that also includes recommendations for sampling and analysis in *The Metals Translator: Guidance for Calculating a Total Recoverable Permit Limit from a Dissolved Criterion* (EPA 1996).

The intermittent element is intended to provide protection from long-term chronic effects on aquatic life caused by short-term elevation of selenium in aquatic systems. Intermittent criterion is intended for use with non-continuous discharges, and should be calculated based on the number of days a discharge containing elevated concentrations of selenium occurs and the equation provided at IDAPA 58.01.02.210.01.a, Table 1, footnote l. Permit writers should use this recommendation when determining whether RPTE exists and to calculate IPDES permit limits when RPTE has been demonstrated. RPTE analysis and WQBEL determination should be based on the intermittent value calculated for the potential effects of the discharge to the receiving water.

12 TMDL Targets

The TMDL process for selenium will follow and be as consistent as possible with existing federal and Idaho guidance for the *Development of Total Maximum Daily Loads* (DEQ 1999) and its successors.

When addressing the intermittent criterion element, the approach of using the monthly average exposure water column criterion element for TMDLs because it was derived to ensure adequate protection of the fish tissue criterion elements of the criterion. (EPA 2021c) There may be instances where available data indicate that the fish tissue criterion element of the criterion is exceeded, and the water column criterion element is not exceeded. In those situations, states and authorized tribes should consider developing a site-specific water column criterion element and use it for developing the TMDL, because the water column criterion element could result in a TMDL that does not meet the fish tissue criterion element. For AUs identified as impaired and needing TMDLs for selenium, TMDL targets and subsequent load and wasteload allocations will be based on statewide water column criteria or site-specific water column criteria, where applicable. Selenium TMDLs will lead to attainment of fish egg-ovary, whole-body, and muscle criteria when the water column selenium criteria are achieved. For a list of water bodies with site-specific selenium criteria, refer to IDAPA 58.0102.58.287.

References

Beatty, J.M. and G.A. Russo. 2014. *Ambient Water Quality Guidelines for Selenium Technical Report Update*. British Columbia Ministry of Environment, Environmental Sustainability and Strategic Policy Division, Water Protection and Sustainability Branch. ISBN 978-0-7726-6740-3.

Chapman P.M., W.J. Adams, M.L. Brooks, C.G. Delos, S.N. Luoma, W.A Maher, H.M. Ohlendorf, T.S. Presser, and D.P. Shaw, eds. 2010. *Ecological Assessment of Selenium in the Aquatic Environment***.** Pensacola, FL: SETAC Press.

Coleman, L., J. Bragg, and R.B. Finkelman. 1993. "Distribution and Mode of Occurrence of Selenium in US Coals*." Environmental Geochemistry and Health* 15: 215–227.

DEQ (Idaho Department of Environmental Quality). 1999. *Guidance for Development of Total Maximum Daily Loads*. Boise, ID: Water Quality Division.

DEQ (Idaho Department of Environmental Quality). 2014. *Geography and Timing of Salmonid Spawning in Idaho*. Boise, ID: Prepared by BioAnalysts Inc.

DEQ (Idaho Department of Environmental Quality). 2016. *Water Body Assessment Guidance, 3rd Edition*. Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2017a. *Public Comment Summary for Se*. Boise, ID: DEQ. Docket 58-0102-1701.

DEQ (Idaho Department of Environmental Quality). 2017b. *Justification for Site-Specific Selenium Criterion for Aquatic Life in Portions of Idaho*. Boise, ID: DEQ, Water Quality Division.

DEQ (Idaho Department of Environmental Quality). 2018. *Idaho Aquatic Life Criteria for Selenium – Supplemental Technical Justification*. Boise, ID: DEQ. Docket 58-0102-1701.

DEQ (Idaho Department of Environmental Quality). 2020. *Idaho's 2018/2020 Integrated Report*. Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2021a. *Fact Sheet, Phosphate Resource Area, Southeast Idaho Selenium Project.* Boise, ID: DEQ. *https://www2.deq.idaho.gov/admin/LEIA/api/document/download/16145*

DEQ (Idaho Department of Environmental Quality). 2021b. *Protocol for Collecting Fish for Selenium Tissue Analysis*. Pocatello, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2022. *Beneficial Use Reconnaissance Program 2022 Annual Work Plan*. Boise, ID: DEQ.

EPA (US Environmental Protection Agency). 1991. *Technical Support Document for Water Quality-based Toxics Control*. Washington, DC: EPA, Office of Water. EPA/505/2-90-001 PB91–127415.

EPA (US Environmental Protection Agency). 1996. *The Metals Translator: Guidance For Calculating a Total Recoverable Permit Limit from a Dissolved Criterion*. Washington, DC: EPA, Office of Water. EPA 822-R-98-007.

EPA (US Environmental Protection Agency). 2000. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000), Final*. Washington, DC: EPA, Office of Water. EPA-822-B-00-004.

EPA (US Environmental Protection Agency). 2003. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000) Volume 2: Development of National Bioaccumulation Factors*. Washington, DC: EPA, Office of Water, EPA-882-R-03-030.

EPA (US Environmental Protection Agency). 2009. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000), Technical Support Document Volume 3: Development of Site-Specific Bioaccumulation Factors*. Washington, DC: EPA, Office of Water. EPA-822-R-09-008.

EPA (US Environmental Protection Agency). 2012**.** *Update: Phosphate Mine Site Investigations and Cleanup in Southeast Idaho*. *Southeast Idaho Selenium Project.* Prepared by EPA, Region 10, US Forest Service, and Idaho Department of Environmental Quality.

EPA (US Environmental Protection Agency). 2016a. *Appendix K: Translation of a Selenium Fish Tissue Criterion Element to a Site-Specific Water Column Value--Aquatic Life Ambient Water Quality Criterion for Selenium–Freshwater***.** Washington, DC: EPA, Office of Water. Office of Science and Technology. EPA 822-R-16-006.

EPA (US Environmental Protection Agency). 2016b*. Frequently Asked Questions: Implementing EPA's 2016 Selenium Criterion in Clean Water Act Sections 303(d) and 305(b) Assessment, Listing, and Total Maximum Daily Load Programs–2016 Draft*. Washington, DC: EPA, Office of Water. EPA-823-D-21-004.

EPA (US Environmental Protection Agency). 2018. *Technical Support for Fish Tissue Monitoring for Implementation of EPA's 2016 Selenium Criterion. Draft*. Washington, DC: EPA, Office of Water. EPA-820-F-16-007.

EPA (US Environmental Protection Agency). 2019. *Technical Support Document. The EPA Review and Action on Idaho's New and Revised Water Quality Standards, Selenium Aquatic Life Criterion, Idaho Rule Docket 58-0102-1701*. Seattle, WA: EPA, Region 10.

EPA (US Environmental Protection Agency). 2020. *Frequently Asked Questions (FAQs): Implementing WQS that Include Elements Similar or Identical to EPA's 2016 Selenium Criterion in Clean Water Act Section 402 NPDES Programs, Draft*. Washington, DC: EPA, Office of Water. EPA 820-F-16-009.

EPA (US Environmental Protection Agency). 2021a. *Aquatic Life Ambient Water Quality Criterion for Selenium –Freshwater 2016*. Washington, DC: EPA, Office of Water, Office of Science and Technology. EPA 822-R-16-006.

EPA (US Environmental Protection Agency). 2021b. *Technical Support for Fish Tissue Monitoring for Implementation of EPA's 2016 Selenium Criterion, Draft.* Washington, DC: EPA Office of Water. EPA 823-D-21-002.

FishBase, accessed March 1, 2016, http://www.fishbase.org/Glossary/

IDFG (Idaho Department of Fish and Game). 2008. *White Sturgeon (Snake River System), Acipenser Transmontanu*s. Boise, ID: IDFG.

J.R. Simplot. 2007. *Final Work Plan–Field Monitoring Studies for Developing a Site-Specific Selenium Criterion*. Prepared by Newfields.

J.R. Simplot. 2012. *Technical Support Document: Proposed Site-Specific Selenium Criterion, Sage and Crow Creeks, Idaho*. Prepared by Formation Environmental.

J.R. Simplot. 2017. *Proposed Site-Specific Selenium Criterion for Hoopes Spring, Sage Creek, and Crow Creek near the Smoky Canyon Mine*. Prepared by Formation Environmental.

Lemly, A.D. 1993a. "Guidelines for Evaluating Selenium Data from Aquatic Monitoring and Assessment Studies." *Environ. Monitor. Assess*. 28(1):83–100.

Lemly, A.D. 1993b. “Teratogenic Effects of Selenium in Natural Populations of Freshwater Fish.” *Ecotoxicol. Environ. Safety* 26(2):181–204.

Lemly, A.D. 2002. “Selenium Assessment in Aquatic Ecosystems.” New York, NY: Springer-Verlag.

Janz, D.M., et al. 2010. “Selenium Toxicity to Aquatic Organisms.” In P.M. Chapman, W.J. Adams, M.I. Brooks, C.G.T. Delos, S.N. Luoma, W.A. Maher, H.M. Ohlendorf, T.S. Presser, and D.P. Shaw, eds. *Ecological Assessment of Selenium in the Aquatic Environment*. Pensacola, FL: SETAC Press.

Nu-West. 2017. *Proposal for Site-Specific Selenium Criteria Upper Blackfoot River and Georgetown Creek Watersheds*. Prepared by Arcadis.

Ranjard, L., S. Nazaret, and B. Cournoyer. 2003. “Freshwater Bacteria Can Methylate Selenium Through the Thiopurine Methyltansferase Pathway.” *Appl. Environ. Micorbiol*. 69(7): 3784–3790.

Sigler, J.W. and D.W. Zaroban. 2018. “*Fishes of Idaho, A Natural History Survey*”. Library of Congress.

Appendix A. Definitions

Anadromous fish
Fish with a life cycle that is divided between fresh and saltwater, including fish migration to spawn in freshwater. Migration should be cyclical, predictable, and cover more than 100 km. (FishBase 2016).

Bioaccumulation
The uptake and retention of a chemical by an aquatic organism from all surrounding media (e.g., water, food, sediment) (EPA 2003).

Bioaccumulation factor (BAF).
The ratio of the concentration of a chemical in the tissue of an aquatic organism to its concentration in water, in situations where both the organism and its food are exposed and the ratio does not change substantially over time (EPA 2000).

Equilibrium
A thermodynamic condition under which a chemical's activity, or fugacity, is equal among all phases composing the system of interest. In systems at equilibrium, chemical concentrations in all phases will remain unchanged over time.

Gravid
Distended with or full of eggs.

New inputs
New activities resulting in the release of selenium into a lentic or lotic aquatic system.

Steady State
Steady-state is the condition where an organism's rates of chemical uptake and depuration are equal and tissue concentrations remain relatively constant over time. Steady state is achieved when sufficient time has passed after the introduction of new or increased discharge of selenium into a water body so that fish tissue concentration of selenium is no longer increasing, and the aquatic community has reached equilibrium with the concentration of selenium in the water column.

Trophic Level
A trophic level of an organism is its position in a food chain. Levels are numbered according to how far particular organisms are along the chain from the primary producers (e.g., phytoplankton) at level 1, to herbivores (zooplankton; level 2), to predators (forage fish; level 3), to carnivores or top predators (level 4) (EPA 2000).

Appendix B. Additional Resources

For more information, consult the following resources:

Title of Document	Synopsis
DEQ. (Idaho Department of Environmental Quality). 2015. *Idaho Human Health Criteria Technical Support Document*. December 2015. Water Quality Division.	Serves as a reference to understand how Idaho's 2015 human health criteria were derived.
DEQ. (Idaho Department of Environmental Quality). 2016. *Water Body Assessment Guidance, 3rd Edition*. October 2016. Water Quality Division. https://www2.deq.idaho.gov/admin/LEIA/api/document/download/14844	Describes DEQ's methods used to consistently evaluate data and determine beneficial use support of Idaho water bodies.
DEQ. (Idaho Department of Environmental Quality). 2017. *Justification for Site-Specific Selenium Criterion for Aquatic Life in Portions of Idaho*. August 2017. Water Quality Division.	Provides the scientific justification and rationale for including a site-specific selenium criterion in IDAPA 58.01.02.287.05, including geographic scope of the site-specific criteria, determination of resident fish occurring at site, recalculation of these selenium criterion based on resident fish, and protectiveness of the SSC.
DEQ. (Idaho Department of Environmental Quality). 2017. *Rulemaking and Public Comment Summary*. Docket Number 58-0102-1701. Water Quality Standards.	Public comments.
DEQ. (Idaho Department of Environmental Quality). 2018. *Idaho Aquatic Life Criteria for Selenium – Supplemental Technical Justification, Docket 58-0102-1701*. June 2018. Water Quality Division.	Contains hierarchy of elements within a fish tissue based criterion, derivations of fish-tissue elements for site-specific criteria, adoption of EPA's *Appendix K* and derivation of water column elements, frequency of exceedance, downstream protections, and monitoring requirements.
EPA. (US Environmental Protection Agency). 2000. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000), Final*. October 2000. Office of Water. EPA-822-B-00-004. *https://www.epa.gov/sites/production/files/2018-10/documents/methodology-wqc-protection-hh-2000.pdf*	Provides clarifications on methodology, risk characterization, and other issues for developing criteria; risk assessment, exposure, and bioaccumulation for the protection of human health.
EPA. (US Environmental Protection Agency). 2000. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (2000), Technical Support Document Volume 1: Risk Assessment, Final. October 2000. Office of Water. EPA-822-B-00-005. *https://www.epa.gov/sites/production/files/2018-12/documents/methodology-wqc-protection-hh-2000-volume1.pdf*	Provides technical support concerning cancer and noncancer risk assessment methods.
EPA. (US Environmental Protection Agency). 2003. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (2000), Technical Support Document Volume2: Development of National Bioaccumulation Factors. December 2003. Office of Water. EPA-822-B-03-030. *https://www.epa.gov/sites/production/files/2018-10/documents/methodology-wqc-protection-hh-2000-volume2.pdf*	This Technical Support Document (TSD) focuses on the technical components of the 2000 Human Health Methodology that pertain to the assessment of chemical bioaccumulation.

Title of Document	Synopsis
EPA. (US Environmental Protection Agency). 2009. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000), Technical Support Document Volume 3: Development of Site-Specific Bioaccumulation Factors. September 2009. Office of Water. EPA-822-R-09-008. *https://www.epa.gov/sites/production/files/2018-12/documents/methodology-wqc-protection-hh-2000-volume3.pdf*	This Technical Support Document (TSD) provides guidance on different approaches that investigators can take to develop site-specific bioaccumulation factors (BAFs) that are representative of the bioaccumulation potential at a given location, and the factors that should be considered when selecting an approach for developing a site-specific BAF in a given situation.
EPA. (US Environmental Protection Agency). 2016. *Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater 2016*. Office of Water. EPA-822-R-16-006. *https://www.epa.gov/sites/production/files/2016-07/documents/aquatic_life_awqc_for_selenium_-_freshwater_2016.pdf*	For selenium fish tissue sampling -- describes fish tissue sampling methods and sample collection considerations.
EPA. (US Environmental Protection Agency). 2016. *Appendix K: Translation of a Selenium Fish Tissue Criterion Element to a Site-Specific Water Column Value in Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater*. June 2016. Office of Water. EPA-822-R-16-006. *https://www.epa.gov/sites/production/files/2016-07/documents/aquatic_life_awqc_for_selenium_-_freshwater_2016.pdf*	This appendix describes approaches that states may choose to use regarding application of this same mechanistic modeling approach (or alternatively an empirical bioaccumulation factor (BAF) approach) to translate a fish tissue criterion element (egg-ovary, whole body, or muscle) into site-specific water-column concentrations to more precisely manage selenium in specific aquatic systems.
EPA. (US Environmental Protection Agency). 2016. *Technical Support for Fish Tissue Monitoring for Implementation of EPA's 2016 Selenium Criterion. Draft*. October 2021. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC. *https://www.epa.gov/system/files/documents/2021-10/selenium-fishtissue-tsd-draft-2021.pdf*	This document provides an overview on how to establish or enhance existing fish tissue monitoring programs to facilitate implementation of the fish tissue-based criterion elements in the national CWA § 304(a) recommended selenium criterion.
EPA. (US Environmental Protection Agency). 2021. *Frequently Asked Questions (FAQs): Implementing WQS for EPA's 2016 Recommended Selenium Criterion in Clean Water Act Section 402 NPDES Permits.* Draft. October 2021. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC. *https://www.epa.gov/system/files/documents/2021-10/selenium-faq-cwa305-draft-2021.pdf*	This document is intended to help NPDES permit writers understand what permitting procedures may be appropriate to implement state and authorized tribal water quality standards similar or identical to the EPA's national CWA § 304(a) recommended selenium criterion. This set of FAQs also provides information on how to establish water quality-based effluent limits (WQBELs) in NPDES permits.
EPA. (US Environmental Protection Agency). 2021. *Technical Support for Adopting and Implementing EPA's 2016 Selenium Criterion in Water Quality Standards. Draft*. October 2021. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC. *https://www.epa.gov/system/files/documents/2021-10/selenium-adopting-tsd-draft-2021.pdf*	This document provides an overview on how to establish or enhance existing fish tissue monitoring programs to facilitate implementation of the fish tissue-based criterion elements in the national CWA § 304(a) recommended selenium criterion.

Title of Document	Synopsis
EPA. (US Environmental Protection Agency). 2020. *Frequently Asked Questions: Implementing the 2016 Selenium Criterion in Clean Water Act Sections 303(d) and 305(b) Assessment, Listing, and Total Maximum Daily Load Programs*. Draft. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC.	This document provides information on how to complete assessments, list impaired waters, and develop TMDLs based on EPA approved water quality standards that adhere to EPA's national CWA § 304(a) recommended selenium criterion (i.e., including all four elements). Together, these TSMs provide information that will assist states and authorized tribes with adopting this criterion and implementing it in various CWA implementation programs.
J.R. Simplot. 2007. *Final Work Plan – Field Monitoring Studies for Developing a Site-Specific Selenium Criterion*. April 2007. Prepared by Newfields.	This study was developed to document and evaluate the existing chemical, biological, and physical conditions in Hoopes Spring and downstream receiving waters. The purpose of the field monitoring studies was to characterize the spatial and temporal characteristics of the exposure environment. Development of a selenium criterion that is protective of the aquatic community was the goal of this study.
J.R. Simplot. 2012. *Technical Support Document: Proposed Site-Specific Selenium Criterion, Sage and Crow Creeks, Idaho*. January 2012. Prepared by Formation Environmental.	This technical support document is the final version of the Interpretative Report. It provides an integration of the field and laboratory studies and a literature review.
J.R. Simplot. 2017. *Revised Proposed Site-Specific Selenium Criterion for Hoopes Spring, Sage Creek, and Crow Creek near the Smoky Canyon Mine.* October 2017. Prepared by Formation Environmental.	This document proposes a chronic site-specific selenium criterion (SSSC) comprised of four elements for streams adjacent to its Smoky Canyon Mine in southeast Idaho.
Nu-West. 2017. *Proposal for Site-Specific Selenium Criteria Upper Blackfoot River and Georgetown Creek Watersheds*. April 2017. Prepared by Arcadis.	This document presents Nu-West Industries, Inc. (Nu-West) proposal for site-specific selenium criteria for surface waters located in two watersheds in Southeast Idaho: Upper Blackfoot River (UBR) watershed and Georgetown Creek watershed.
Nu-West. 2017. *Proposal for Site-Specific Selenium Criteria Upper Blackfoot River and Georgetown Creek Watersheds.* November 2017. Prepared by Arcadis.	This document presents Nu-West Industries, Inc. (Nu-West) proposal for site-specific selenium criteria for surface waters located in two watersheds in Southeast Idaho: Upper Blackfoot River (UBR) watershed and Georgetown Creek watershed.
Zinsser, L.M., C.A. Mebane, G.C. Mladenka, L.R. Van Every, and M.L. Williams. 2018, *Spatial and Temporal Trends in Selenium in the Upper Blackfoot River Watershed, Southeastern Idaho, 2001–16.* U.S. Geological Survey Scientific Investigations Report. 2018-5081. https://doi.org/10.3133/sir20185081.	This report analyzes and presents data from three separate but complementary studies monitoring selenium in streams in the region. The U.S. Geological Survey (USGS), in cooperation with the Bureau of Land Management, has been collecting streamflow and water-quality samples year-round on the Blackfoot River above reservoir near Henry, Idaho, (USGS streamgage 13063000) since 2001.