

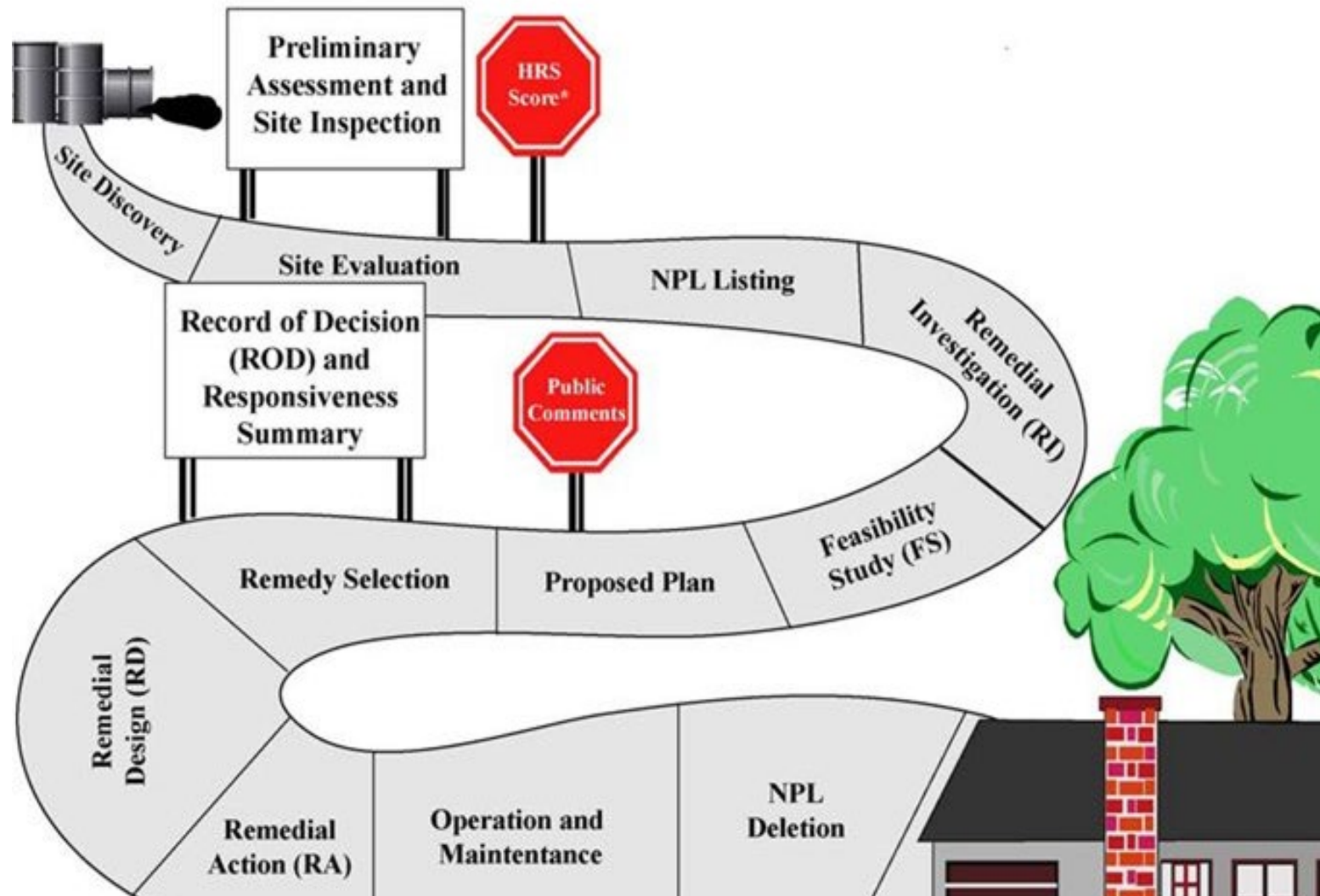
**Using 30 years of Water Quality and Biological  
Monitoring Data to Gauge Success and Limitations  
Superfund Cleanup of Silver Bow Creek**





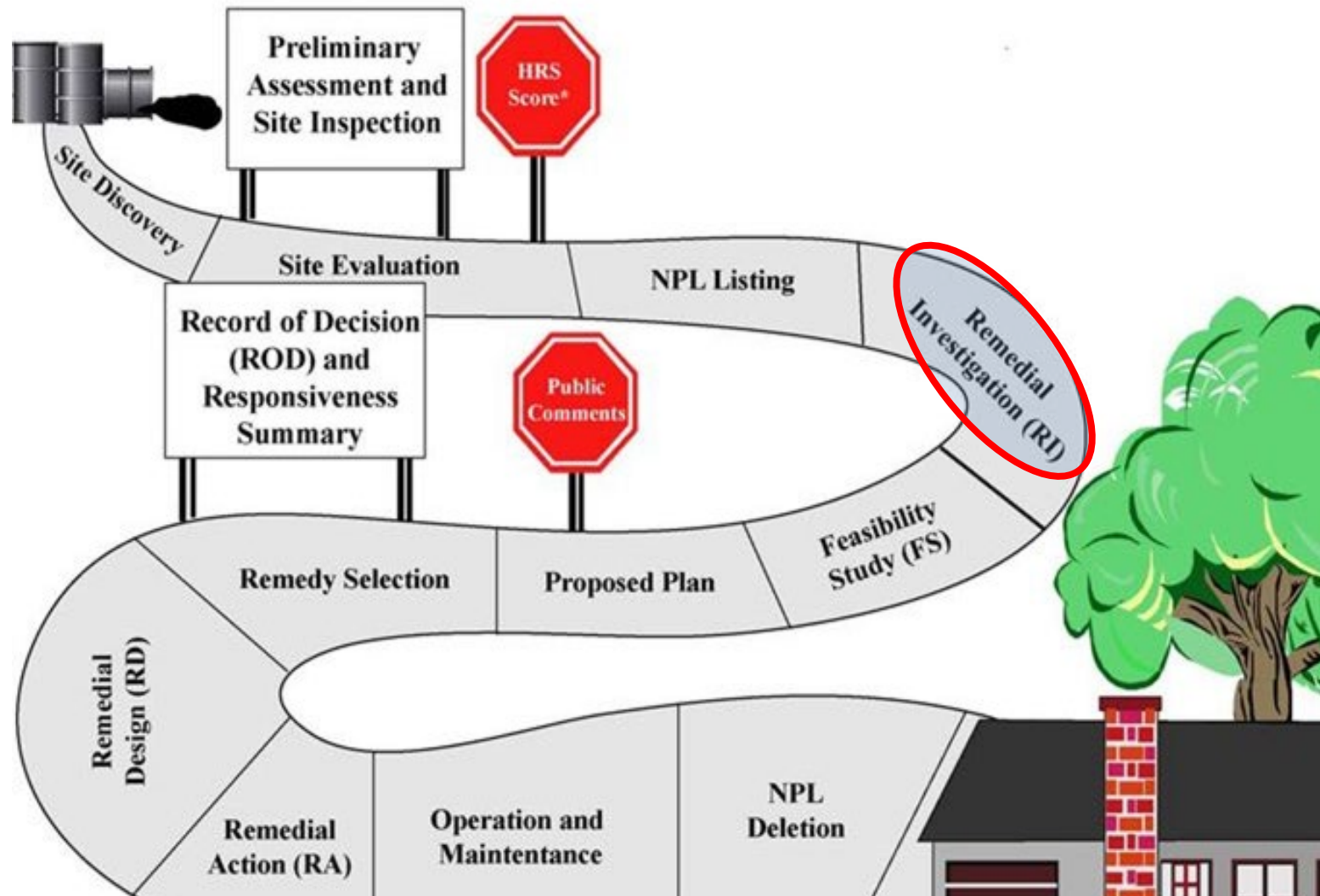
Are we there yet?

# The Superfund Process



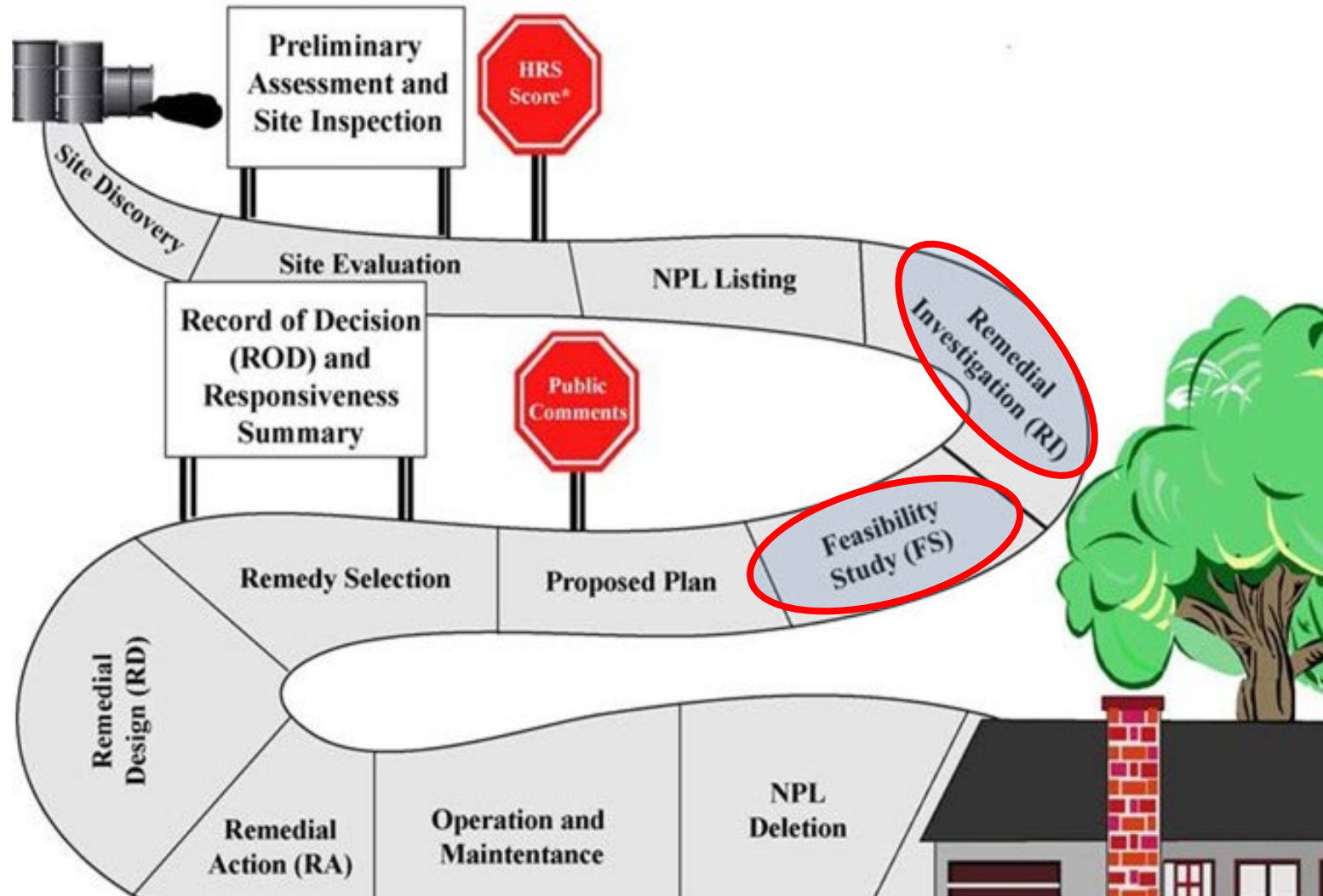
**Stream Water Quality and Biological Monitoring  
1990 - Ongoing**

# The Superfund Process



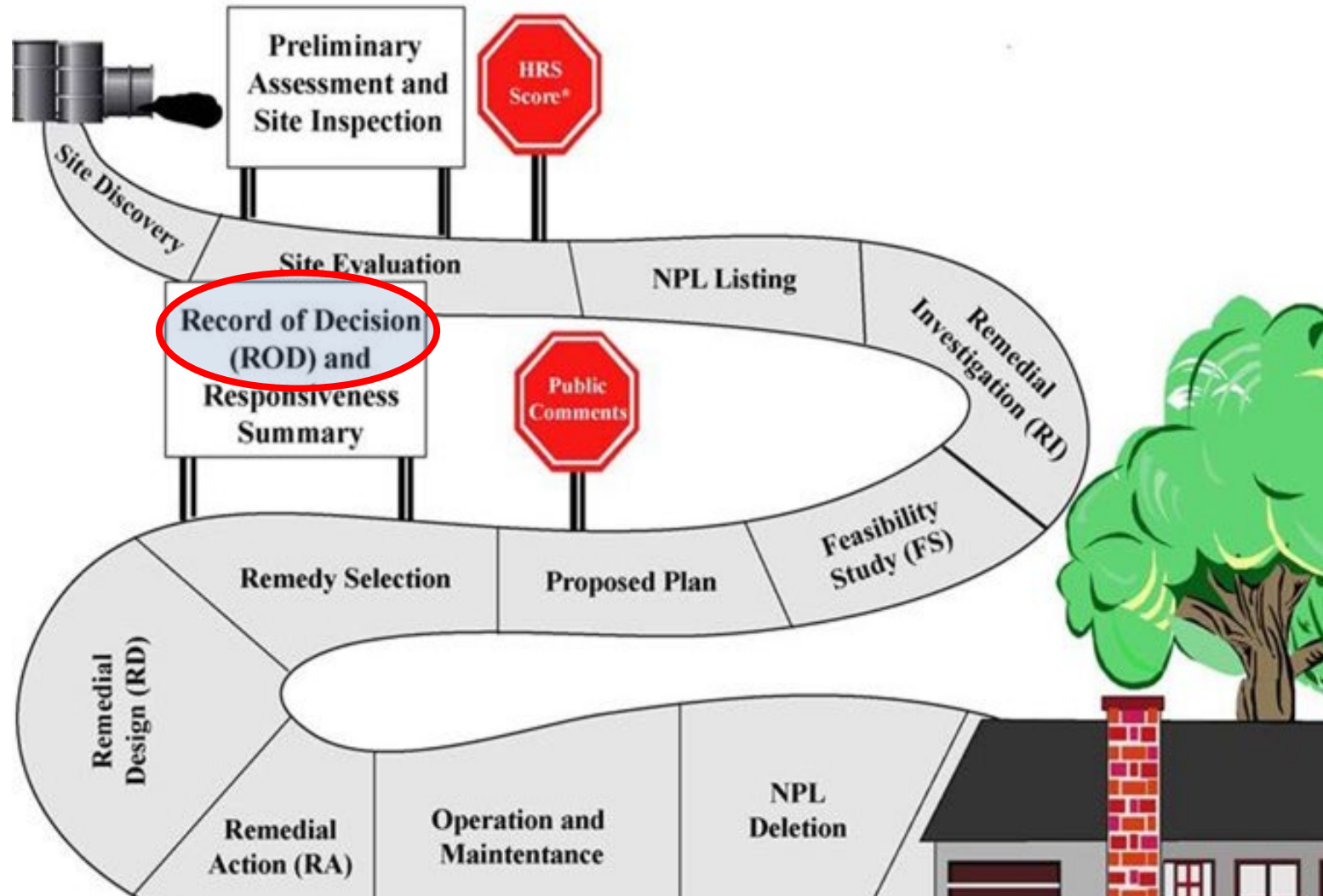
Stream Water Quality and Biological Monitoring  
1990 - Ongoing

# The Superfund Process



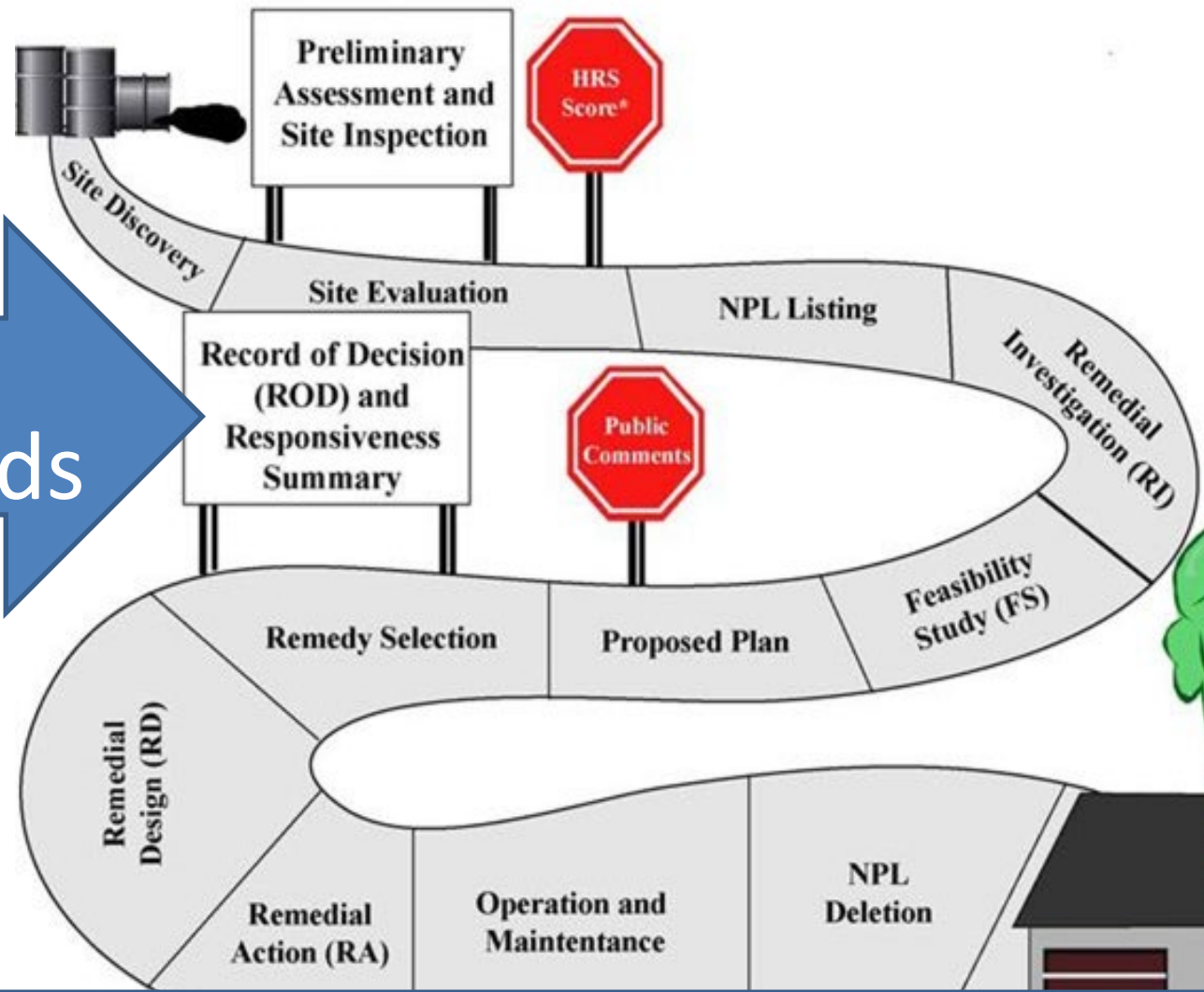
Stream Water Quality and Biological Monitoring  
1990 - Ongoing

# The Superfund Process



**Stream Water Quality and Biological Monitoring  
1990 - Ongoing**

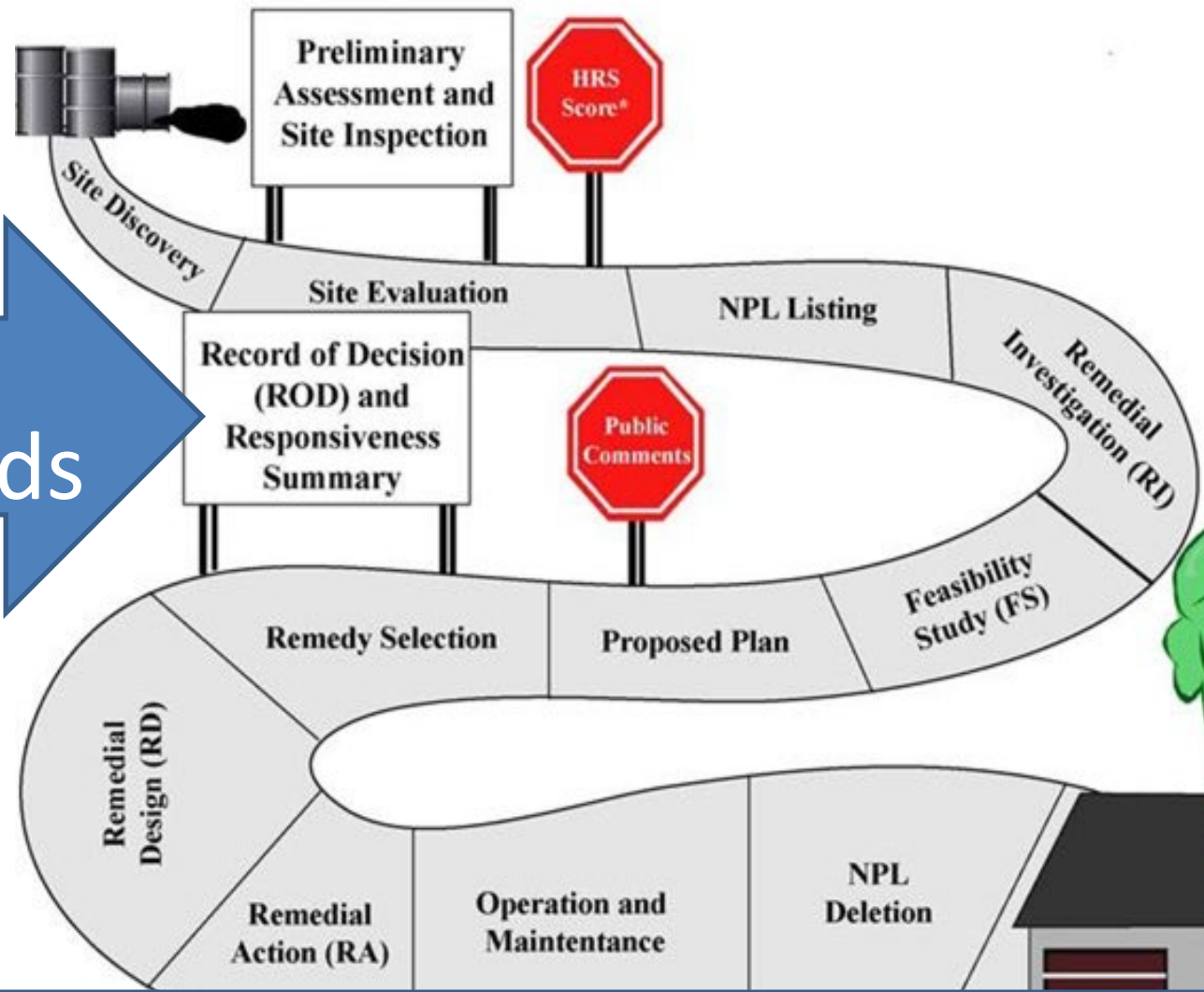
# The Superfund Process



WQ standards

Err on the Side of Caution

# The Superfund Process



WQ standards

TI WAIVERS?

Amend ROD – Waived To Standard



**A lawyer and a geologist walk into a bar....**



**A lawyer and a  
geologist walk  
into a bar....**

**Civil Action No. CV89-039-BU-SEH**

**Plaintiffs**

**UNITED STATES OF AMERICA AND  
THE STATE OF MONTANA**

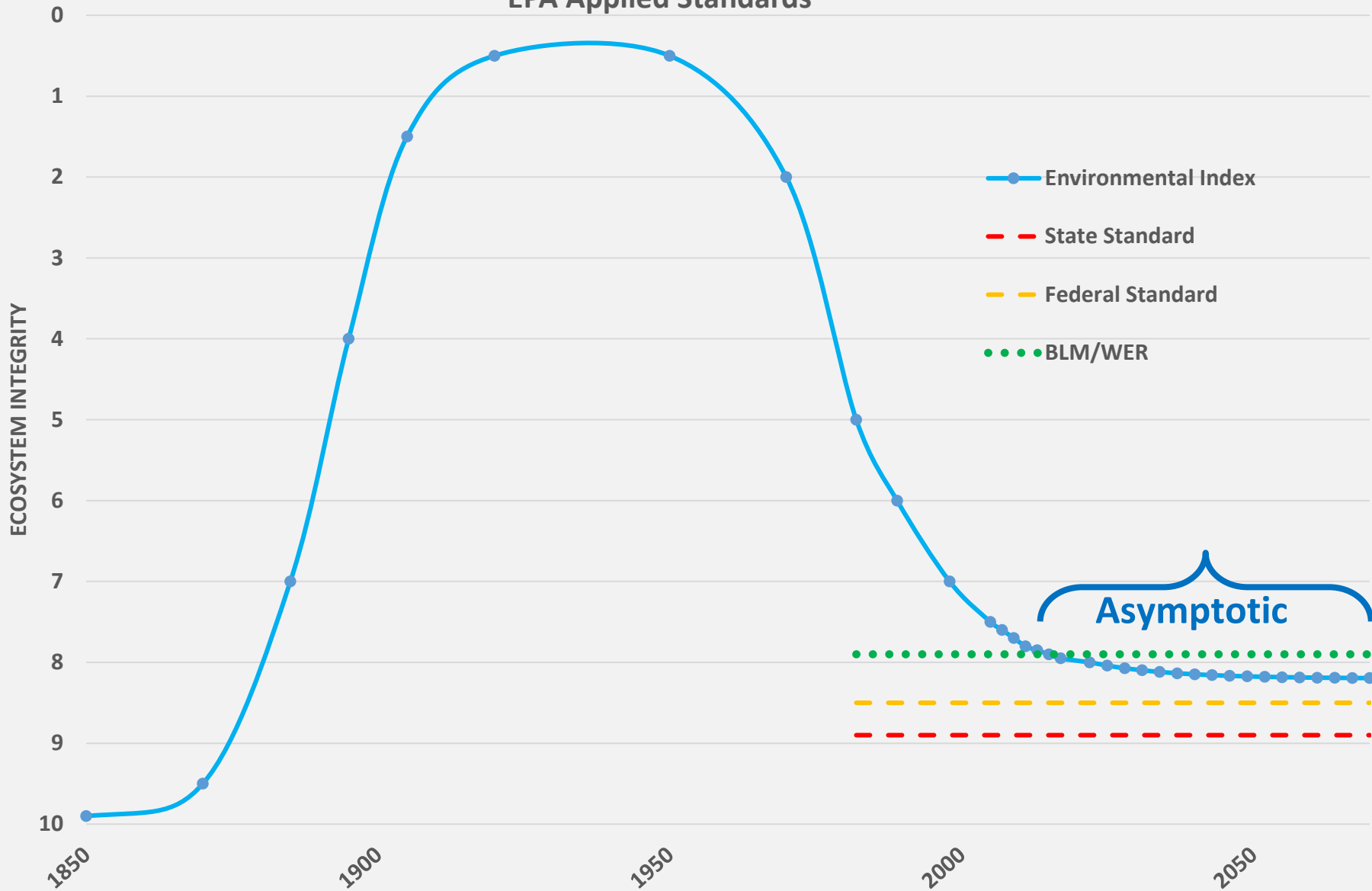
**Vs**

**Defendant**

**ATLANTIC RICHFIELD COMPANY**

# Conceptual Ecosystem Story Arc

## EPA Applied Standards

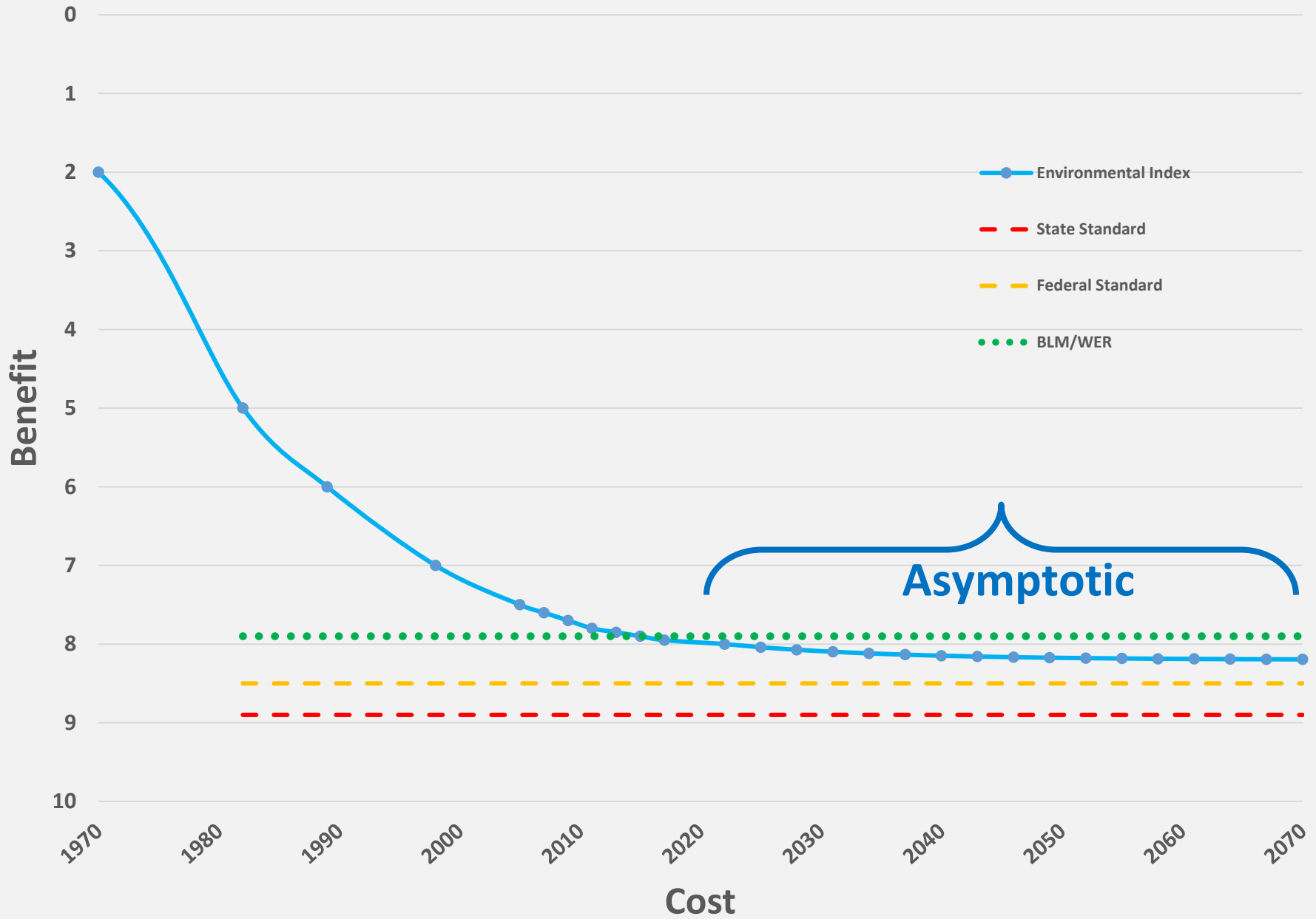


Pristine

Dead Stream

Novel

# Ecosystem Story Arc VS Standards



# WAIVERS

(4) The President may select a remedial action meeting the requirements .....Blah Blah Blah....

**.....Must Be Protective of Human Health and the Environment**

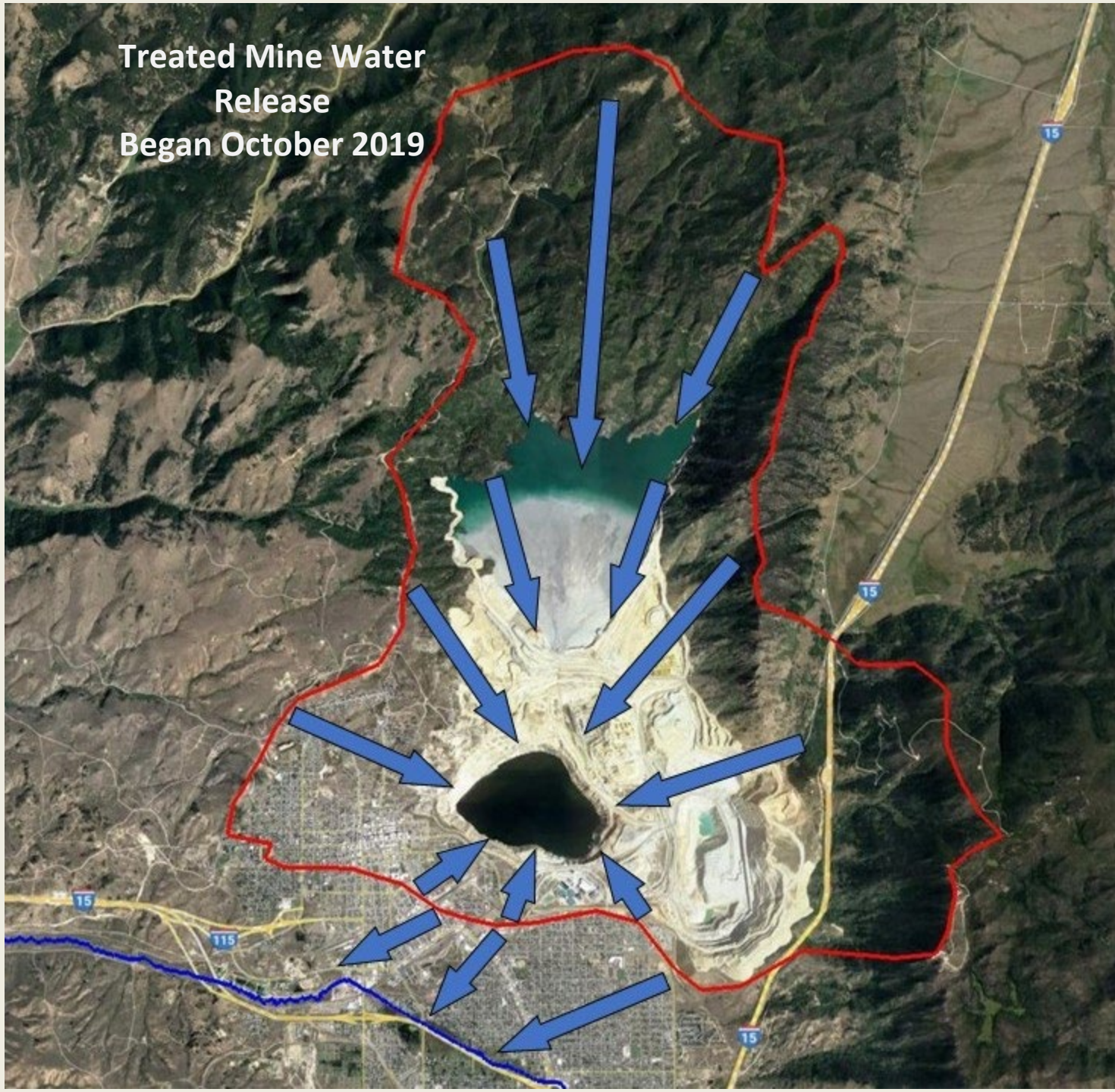
(B) compliance with such requirement at that facility will result in greater risk to human health and the environment than alternative options – **“Do No Harm”**

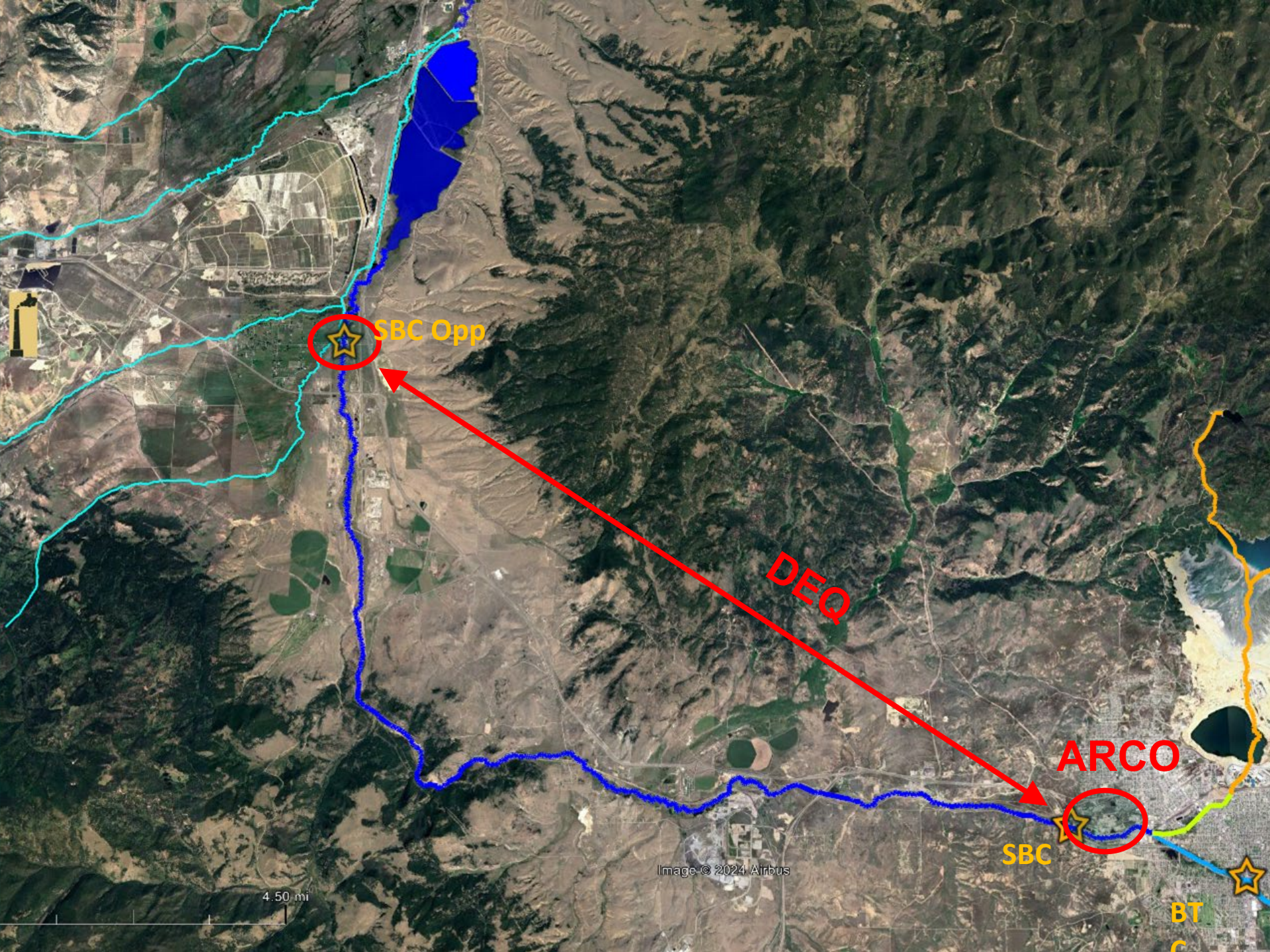
(C) compliance with such requirements is technically impracticable from an engineering perspective – **“TI Waiver”**

- Acidic mine water discharge
- Tailings



Treated Mine Water  
Release  
Began October 2019





SBC Opp

DEQ

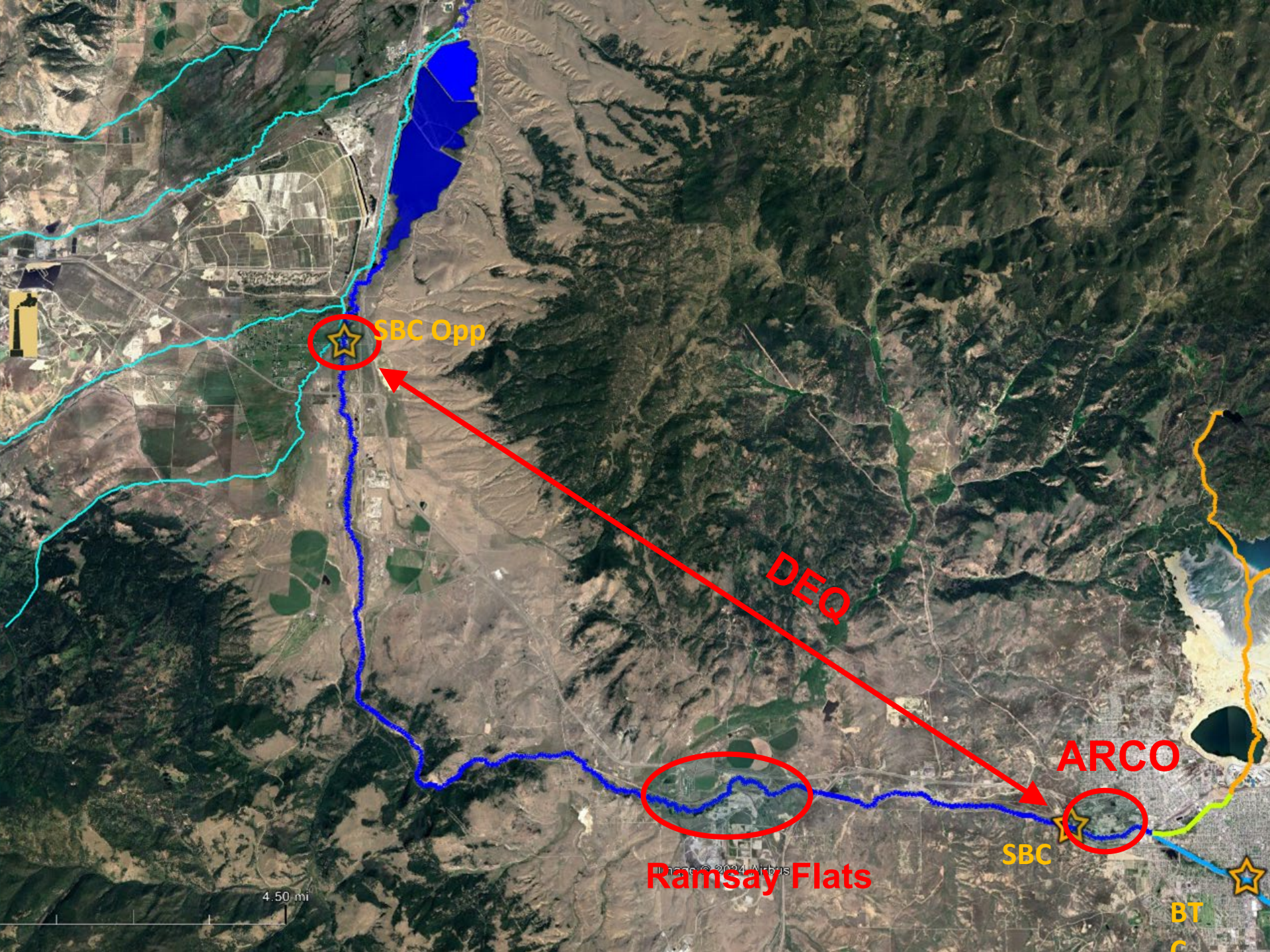
ARCO

SBC

BT

4.50 mi

Image © 2024 Airbus



SBC Opp

DEQ

Ramsay Flats

ARCO

SBC

BT

C

4.50 mi

# RAMSAY FLATS ~ Early 2000s



2000 – 2015 Streamside Tailings  
MT DEQ Cleans 26 miles Downstream of Butte  
~ \$130M





Image © 2016 DigitalGlobe

2002



2014

Google earth

# When is it complete?



ARSENIC LEAD  
CADMIUM ZINC  
COPPER  
 $\text{EXP}\{\text{M}[\text{LN}(\text{HARD})]\text{+B}\}$

# EPA Says

## Meet These Water Quality Standards



# APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

## ARARs

$$\text{STANDARD} = \exp\{m[\ln(\text{hardness})]+b\}$$

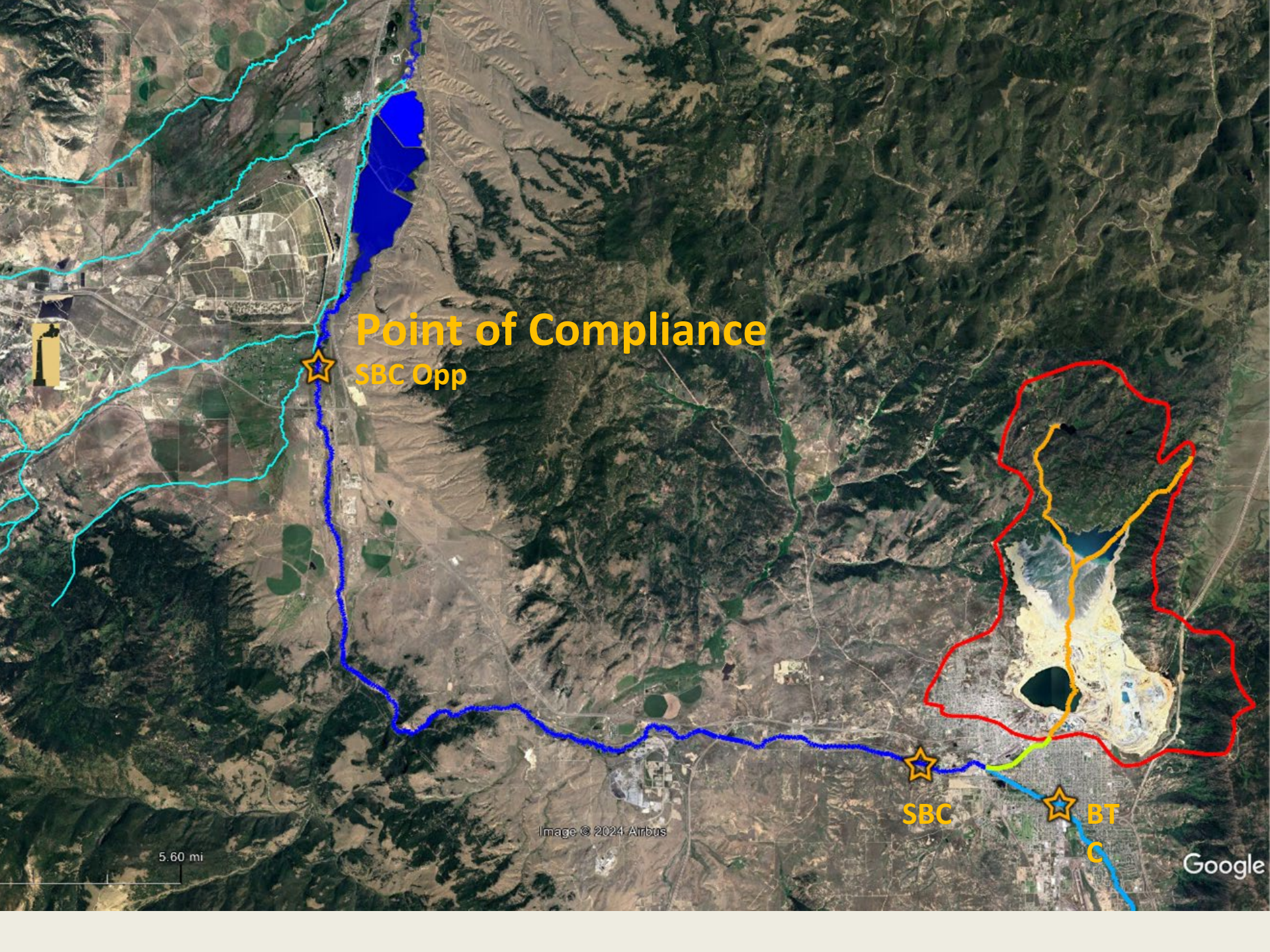
	M	B	HARDNESS	STANDARD (µg/L)
Copper Chronic	0.8545	-1.702	141	12.5

**State Standard = Unfiltered (“Total Recoverable”)**

**Federal Standard = Filtered 0.45 microns(Dissolved)**

**Federal Water Effects Ratio**

**Federal Biotic Ligand Model**



**Point of Compliance**

**SBC Opp**

**SBC**

**BT  
C**

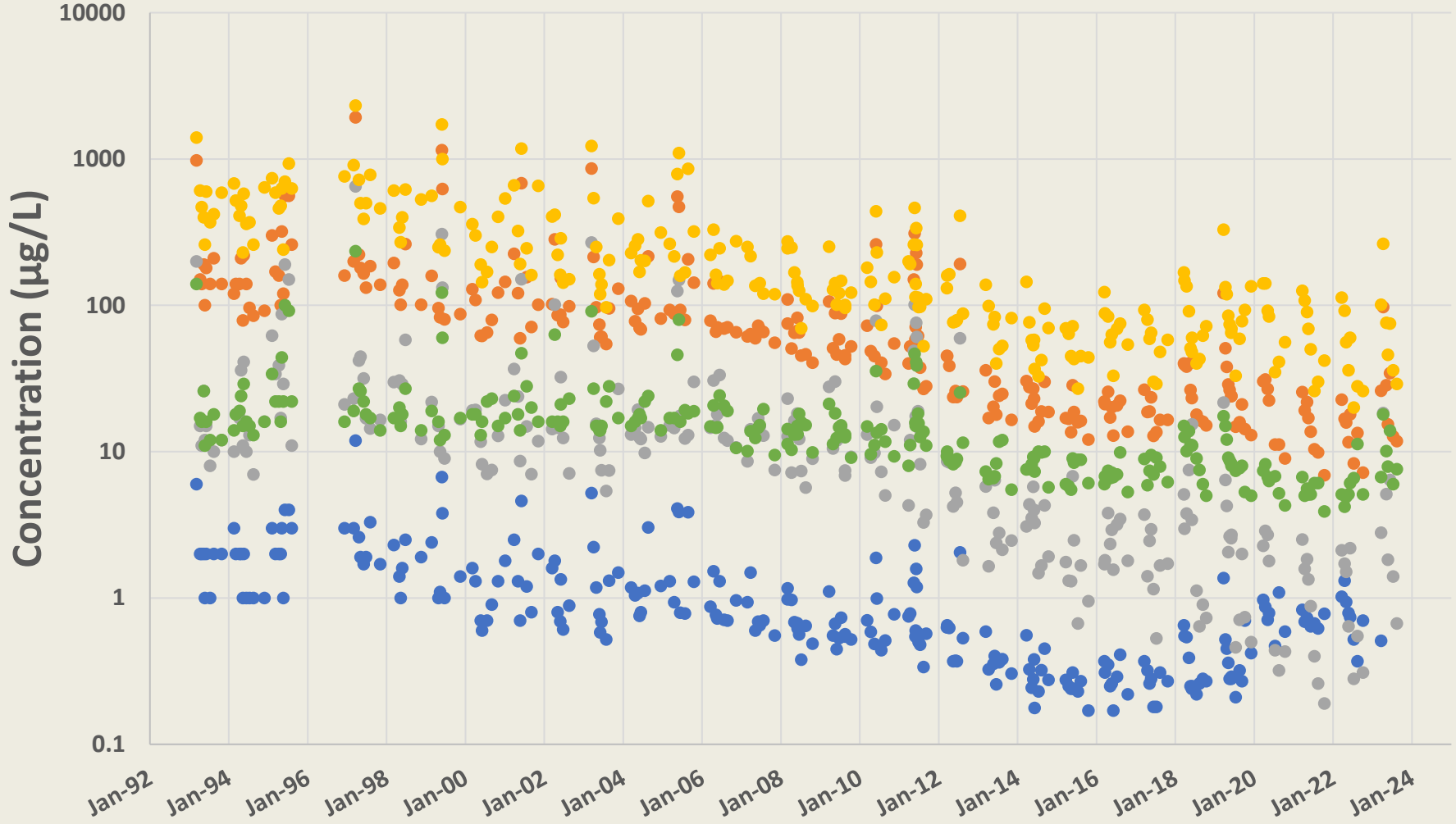
5.60 mi

Image © 2024 Airbus

Google

# Silver Bow Creek - Opportunity

## Total Recoverable Concentration $\mu\text{g/L}$



● CdT

● CuT

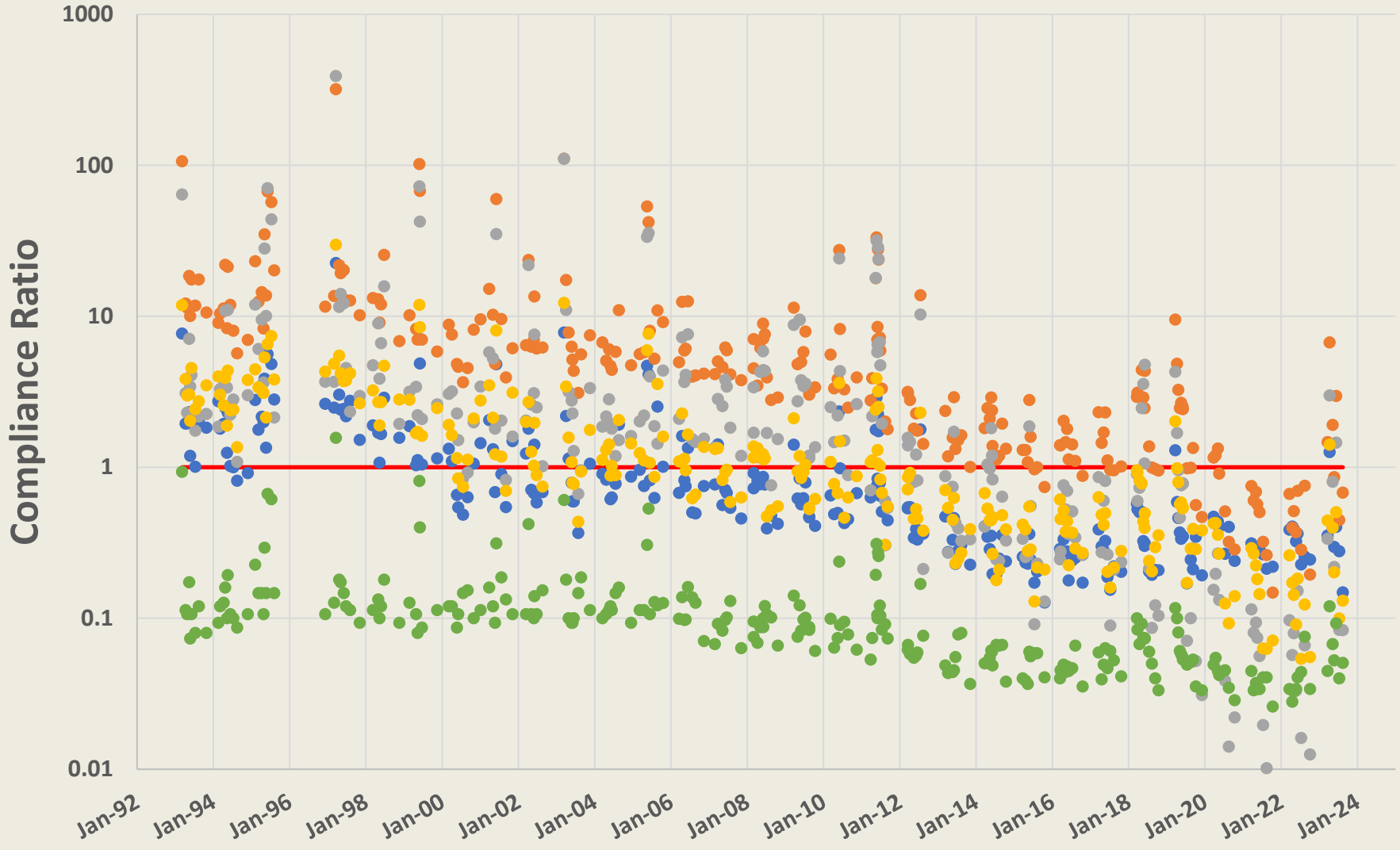
● PbT

● ZnT

● AsT

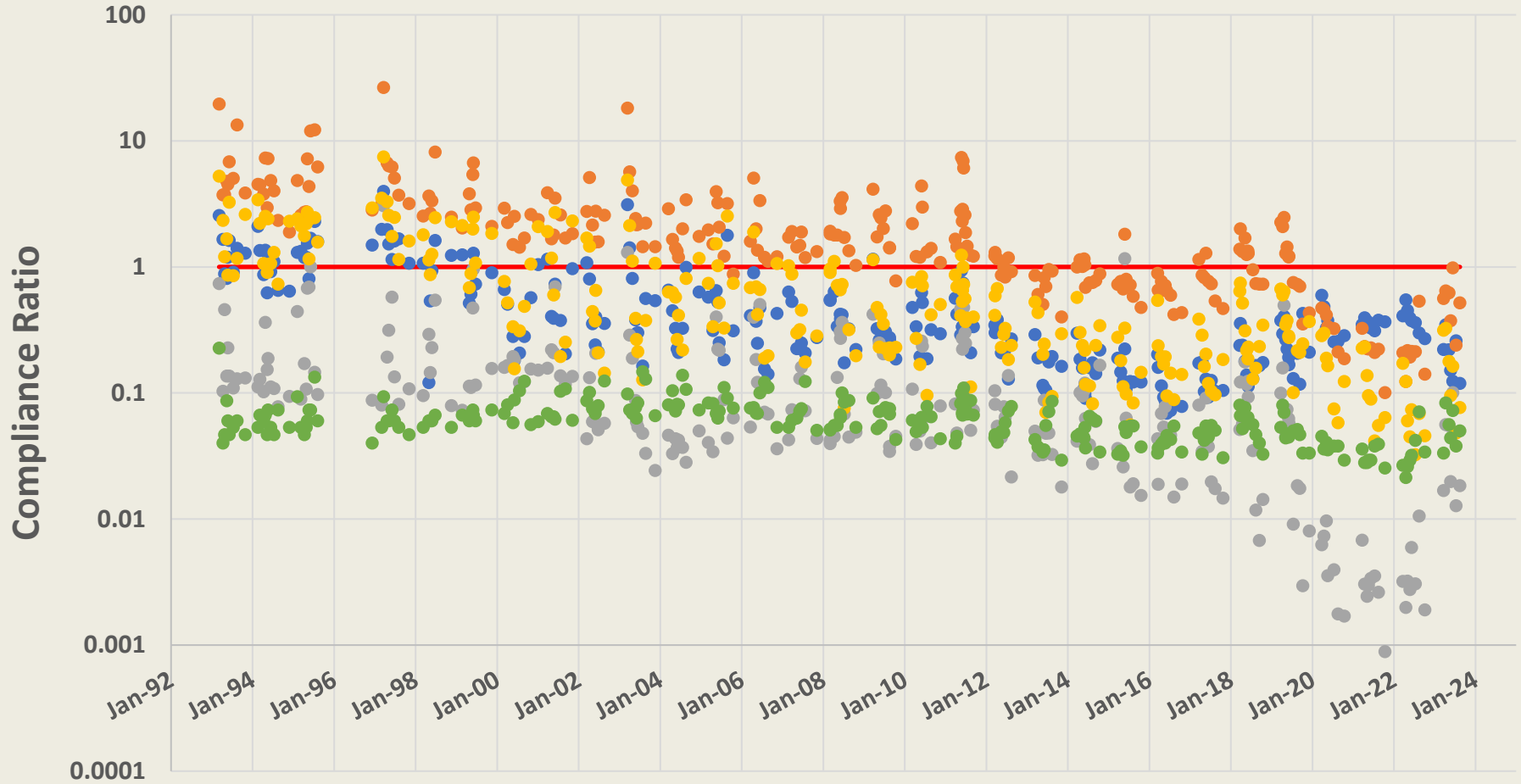
# Silver Bow Creek - Opportunity

## Total Recoverable Compliance Ratio



● CdT      ● CuT      ● PbT      ● ZnT      — Complies      ● AsT

# Silver Bow Creek - Opportunity Filtered (“Dissolved” – ionic + particulate)



● Cd D      ● Cu D      ● Pb D      ● Zn D      — Complies      ● As D

# 2013 Copper Bioavailability Testing in Silver Bow Creek and Anaconda Tributaries (Warm Springs Creek, Mill Creek, Willow Creek, Lost Creek)

*Winter, Spring, and Summer/Fall Sampling*

*For:*

Atlantic Richfield Company

Butte, Montana, USA

---

Prepared by:

**TRE**  
TRE Environmental  
Strategies, LLC.  
4303 West LaPorte  
Avenue  
Fort Collins, Colorado



ARCADIS U.S., Inc.  
1887 Cole Blvd, Suite 200  
Lakewood, CO, 80401

October 2014

**DRAFT**

**2013 Copper Bioavailability Testing in  
Silver Bow Creek and Anaconda  
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*Winter, Spring, and Summer/Fall Sampling*

*For:*  
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**Butte, Montana, USA**

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**TRE**  
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4303 West LaPorte  
Avenue  
Fort Collins, Colorado

 **ARCADIS**  
Infrastructure Water Environment Buildings

**ARCADIS U.S., Inc.**  
1887 Cole Blvd, Suite 200  
Lakewood, CO, 80401

October 2014

**DRAFT**

**WATER EFFECTS RATIO  
BIOTIC LIGAND MODEL**

# WARM SPRINGS CREEK

Copper LC<sub>50</sub> (µg/L)

Site

Season

Site water

Lab water

WER

WSC

Winter

Unfiltered

277.7

145.1

1.914

Filtered

255.5

119.8

2.133

Spring

Unfiltered

360.3

62.71

5.745

Filtered

216.6

56.21

3.853

Summer/  
Fall

Unfiltered

233.7

121.3

1.927

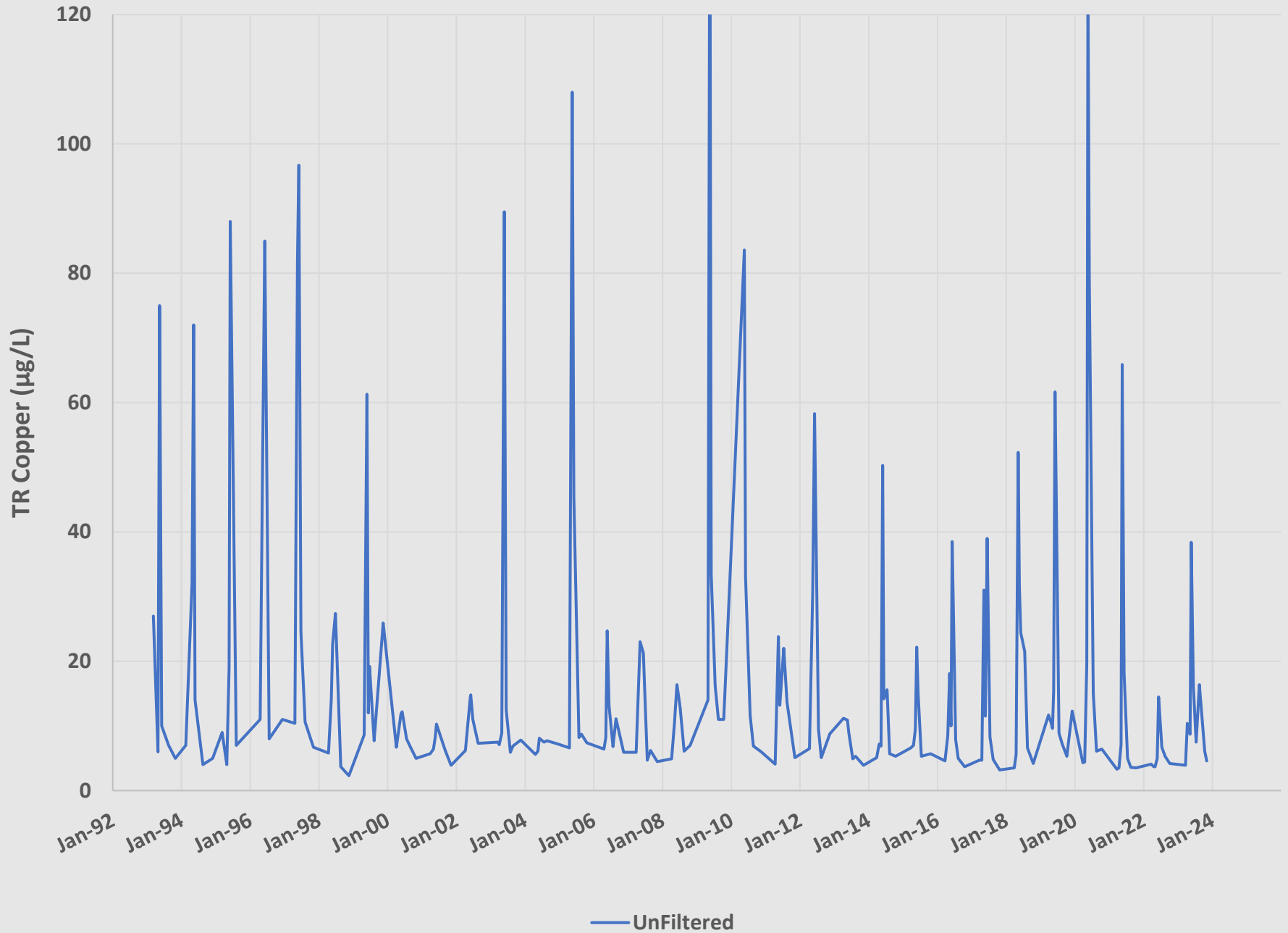
Filtered

176.1

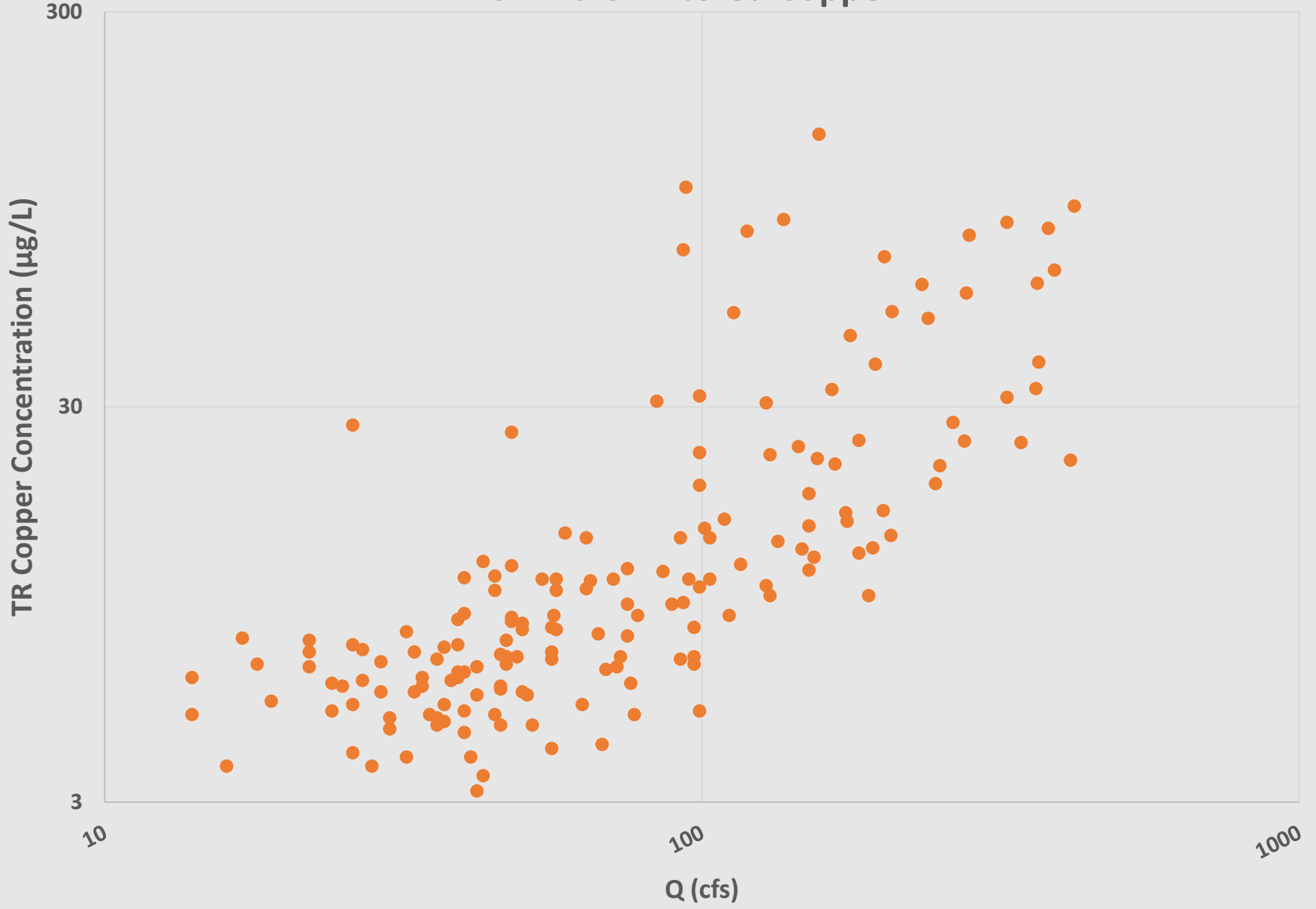
99.28

1.774

# Warm Springs Creek Copper

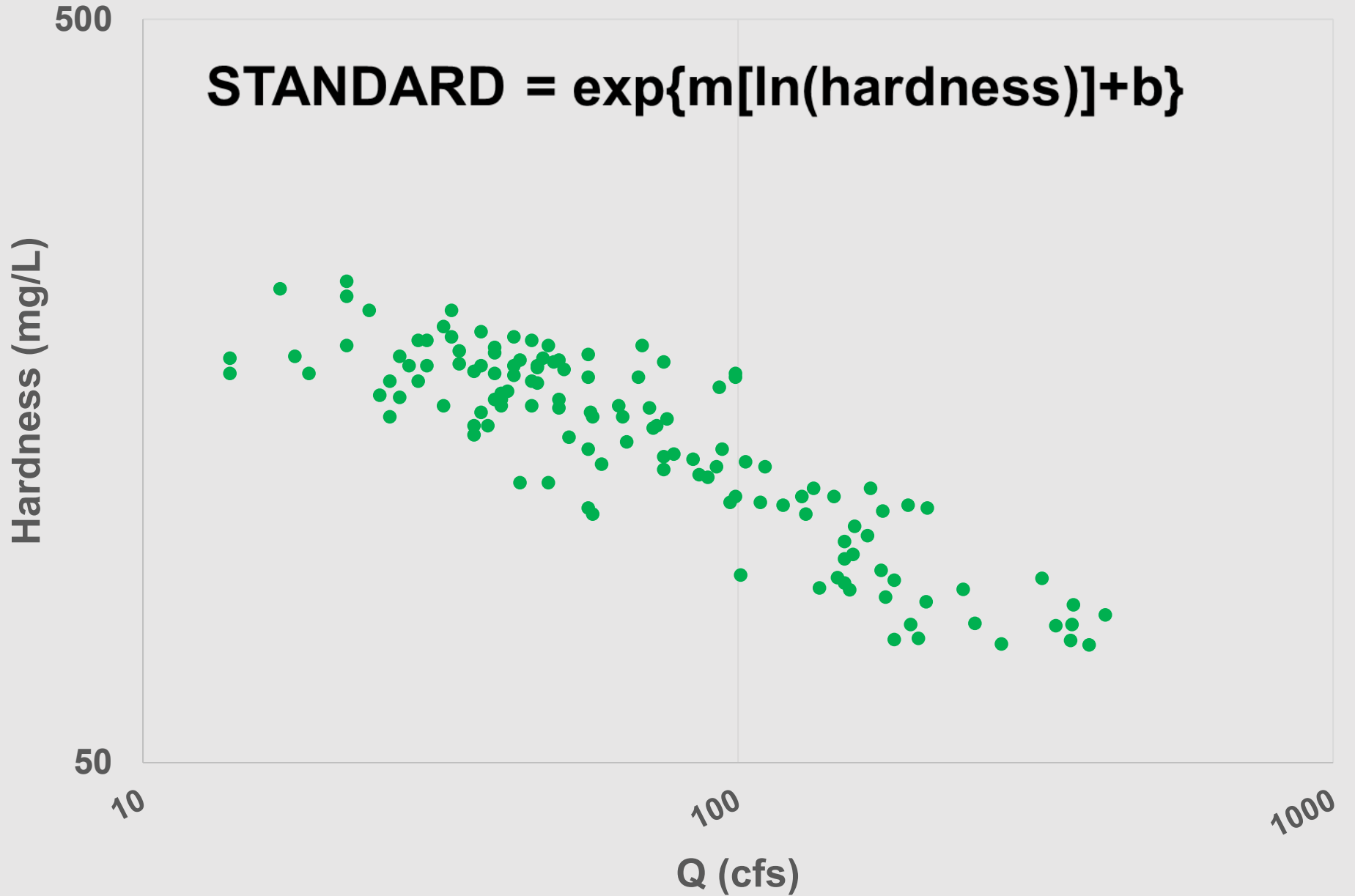


# Warm Springs Creek Flow VS Unfiltered Copper

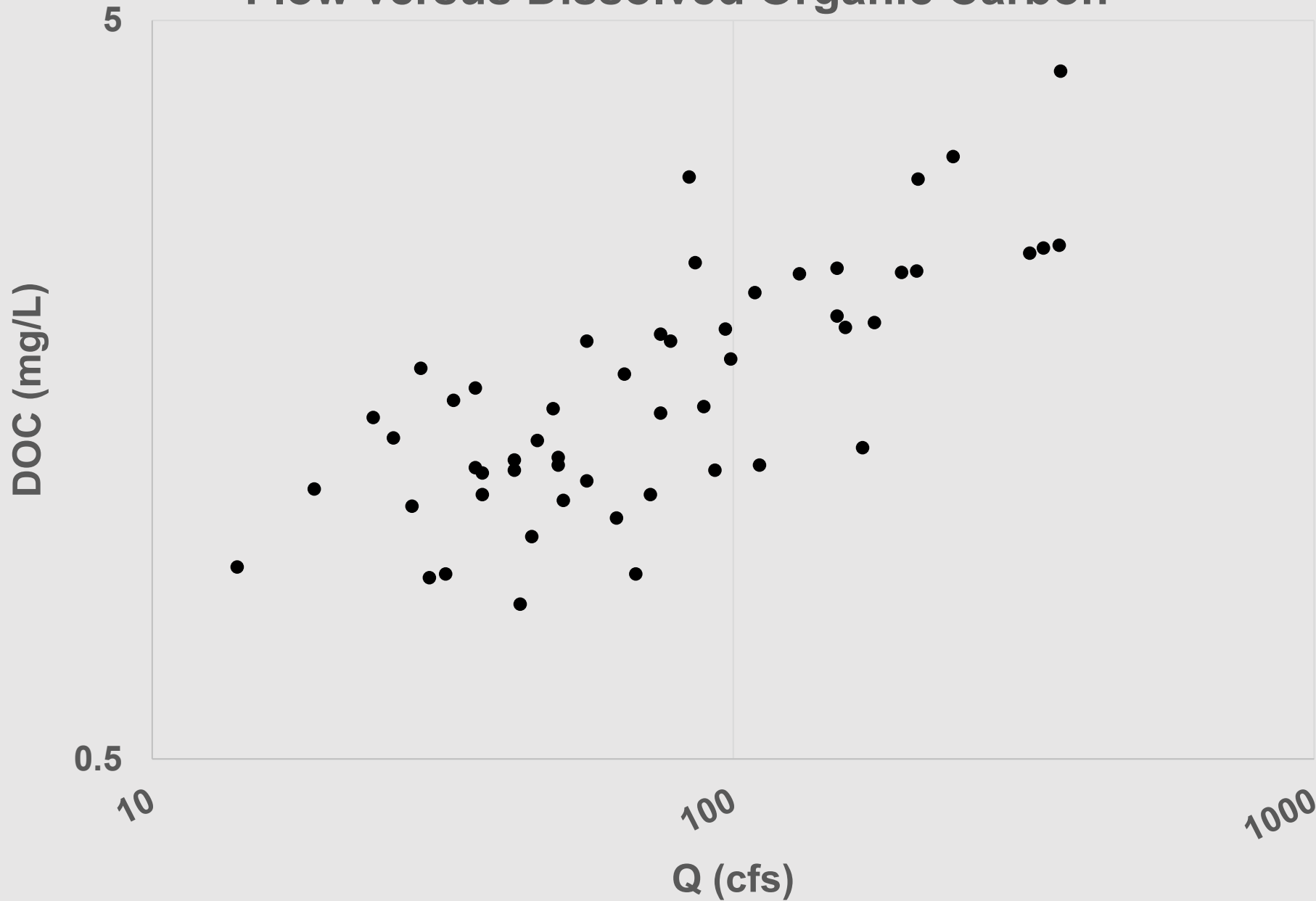


# Warm Springs Creek Flow VS Hardness

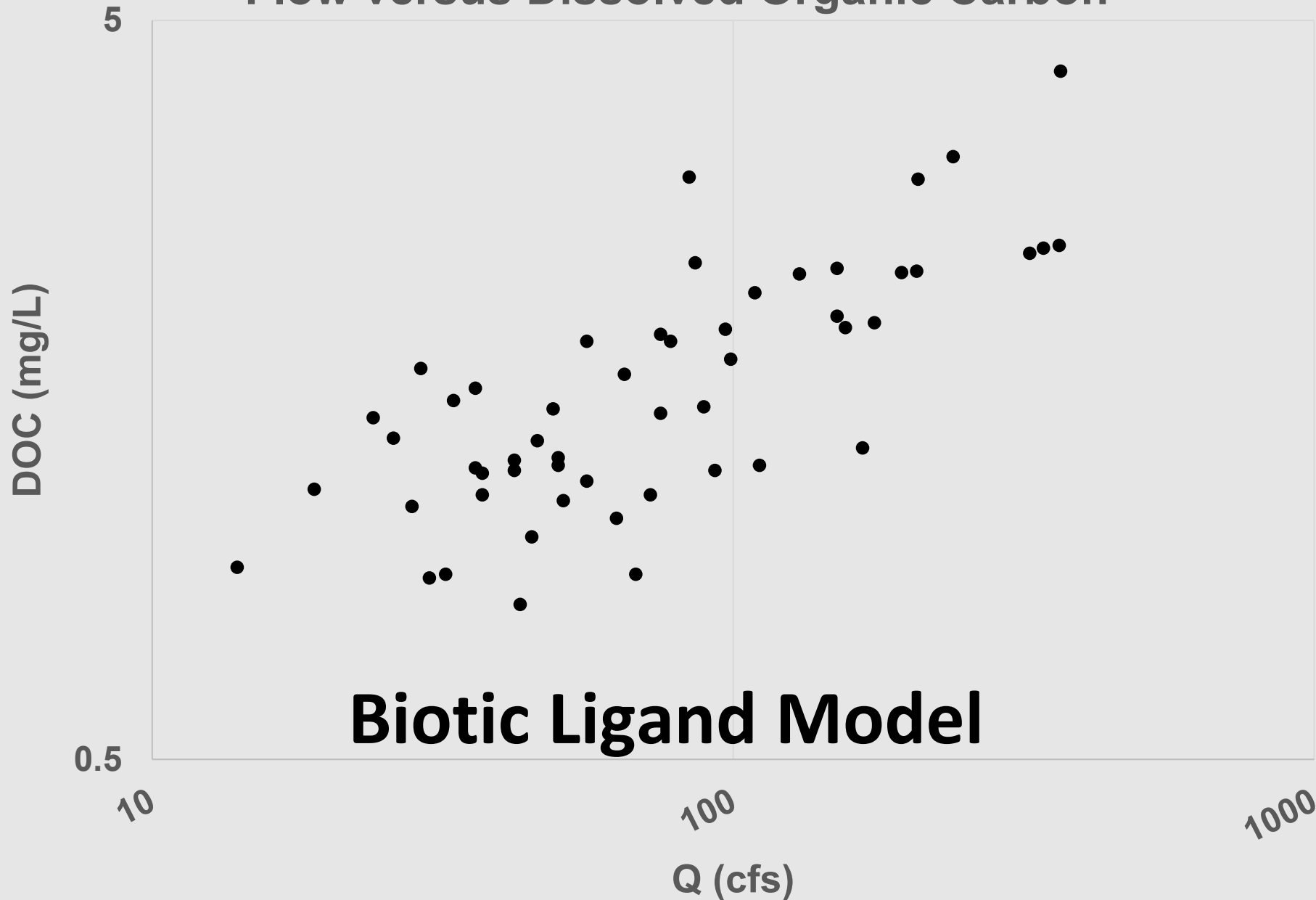
**STANDARD =  $\exp\{m[\ln(\text{hardness})]+b\}$**



# Warm Springs Creek Flow versus Dissolved Organic Carbon



# Warm Springs Creek Flow versus Dissolved Organic Carbon



# Silver Bow Creek at Opportunity

## Annual Max-Min

1000.0

100.0

10.0

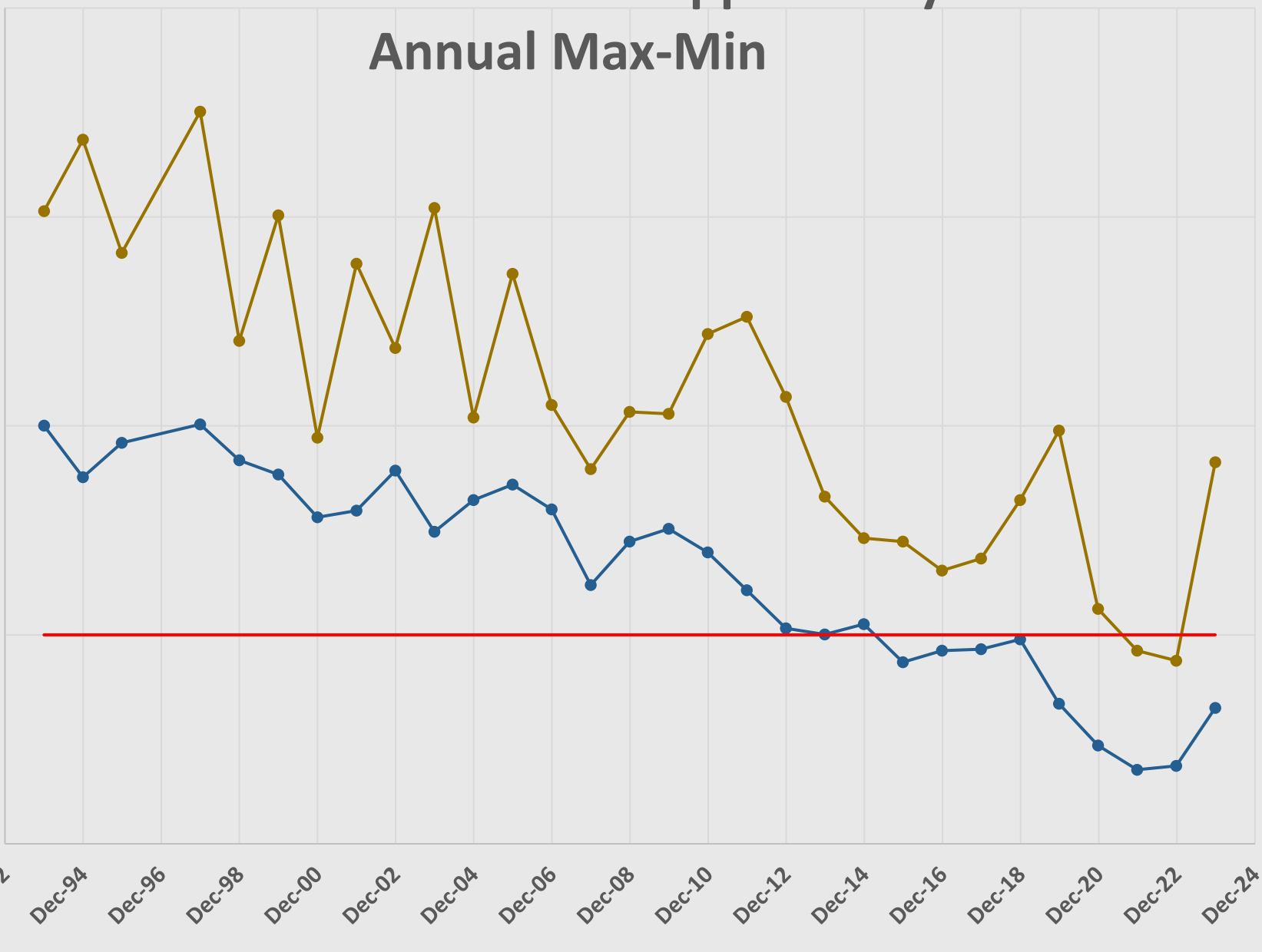
1.0

0.1

TR Copper Compliance

Dec-92 Dec-94 Dec-96 Dec-98 Dec-00 Dec-02 Dec-04 Dec-06 Dec-08 Dec-10 Dec-12 Dec-14 Dec-16 Dec-18 Dec-20 Dec-22 Dec-24

—●— SBC Opp CuT Ratio Max —●— SBC Opp CuT Ratio Min

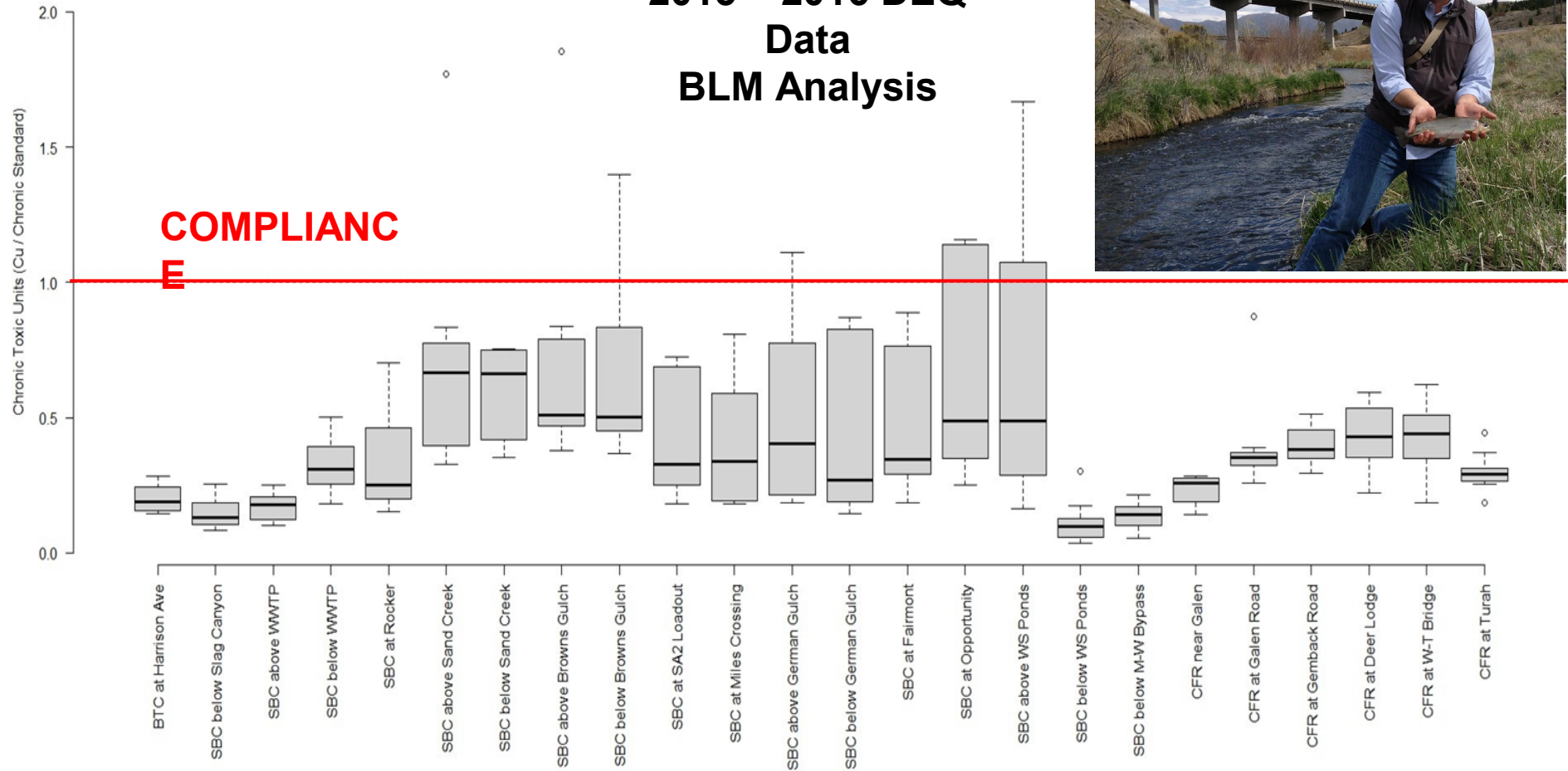


# Silver Bow Creek at Opportunity Biotic Ligand Model Fall/Winter

Measured Concentration					
Hardness	Conc Cu ( $\mu\text{g/L}$ )	Hard Std	WER	WER Chronic Std	BLM Chronic Std
178	<b>10.3</b>	14.7	2.083	30.5	<b>15.6</b>

Filtered  
(0.45 $\mu$ )

# 2015 – 2016 DEQ Data BLM Analysis

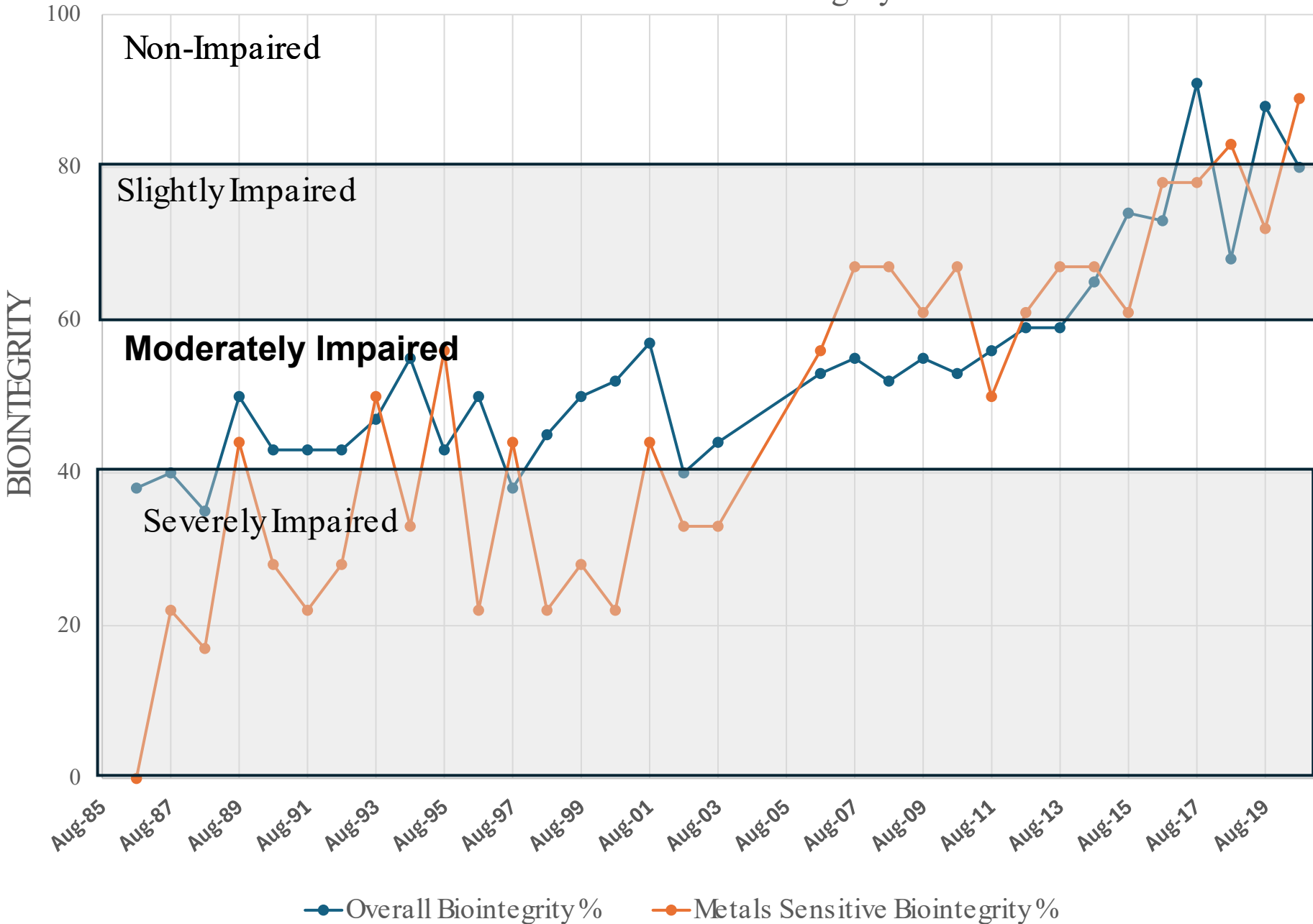


**Longitudinal analysis of Chronic BLM compliance  
Blacktail Creek to Clark Fork at Turah**



**Macroinvertebrate Monitoring late 1980s to Present**

# Silver Bow Creek Opportunity Macroinvertebrate Biointegrity





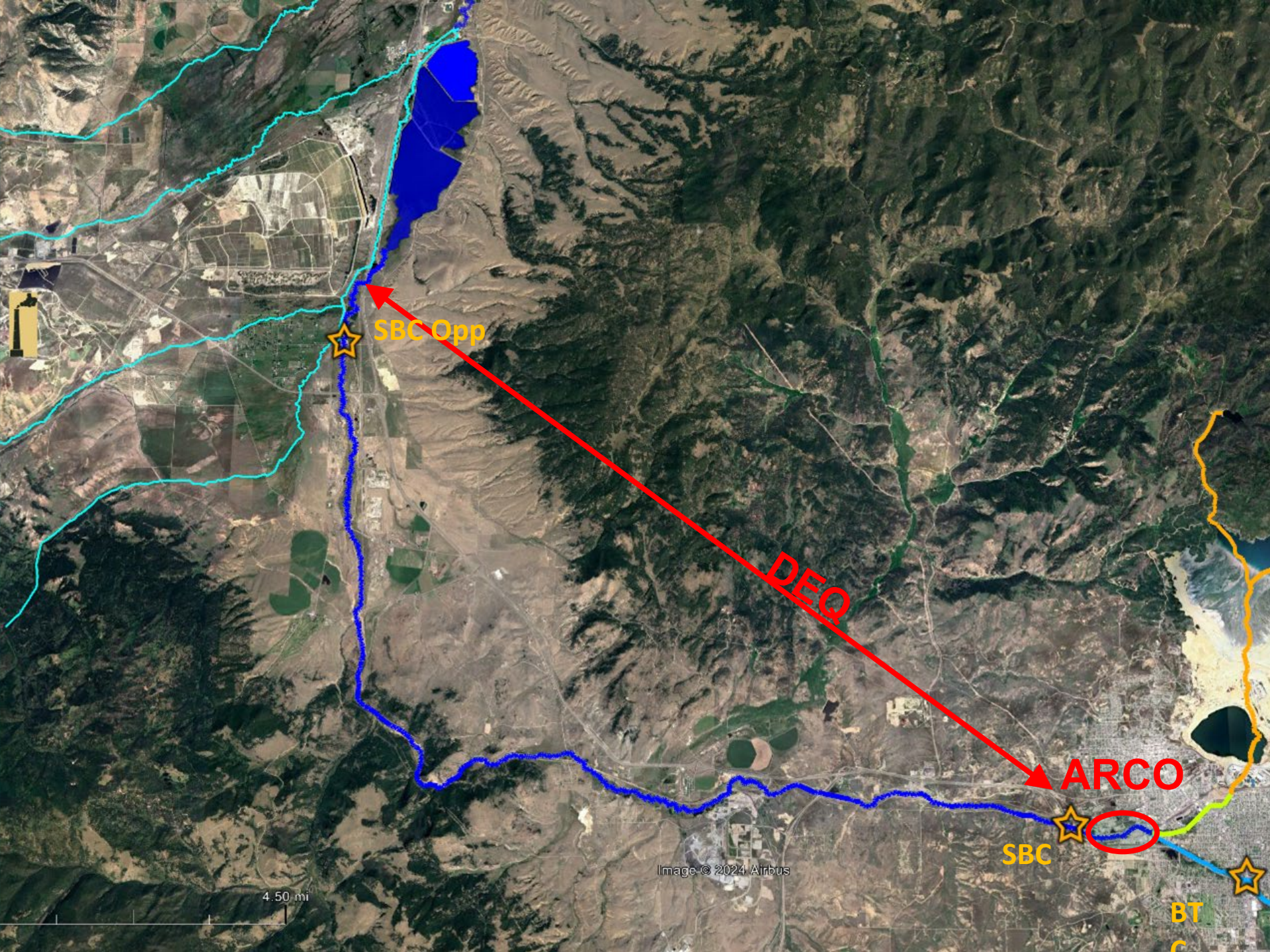
Common Name	Scientific Name	Subarea			
		1	2	3	4
American Dipper	<i>Cinclus mexicanus</i>	x		x	
American Goldfinch	<i>Spinus tristis</i>	x	x	x	x
Bald Eagle	<i>Haliaeetus leucocephalus</i>	x	x		x
Bank Swallow	<i>Riparia riparia</i>	x	x	x	x
Belted Kingfisher	<i>Megasceryle alcyon</i>		x	x	x
Black-capped Chickadee	<i>Parus atricapillus</i>	x	x	x	
Bullock's Oriole	<i>Icterus bullockii</i>		x		
Common Goldeneye*	<i>Bucephala clangula</i>		x	x	x
Common Merganser*	<i>Mergus merganser</i>	x	x	x	x
Common Yellowthroat	<i>Geothlypis trichas</i>	x	x	x	x
Cooper's Hawk	<i>Accipiter cooperii</i>	x			x
Eastern Kingbird	<i>Tyrannus tyrannus</i>		x		x
Gray Catbird	<i>Dumetella carolinensis</i>			x	
Hooded Merganser*	<i>Lophodytes cucullatus</i>		x		x
Lazuli Bunting	<i>Passerina amoena</i>		x	x	
Lincoln's Sparrow	<i>Melospiza lincolni</i>	x	x	x	x
MacGillivray's Warbler	<i>Geothlypis tolmiei</i>			x	
Northern Goshawk	<i>Accipiter gentilis</i>				x
Northern Waterthrush*	<i>Parkesia noveboracensis</i>			x	
Osprey*	<i>Pandion haliaetus</i>		x	x	x
Red-naped Sapsucker	<i>Sphyrapicus nuchalis</i>			x	
Song Sparrow	<i>Melospiza melodia</i>	x	x		x
Swainson's Hawk	<i>Buteo swainsoni</i>				x
Swainson's Thrush	<i>Catharus ustulatus</i>			x	
Tree Swallow	<i>Tachycineta bicolor</i>	x	x	x	x
Warbling Vireo	<i>Vireo gilvus</i>			x	
Western Wood-Pewee	<i>Contopus sordidulus</i>			x	
Willow Flycatcher	<i>Empidonax traillii</i>	x	x		x
Wilson's Warbler	<i>Cardellina pusilla</i>	x			
Wood Duck*	<i>Aix sponsa</i>	x	x		
Yellow Warbler	<i>Setophaga petechia</i>	x	x	x	x
<b>Total riparian-obligate or -dependent species</b>		<b>15</b>	<b>19</b>	<b>20</b>	<b>18</b>



Are we there yet?

# QUESTIONS OR COMMENTS





SBC Opp

DEQ

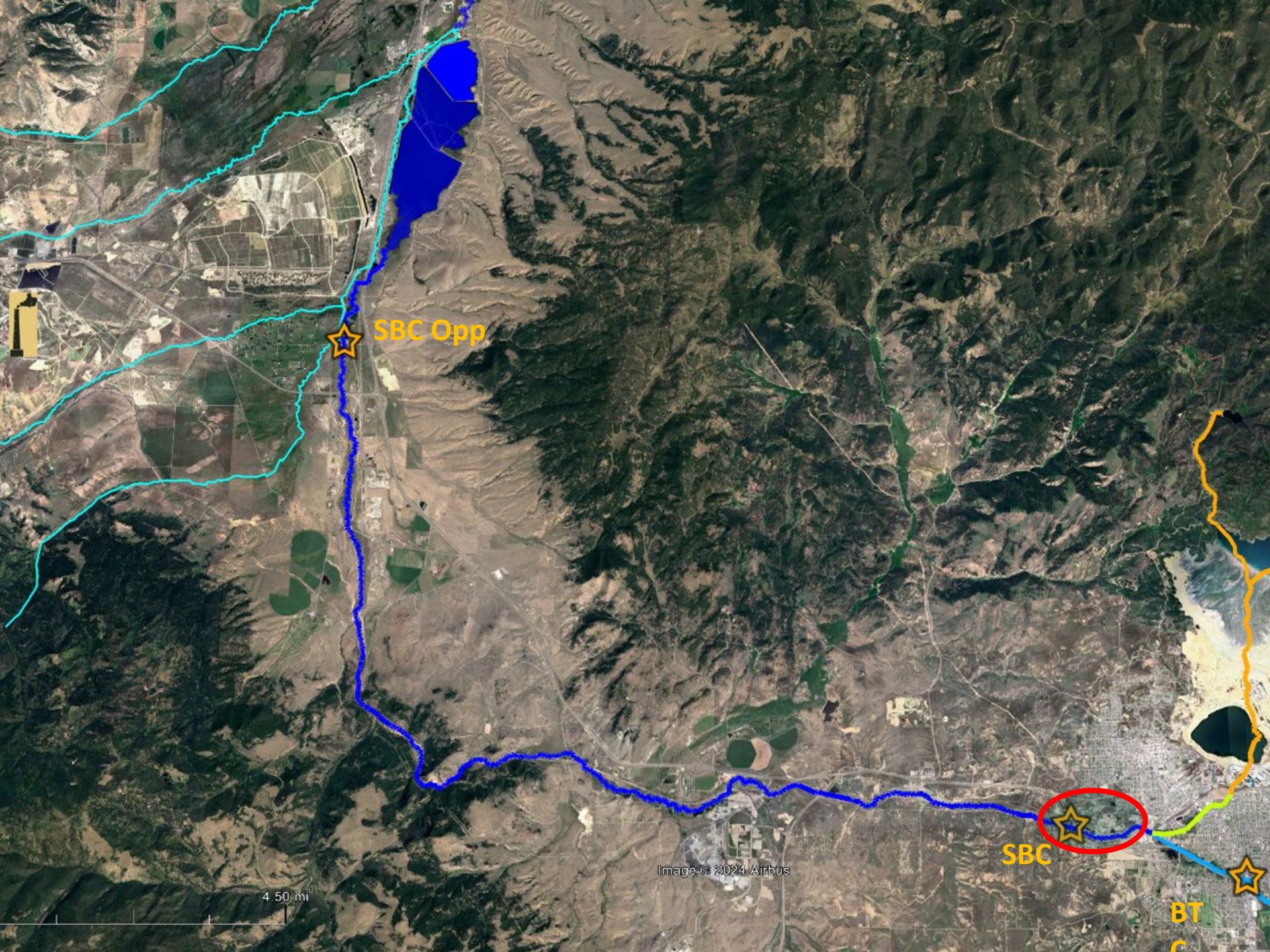
ARCO

SBC

BT

4.50 mi

Image © 2024 Airbus



SBC Opp

SBC

BT

C

4.50 mi

Image © 2024 Airbus

# Colorado Tailings - "Slickens"

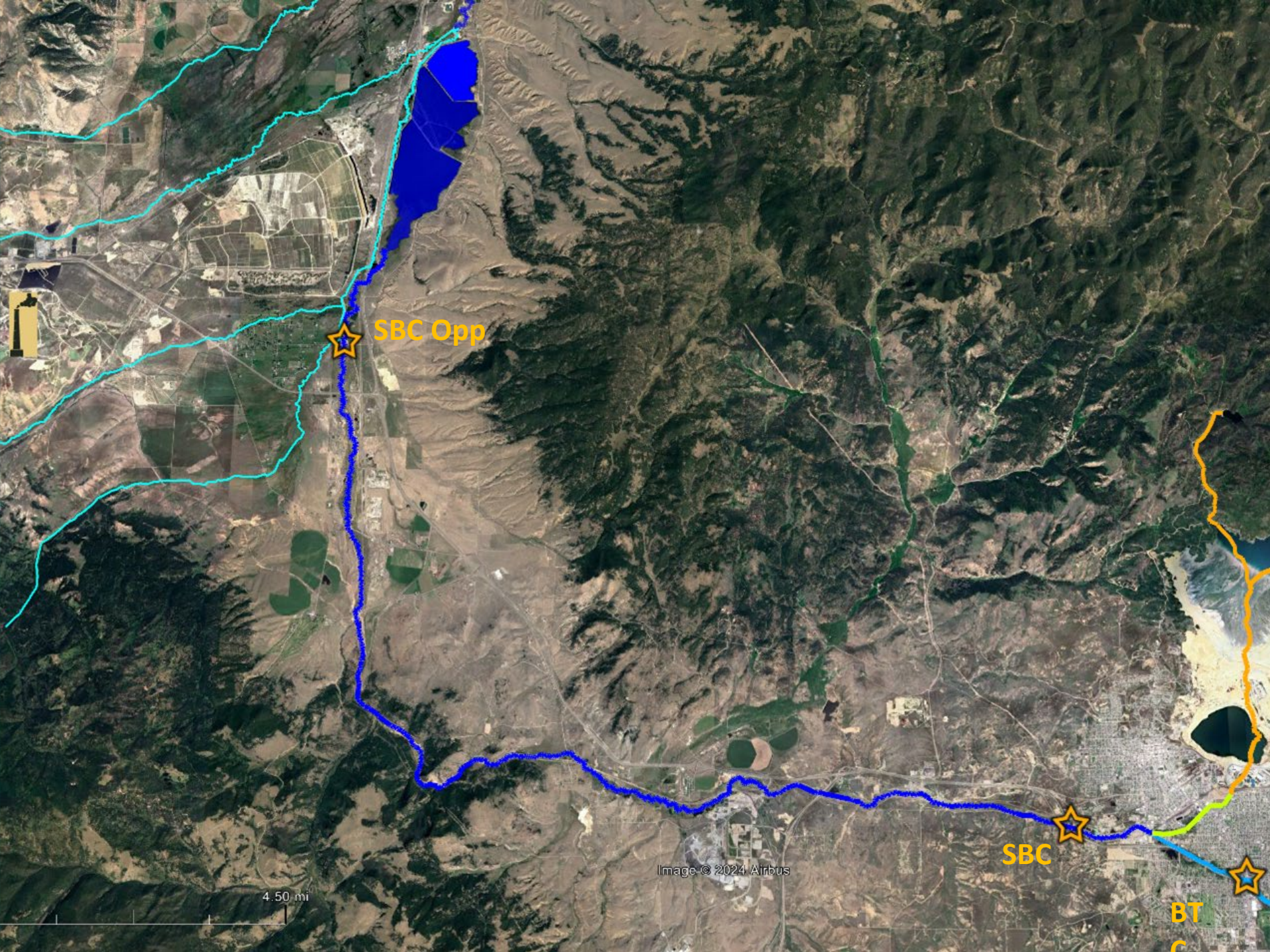


1997









SBC Opp

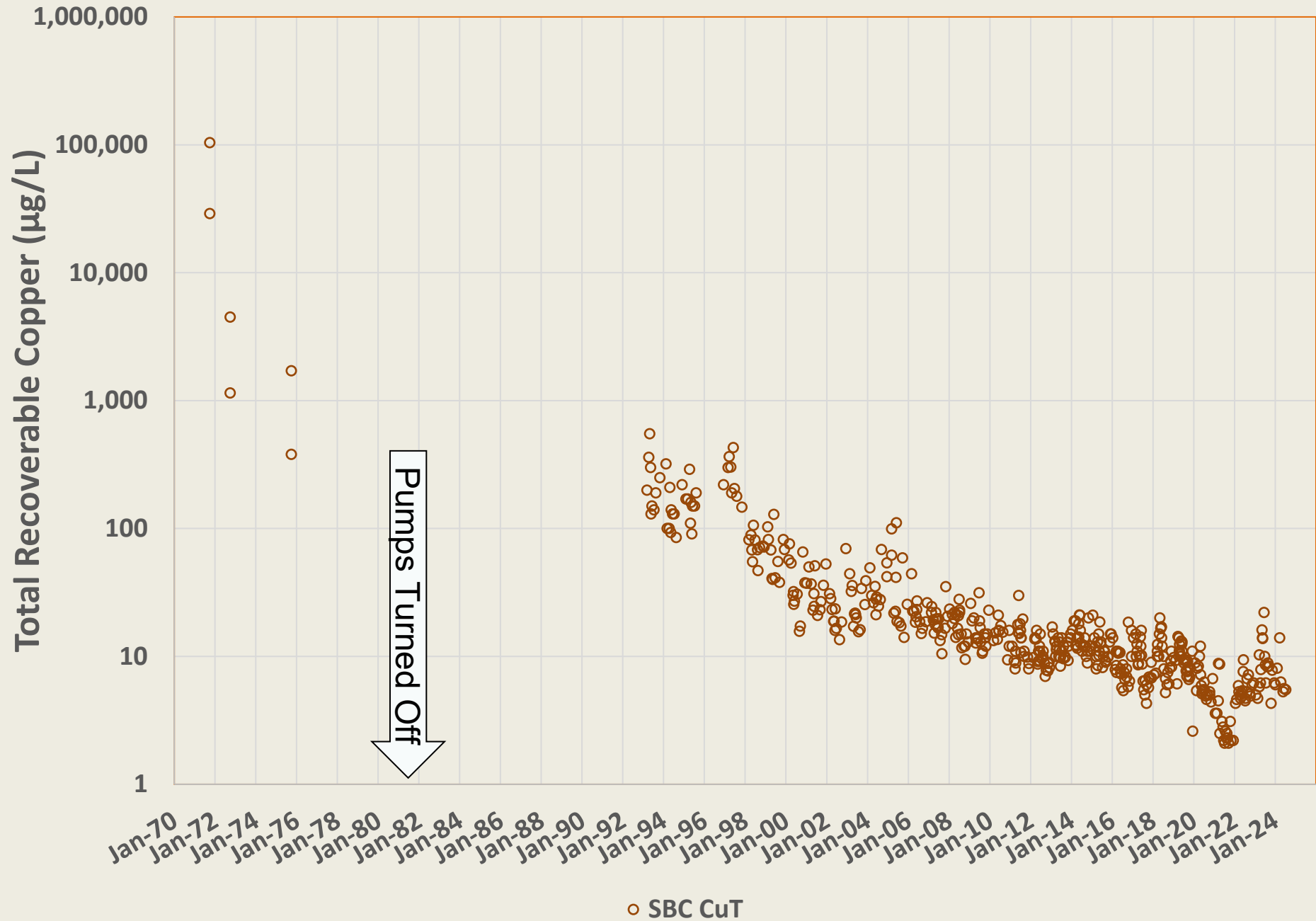
SBC

BT

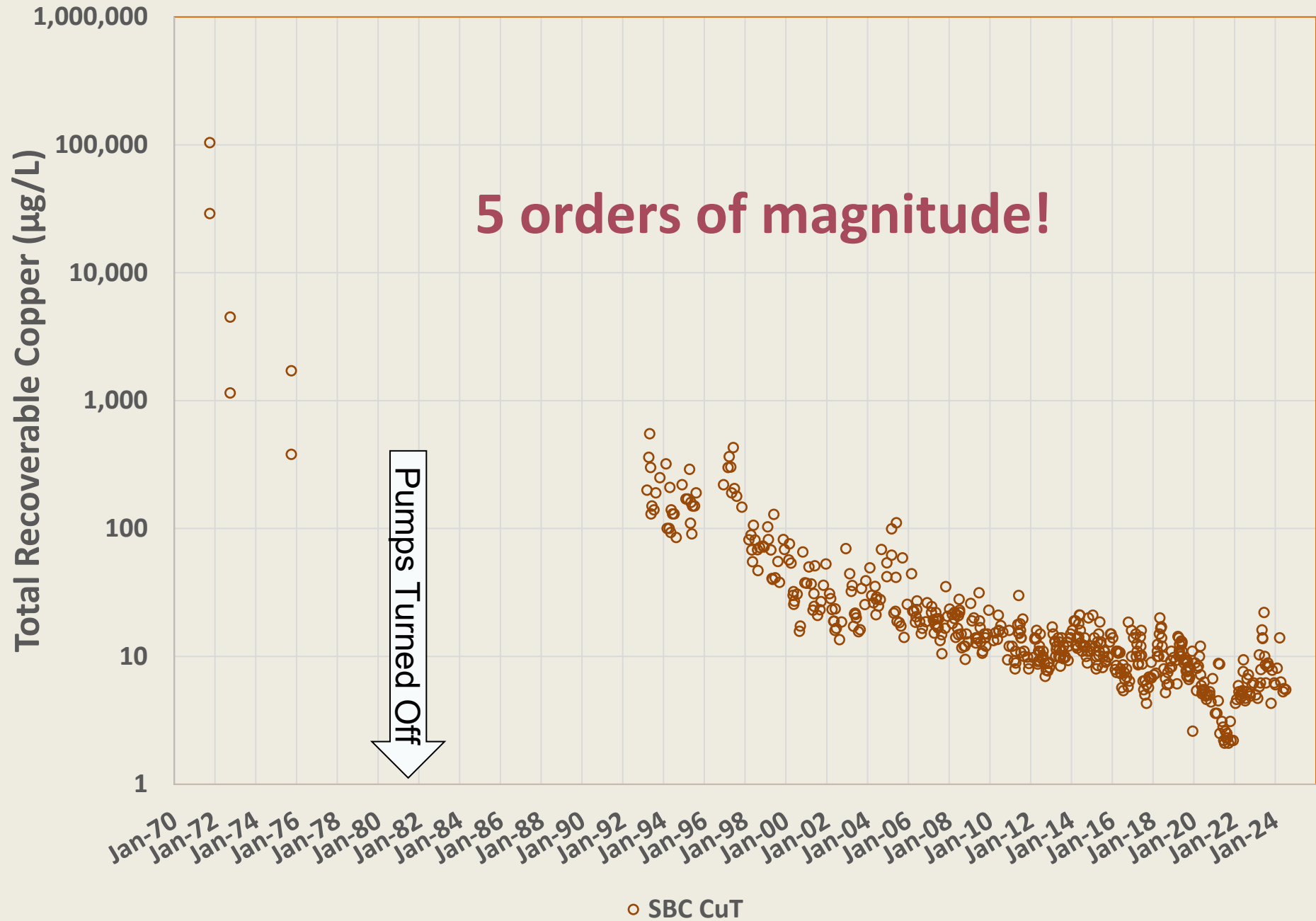
4.50 mi

Image © 2024 Airbus

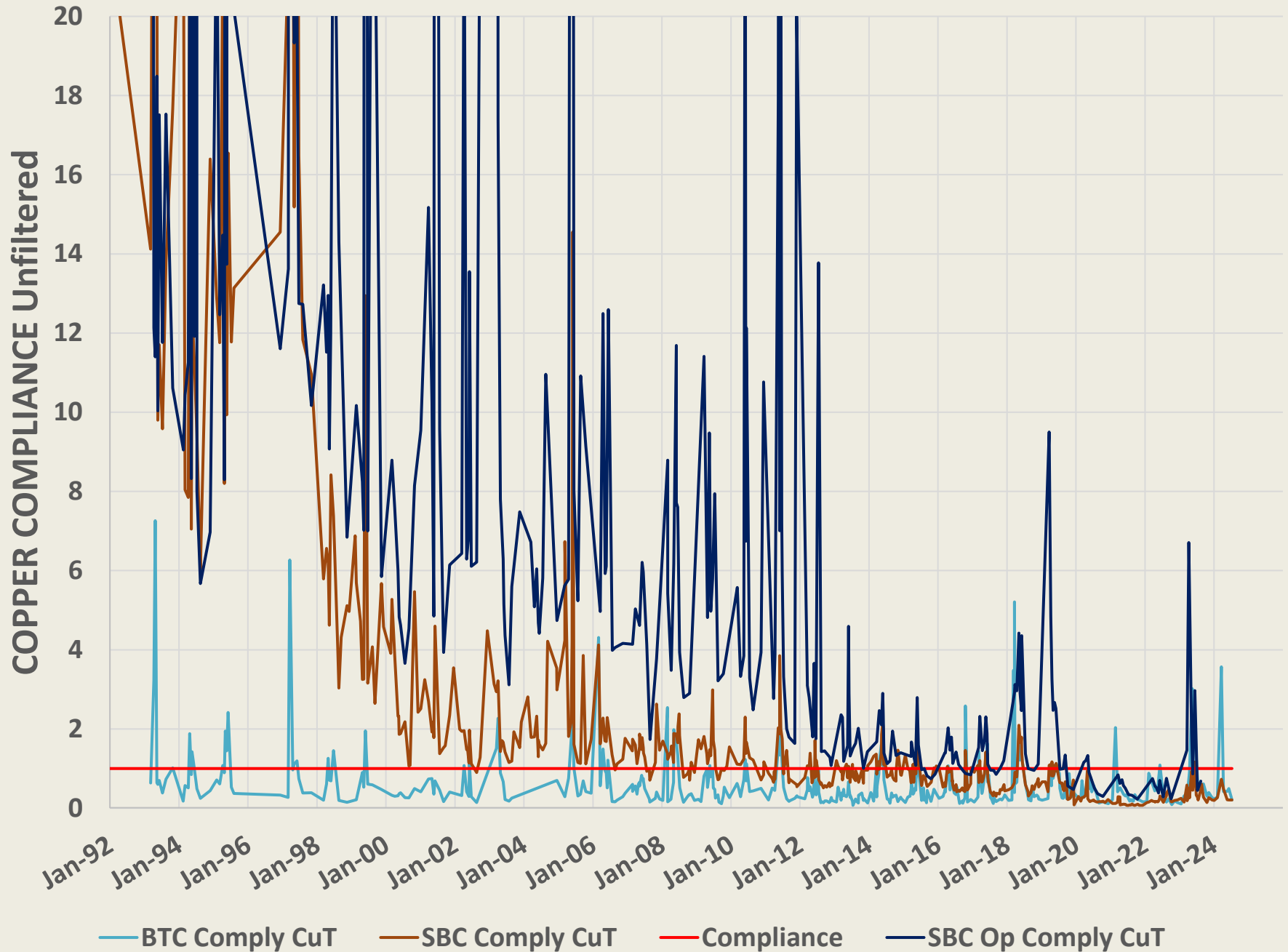
# Silver Bow Creek at Butte



# Silver Bow Creek at Butte



# Blacktail and Silver Bow Creek



# Blacktail and Silver Bow Creek

