

Sampling and Analysis Plan for Harmful Cyanobacteria Blooms



Version 1: April 2025

**Document Applicable for up to 5 years from the date of the WQD Quality Assurance Officer's
Signature**

**Wyoming Department of Environmental Quality
Water Quality Division
Watershed Protection Program**

Harmful Cyanobacteria Blooms

Sampling and Analysis Plan

Reviewed and Approved by:

Rachel Eyres

4/17/2025

Rachel Eyres, Recreational Water Quality Program Coordinator (Project Manager)
Wyoming Department of Environmental Quality, Water Quality Division

Date

Eric Hargett

4/18/2025

Eric Hargett, Surface Water Quality Standards Program Supervisor
Wyoming Department of Environmental Quality, Water Quality Division

Date

Jillian Scott

04/18/2025

Jillian Scott, Quality Assurance Officer
Wyoming Department of Environmental Quality, Water Quality Division

Date

ADDITIONAL REVIEWERS

Reviewer, Title, Organization	Review Date:
Steve Vien, Water Quality Laboratory Supervisor, WDEQ-WQD	4/2/2025
Ron Steg, TMDL and Assessment Program Coordinator, WDEQ-WQD	4/1/2025

SAMPLING AND ANALYSIS PLAN AMENDMENTS

Version/Date	Amendment Details	Affected Section(s)	Performed By
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TABLE OF CONTENTS

Background	6
Objectives.....	6
Credible Data	7
Quality Assurance Program Plan (QAPP)	7
Study Design.....	7
Routine Monitoring.....	7
One-Time Monitoring	7
Response Monitoring.....	8
Monitoring and Access Permissions	14
Personnel	14
Sample Parameters and Methods	14
Study Duration and Frequency	15
Satellite Imagery	15
Routine Monitoring.....	16
One-Time Monitoring	16
Response Monitoring.....	16
Quality Assurance/Quality Control (QA/QC).....	16
Data Recording.....	17
Sample Containers and Labeling.....	17
Data Quality Objectives (DQOs) and Reconciliation	17
Field Quality Control (QC)	17
Corrective Action	17
Field Audits.....	18
Safety	18
Laboratories	18
Data & Reporting	19
Data Management	19
Data Archival	19
Data Review, Verification, and Validation	19
Data Analysis.....	20
Deliverables.....	20
References	21
Appendix A	22
Process, Information, and Data Used to Prioritize Waterbodies for Routine Monitoring and Screening.....	22

Prioritization Process to Select Waterbodies for Routine and One-Time Monitoring	23
Access and Recreational Use Narrative Assignment.....	23
Toxic Bloom Potential Narrative Assignment	23

TABLES

Table 1. 2025 Routine Monitoring Site Locations.....	10
Table 3. Sampling Personnel.....	14
Table 4. Sample Parameters and Methods.....	15
Table 5. Field Quality Control Samples and Frequency	17
Table 6. Data Type, Storage, and Location	19
Table 7. Data Archival and Storage.....	19
Table 8. Project Analytical Methods & Tools.....	20
Table A - 1. Data and Rankings Used to Prioritize Waterbodies for Routine Monitoring in 2025.....	25
Table A - 2. Data and Rankings Used to Prioritize Waterbodies for One-Time Monitoring in 2025.....	26
Table A - 3. Waterbodies With Past Cyanobacteria or Cyanotoxin Data That Were Not Prioritized for Routine or One-Time Monitoring in 2025.	27

FIGURES

Figure 1. Waterbodies Selected for Routine Monitoring in 2025.....	8
Figure 2. Decision Tree for Site Visits Associated with Routine Monitoring	9
Figure A - 1. Decision Matrix Used to Prioritize Waterbodies for Routine and One-Time Monitoring.	24

Background

Harmful Cyanobacteria Blooms (HCBs) are dense concentrations of cyanobacteria, commonly referred to as blue-green algae. HCBs can occur in any surface water and may be planktonic (suspended) or form mats that may float or attach to rock or other substrate. HCBs can result in serious health effects to humans, pets, and livestock through direct contact, ingestion, or inhalation of cyanotoxins or other cyanobacteria-related irritants.

Cyanobacteria naturally occur at low densities in surface waters, however, factors such as excess nutrients, solar exposure, wind, water clarity, water velocity or level, temperature, and grazing pressure by primary consumers can contribute to the formation of planktonic or mat-forming HCBs. HCBs can occur at any time, though are most common in late summer and fall when water temperatures are warm, water levels have stabilized, and nutrients have been assimilated to promote increased primary productivity. Regarding HCBs in rivers and streams, increased velocities may stress cyanobacteria cells and cause benthic mats to detach and float downstream.

The Wyoming Department of Environmental Quality (WDEQ), in collaboration with the Wyoming Department of Health (WDH), Wyoming Livestock Board (WLB), and other stakeholders, developed Wyoming's HCB Action Plan (WDEQ/WQD 2024a and accessed at wyohcbs.org) to inform the public and collaborators when HCBs are present so they can make informed decisions to protect public and animal health. Publicly accessible waterbodies used for full body contact recreation (e.g., swimming, waterskiing, water-play by children) are the focus because they are the most likely to be associated with exposure of people and animals to cyanotoxins or other cyanobacteria-related irritants via water contact, accidental ingestion, and inhalation. Publicly accessible waterbodies may also be monitored to determine whether human or animal illnesses may be associated with a HCB. Wyoming's HCB Action Plan also outlines the notification process should an HCB be documented in proximity to a public drinking water supply so that public water supplies can be evaluated for the potential presence of cyanotoxins or other HCB-related concerns.

Wyoming's HCB Action Plan establishes a general three-step process to evaluate, confirm, and report HCBs to notify the public and resource management agencies of recreation risks in surface waters associated with HCBs. Step 1 (Surveillance and Reporting) relies on confirmed visual evidence of a bloom, cyanobacteria density estimates identified via satellite imagery using the [Cyanobacteria Assessment Network](#) (CyAN), and historical cyanobacteria density or cyanotoxin concentrations to determine potential health risks that are used to inform and prioritize monitoring among publicly accessible waterbodies. Under Step 2 (Data Collection and Issuing Advisories), prioritized publicly accessible waterbodies are monitored for cyanobacteria cell density or cyanotoxins followed by issuance of bloom or toxin advisories to the public in the event recreational use advisory thresholds are exceeded. Step 3 (Lifting and Discontinuing Advisories) involves the lifting of advisories when evidence confirms recreational use advisory thresholds are no longer exceeded or until December 31st, whichever comes first. HCB monitoring typically occurs from May through October, when full body contact recreation and HCB formation are most likely. Monitoring is primarily conducted by the WDEQ/WQD Watershed Protection staff, with additional data collection by agencies such as the United States Forest Service, Wyoming State Parks, Conservation Districts, and local entities.

Objectives

This sampling and analysis plan (SAP) describes the monitoring that will be conducted during 2025 in accordance with Wyoming's HCB Action Plan. Specific objectives of this SAP are:

Objective 1: Collect data to determine whether a publicly accessible waterbody may pose a health risk due to the presence of cyanotoxins or a cyanobacteria bloom so that appropriate follow-up actions can be taken. Follow-up actions may include, but are not limited to, additional monitoring, notifications to the public regarding potential health risks, and other actions outlined in Wyoming's HCB Action Plan.

Objective 2: Collect data to inform future HCB monitoring and USEPA-coordinated voluntary source public water supply monitoring.

Objective 3: Collect data to help inform the development of data quality objectives.

Objective 4: Collect data that may inform whether a human or animal illness is associated with an HCB.

Credible Data

In accordance with Wyoming State Statutes § 35-11-103(c)(xix), § 35-11-302 (b)(i) and (b)(ii), and Chapter 1, Section 35(a)(i) of the Wyoming Water Quality Rules (WDEQ/WQD 2018), data collected under this SAP will:

- Be collected using accepted laboratory and field methods and quality assurance and quality control procedures, and
- Be collected by a person who has, or works under the supervision of a person who has, received specialized training that includes a thorough knowledge of written sampling protocols, methods, and quality assurance and quality control procedures.

Quality Assurance Program Plan (QAPP)

This SAP is covered under the WDEQ, Water Quality Division (WQD), Watershed Protection Section Quality Assurance Program Plan (QAPP) (WDEQ/WQD 2023).

Study Design

Routine Monitoring

Routine monitoring enables early detection and ongoing oversight of harmful cyanobacteria for waterbodies with extremely high or very high recreational use and bloom risk. For the 2025 season, 22 waterbodies were prioritized for monthly routine monitoring based on recreational use and the potential to produce cyanotoxins that exceed recreational use thresholds ([Figure 1](#), [Table 1](#), Appendix A [Table A-1](#)). Monitoring sites on these waterbodies were established based on access, input from waterbody managers, and past HCB occurrences. Priority was given to publicly accessible, high recreational use areas with past observations of full-body contact recreation such as swimming and waterplay. Based on the number of samples budgeted over the season, existing advisories issued and whether there is visual evidence of a HCB, samples will be collected from one to three sites at each waterbody. In circumstances where multiple sites are identified at a waterbody, a ranking system will be used to establish the order of site visits ([Table 1](#)). Site rankings were based on historical cyanobacteria densities or cyanotoxin concentrations with sites having the highest values for these parameters being visited first. The decision tree in [Figure 2](#) outlines the process for visiting multiple sites at a waterbody in rank order of importance. In circumstances where blooms are not observed at the routine monitoring site, but are present elsewhere in the waterbody, additional sites may be established to document the potential health risks associated with the waterbody.

One-Time Monitoring

While some waterbodies may not be prioritized for routine monitoring, they can still be important candidates for surveillance. One-time monitoring enables the detection of harmful cyanobacteria in waterbodies used for recreation and considered at lower risk for blooms than those selected for routine. This approach improves resource allocation by extending surveillance coverage over more waterbodies, particularly when frequent inspections are restricted due to limited resources or logistical challenges. Using the same prioritization process to select waterbodies for routine monitoring, 13 waterbodies were selected for one-time monitoring ([Table 2](#), Appendix A

[Table A-2](#)). Priority was given to publicly accessible, high recreational use areas with past observations of full-body contact recreation such as swimming and water-play. Monitoring sites on these waterbodies were established based on access, input from waterbody managers, and past HCB occurrences. These waterbodies will be visited once during the monitoring season when blooms are most likely. One site at each waterbody will be sampled, based on whether there is visual evidence of an HCB.

Response Monitoring

Sites to investigate reports of potential HCBs and HCB-related illnesses will be established as needed at the area of concern.

Figure 1. Waterbodies Selected for Routine Monitoring in 2025

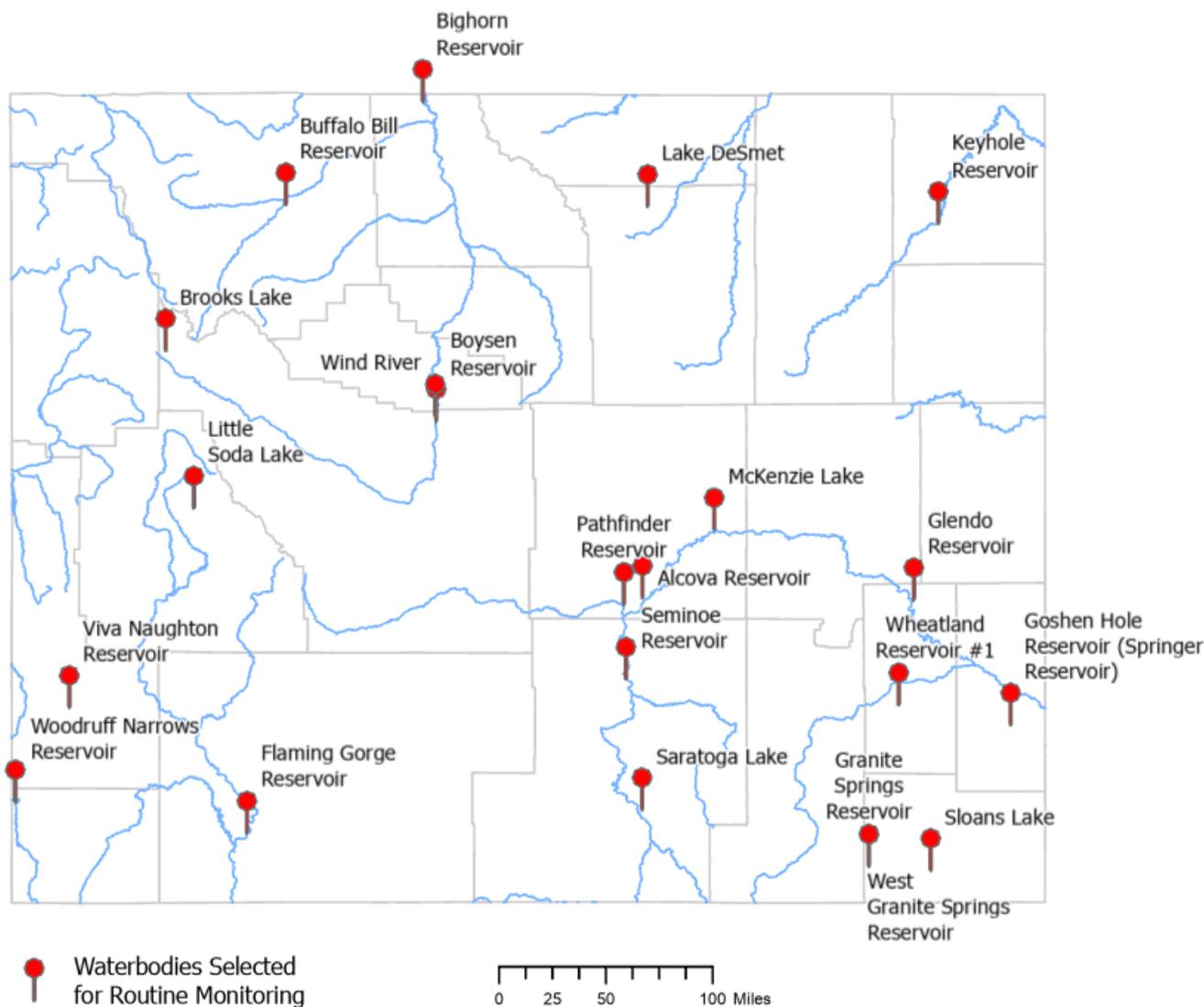


Figure 2. Decision Tree for Site Visits Associated with Routine Monitoring

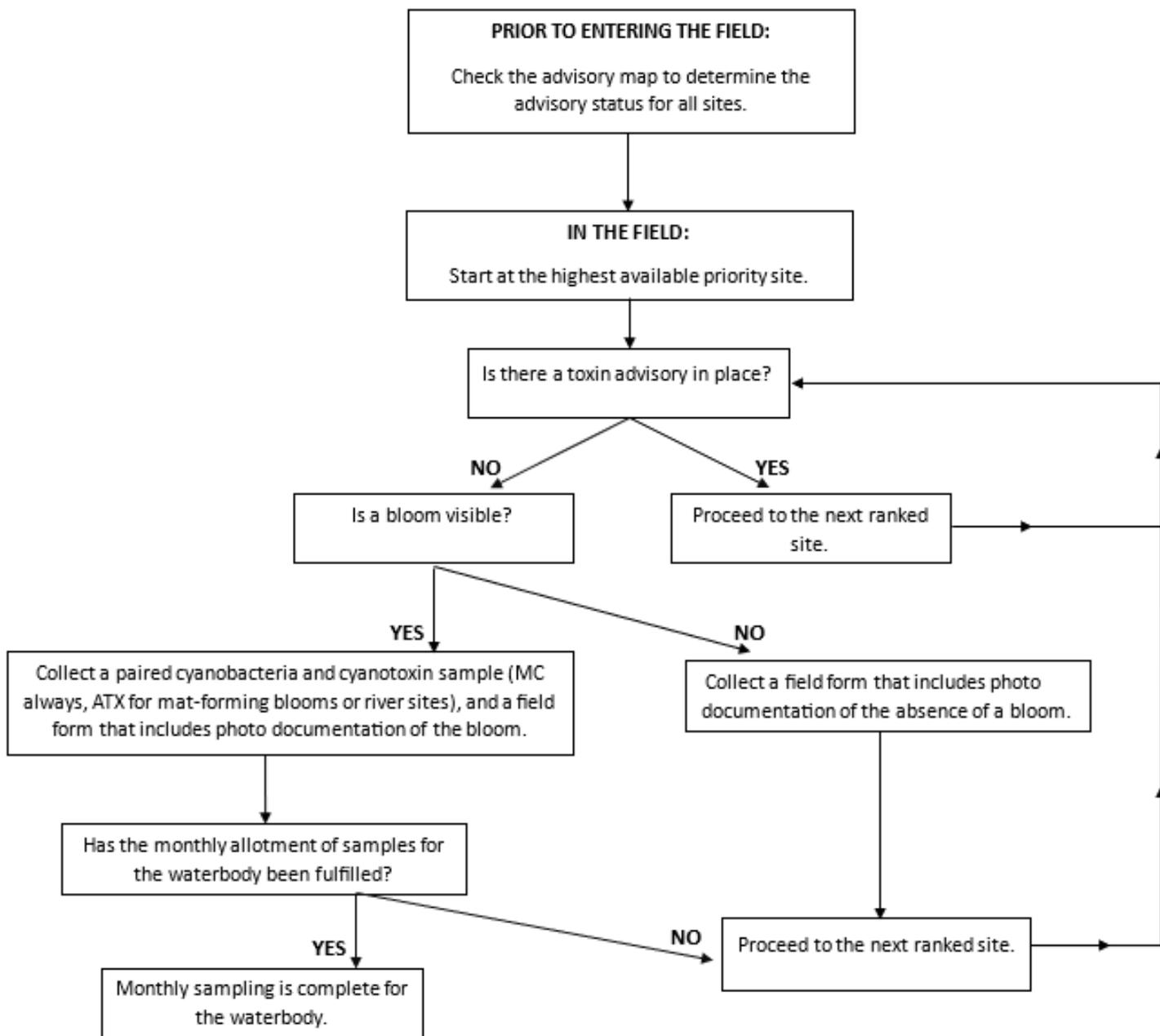


Table 1. 2025 Routine Monitoring Site Locations

Waterbody Name	Resource Management Agency	No. Sites Sampled Per Month	Rank	Site Description	Station ID	Latitude	Longitude	Field Office
Boysen Reservoir	Wyoming State Parks	5	1	N Swim Beach	WYDEQ_RES_321	43.405602	-108.173542	Cheyenne
			2	Marina Campground	WYDEQ_RES_466	43.395341	-108.164533	Cheyenne
			3	Tough Creek Campground	WYDEQ_RES_322	43.330855	-108.156070	Cheyenne
			4	Fremont Bay Campground	WYDEQ_RES_465	43.262254	-108.192341	Cheyenne
			5	Cottonwood Campground	WYDEQ_RES_404	43.343543	-108.226447	Cheyenne
			6	Tamarask Campground	WYDEQ_RES_471	43.390757	-108.159314	Cheyenne
			7	Poison Creek Campground	WYDEQ_RES_468	43.245126	-108.165728	Cheyenne
			8	Brannon Campground	WYDEQ_RES_464	43.402539	-108.175251	Cheyenne
Saratoga Lake	Wyoming Game and Fish Department, Town of Saratoga	2	1	E Beach	WYDEQ_RES_421	41.464312	-106.780548	Cheyenne
			2	W-Central Beach	WYDEQ_RES_371	41.464455	-106.783990	Cheyenne
Pathfinder Reservoir	Natrona County, U.S. Bureau of Land Management	3	1	Bishops Point	WYDEQ_RES_363	42.497431	-106.903497	Cheyenne
			2	Diabase Marina	WYDEQ_RES_364	42.467600	-106.872630	Cheyenne
			3	N Bishops Point Cove	WYDEQ_RES_366	42.500799	-106.909232	Cheyenne
			4	NE Shore	WYDEQ_RES_367	42.505538	-106.914171	Cheyenne
Keyhole Reservoir	Wyoming State Parks, U.S. Bureau of Reclamation	3	1	E Swim Beach	WYDEQ_RES_475	44.370080	-104.776140	Sheridan
			2	Wind Creek Ramp	WYDEQ_RES_355	44.366708	-104.834095	Sheridan
			3	Rocky Point	WYDEQ_RES_352	44.379671	-104.772220	Sheridan
			4	Tatanka Ramp	WYDEQ_RES_354	44.364981	-104.764841	Sheridan
			5	Coulter Bay	WYDEQ_RES_474	44.368070	-104.802770	Sheridan

Waterbody Name	Resource Management Agency	No. Sites Sampled Per Month	Rank	Site Description	Station ID	Latitude	Longitude	Field Office
Alcova Reservoir	Natrona County	3	1	Kids' Beach	WYDEQ_RES_311	42.531210	-106.778010	Cheyenne
			2	Sandy Beach	WYDEQ_RES_313	42.549240	-106.743160	Cheyenne
			3	Okie Beach	WYDEQ_RES_312	42.533440	-106.759440	Cheyenne
			4	Black Beach	WYDEQ_RES_478	42.535960	-106.716770	Cheyenne
			5	Cottonwood Beach	WYDEQ_RES_479	42.524918	-106.746952	Cheyenne
Goshen Hole Reservoir	Wyoming Game and Fish Department	1	1	NW Campground	WYDEQ_RES_410	41.893251	-104.286680	Cheyenne
Flaming Gorge Reservoir	Ashley National Forest	3	1	Firehole Beach	WYDEQ_RES_334	41.345676	-109.454676	Cheyenne
			2	Lost Dog Shore	WYDEQ_RES_476	41.296420	-109.548710	Cheyenne
			3	Buckboard Ramp	WYDEQ_RES_333	41.245644	-109.592861	Cheyenne
			4	Brinegar Ramp	WYDEQ_RES_332	41.164123	-109.556921	Cheyenne
			5	Anvil Draw Ramp	WYDEQ_RES_480	41.070759	-109.550525	Cheyenne
McKenzie Lake	City of Casper	2	1	E Cove	WYDEQ_RES_416	42.868495	-106.292618	Cheyenne
			2	Dog Park Shore	WYDEQ_RES_473	42.868031	-106.295943	Cheyenne
Seminole Reservoir	U.S. Bureau of Land Management, Wyoming State Parks, U.S. Bureau of Reclamation	3	1	Sunshine Beach S Cove	WYDEQ_RES_423	42.123641	-106.890064	Cheyenne
			2	N Red Hills Ramp	WYDEQ_RES_372	42.136210	-106.887920	Cheyenne
			3	S Red Hills Ramp	WYDEQ_RES_373	42.129706	-106.899786	Cheyenne
			4	Sand Mountain	WYDEQ_RES_374	42.075909	-106.879101	Cheyenne
Buffalo Bill Reservoir	Wyoming State Parks, U.S. Bureau of Reclamation	2	1	Bartlett Beach	WYDEQ_RES_325	44.460022	-109.190629	Sheridan
			2	Lake Shore Campground	WYDEQ_RES_326	44.498968	-109.234052	Sheridan
			3	Lake Shore Ramp	WYDEQ_RES_327	44.500081	-109.240910	Sheridan

Waterbody Name	Resource Management Agency	No. Sites Sampled Per Month	Rank	Site Description	Station ID	Latitude	Longitude	Field Office
Glendo Reservoir	Wyoming State Parks	3	1	Sandy Beach Campground	WYDEQ_RES_341	42.520916	-104.941562	Cheyenne
			2	Custer Cove Campground	WYDEQ_RES_340	42.484368	-104.982980	Cheyenne
			3	Cottonwood Campground	WYDEQ_RES_459	42.530987	-104.941692	Cheyenne
			4	Marina	WYDEQ_RES_481	42.471270	-104.972710	Cheyenne
Sloans Lake	City of Cheyenne	1	1	S Beach	WYDEQ_RES_377	41.155280	-104.827490	Cheyenne
Wind River	Wyoming State Parks	2	1	Upper Campground	WB0564	43.430758	-108.180500	Cheyenne
			2	Lower Campground	WB0565	43.443395	-108.170703	Cheyenne
			3	Below Dam	WYDEQ_RES_460	43.418519	-108.178435	Cheyenne
Woodruff Narrows Reservoir	U.S. Bureau of Land Management, Wyoming Game and Fish Department	2	1	N Ramp	WYDEQ_RES_393	41.503990	-111.022241	Cheyenne
			2	W Shore	WYDEQ_RES_394	41.469326	-111.022303	Cheyenne
Viva Naughton Reservoir	Pacificorps, Wyoming Game and Fish Department	2	1	E Ramp	WYDEQ_RES_385	41.980760	-110.657250	Cheyenne
			2	NW Campground	WYDEQ_RES_386	42.001125	-110.670633	Cheyenne
			3	SE Cove	WYDEQ_RES_384	41.964856	-110.654560	Cheyenne
			4	NE Campground	WYDEQ_RES_482	41.997830	-110.657250	Cheyenne
Lake De Smet	Johnson County	1	1	Mikesell-Potts Recreation Area	WYDEQ_RES_477	44.452468	-106.742865	Sheridan
			2	Dam	WYDEQ_RES_356	44.515181	-106.785392	Sheridan
Wheatland Reservoir #1	Wyoming Game and Fish Department	1	1	SW Ramp	WYDEQ_RES_389	41.994261	-105.043992	Cheyenne
			2	NW Ramp	WYDEQ_RES_431	42.000258	-105.043482	Cheyenne
West Granite Springs Reservoir	Wyoming State Parks, Cheyenne Board of Public Utilities	1	1	W Causeway	WYDEQ_RES_342	41.176350	-105.245050	Cheyenne
Bighorn Reservoir	National Park Service	1	1	Horseshoe Bend Beach	WYDEQ_RES_449	44.958320	-108.264482	Sheridan

Waterbody Name	Resource Management Agency	No. Sites Sampled Per Month	Rank	Site Description	Station ID	Latitude	Longitude	Field Office
			2	Cottonwood Creek Ramp	WYDEQ_RES_402	44.866190	-108.176317	Sheridan
Granite Springs Reservoir	Wyoming State Parks, Cheyenne Board of Public Utilities	1	1	E Causeway	WYDEQ_RES_411	41.177940	-105.245630	Cheyenne
Brooks Lake	Shoshone National Forest	2	1	Brooks Lake Campground	WYDEQ_RES_324	43.751827	-110.004945	Cheyenne
			2	SE Outlet	WYDEQ_RES_405	43.752144	-109.997509	Cheyenne
Little Soda Lake	Bridger-Teton National Forest	1	1	Shore	WYDEQ_RES_463	42.976641	-109.813919	Cheyenne

*TBD – to be determined

Table 2. 2025 One-Time Monitoring Site Locations

Waterbody Name	Resource Management Agency	Site Description	Station ID	Latitude	Longitude	Field Office
Ocean Lake	Wyoming Game and Fish Department	Long Point Ramp	WYDEQ_RES_359	43.176808	-108.618007	Cheyenne
Fontenelle Reservoir	U.S. Bureau of Reclamation	Campground	WYDEQ_RES_337	42.071500	-110.150500	Cheyenne
New Cody Reservoir	City of Cody	SW Shore	WYDEQ_RES_419	44.507628	-109.052311	Sheridan
Homesteader Park Pond	City of Powell	Shore	WYDEQ_RES_448	44.756160	-108.742652	Sheridan
Diamond Lake (Bosler Reservoir)	Wyoming Game and Fish Department	NW Access	WYDEQ_RES_318	41.611520	-106.092430	Cheyenne
Big Sandy Reservoir	U.S. Bureau of Reclamation, Eden Valley Irrigation District	W Campground	WYDEQ_RES_401	42.259542	-109.435958	Cheyenne
Gillette Fishing Lake	City of Gillette	E Outlet	WYDEQ_RES_409	44.267128	-105.484901	Sheridan
Kemmerer City Reservoir	City of Kemmerer	E Access	WYDEQ_RES_348	41.944890	-110.653370	Cheyenne
Bighorn River	Wyoming State Parks	Hot Springs Ramp	WB0568	43.654078	-108.197860	Cheyenne
Wheatland Reservoir #3	Wyoming Game and Fish Department	NW Ramp	WYDEQ_RES_392	41.888947	-105.726590	Cheyenne
Guernsey Reservoir	Wyoming State Parks	Sandy Point Campground	WYDEQ_RES_343	42.308400	-104.812150	Cheyenne
Lower North Crow Reservoir	Wyoming Game and Fish Department	SE Shore	WYDEQ_RES_396	41.220325	-105.188198	Cheyenne
Leazenby Lake	Wyoming Game and Fish Department	S Access	WYDEQ_RES_357	41.175084	-105.584982	Cheyenne

Monitoring and Access Permissions

All priority waterbodies selected for routine and one-time monitoring in 2025 are publicly accessible. In circumstances where access to or across private lands is needed for response monitoring, authorization will be secured according to the WDEQ/WQD Standard Operating Procedure (SOP) for *Private Land Access* (WDEQ/WQD 2024b).

Personnel

The personnel involved with sample collection and data interpretation for this SAP are described in Table 3.

Table 3. Sampling Personnel

Personnel	Project Role
WDEQ/WQD Surface Water Quality Standards Program Staff	Project management, data collection, data interpretation
WDEQ/WQD Quality Assurance Officer	QA/QC
WDEQ/WQD Monitoring Program Staff	Data collection
Other WDEQ/WQD Watershed Protection Program Staff	Data collection
Wyoming State Parks Staff	Data collection
Wyoming Game and Fish Department Staff	Data collection
United States Forest Service Staff	Data collection
Conservation District Staff	Data collection
Other Cooperators	Data collection

WDEQ/WQD Monitoring Program Staff will be responsible for sample collection at waterbodies managed by the ‘Sheridan’ field office as noted in [Tables 1](#) and [2](#). For waterbodies managed by the ‘Cheyenne’ field office, sample collection will be carried out either by WDEQ/WQD staff or under their direction.

Project personnel will provide documentation if requested to meet the specialized training and field experience requirements described in Chapter 1, Section 35 of the Wyoming Water Quality Rules (WDEQ/WQD 2018) and Wyoming’s Methods for Determining Surface Water Quality Condition (WDEQ/WQD 2020).

Sample Parameters and Methods

Unless otherwise noted, all SOPs referenced in Table 4 are found within Wyoming’s Manual of Standard Operating Procedures for Sample Collection and Analysis (WDEQ/WQD 2024b). Table 4 summarizes the water quality parameters that will be collected under this SAP in addition to their associated analytical methods, sample method SOPs, preservation requirements, sample volume and container requirements, reporting units, and analytical reporting limits.

Table 4. Sample Parameters and Methods

Parameter	Sample Method SOP	Reporting Units	Analytical Method	Sample Volume and Container	Preservative	Holding Time	Reporting Limit
Biological Parameters							
Cyanobacteria, Identification, Enumeration, and Biovolume	See SOP for <i>Harmful Cyanobacterial Blooms: Cyanobacteria Collection</i>	Identification & Enumeration: Taxa raw counts & density (cells/mL); Biovolume: μm^3	Identification & Enumeration: Lowest taxonomic resolution; Biovolume: formula derived using taxa dimensional measurements (Hillebrand et al. 1999)	1 x 250 mL opaque Nalgene®	Diffuse samples: 15mL of Lugol's solution per 250mL sample; Dense samples: 20mL of Lugol's solution per 250 mL sample; Store in a cool and dark place	Indefinite	N/A
Chemical Parameters							
Cyanotoxin, Anatoxin-a	See SOP for <i>Harmful Cyanobacterial Blooms: Cyanotoxin Collection</i>	$\mu\text{g/L}$	Abraxis/ EPA SOP <i>Detection of Algal Toxins in Surface Water Samples Using Abraxis Cyanotoxin-Automated Assay System</i>	2 x 40 amber glass VOA vials	18 mL sample & add 2 mL of 10x Diluent; Iced/Frozen to $\leq 8^\circ\text{C}$; store frozen at $< 0^\circ\text{C}$	28 days on wet ice or refrigerated; 180 days frozen	0.17
Cyanotoxin, Total Microcystins and Nodularins	See SOP for <i>Harmful Cyanobacterial Blooms: Cyanotoxin Collection</i>	$\mu\text{g/L}$	EPA 546/EPA SOP <i>Detection of Algal Toxins in Surface Water Samples Using Abraxis Cyanotoxin-Automated Assay System</i>	1 x - 60 mL amber PETG bottle	Iced/Frozen to $\leq 8^\circ\text{C}$; store frozen at $< 0^\circ\text{C}$	5 days on wet ice or refrigerated; 180 days frozen	0.15

Abbreviations: SOP - Standard Operating Procedure; TBD – to be determined; PETG – Polyethylene Terephthalate Glycol; VOA – Volatile Organic Analysis

Study Duration and Frequency

Satellite Imagery

The [Cyanobacteria Assessment Network](#) (CyAN) utilizes satellite imagery to detect the presence, aerial extent, and density of harmful cyanobacteria blooms (HCBs). Where applicable, CyAN will be used to inform the scheduling of

routine and one-time monitoring efforts and will also serve as a verification tool to confirm the continued presence of previously detected blooms. Additionally, CyAN imagery could be used in identifying other lakes and reservoirs that warrant further investigation.

Routine Monitoring

Routine monitoring will occur monthly from July through October. For lake and reservoir sites, if no existing toxin advisories have been issued but an HCB is observed at a sample location, a cyanobacteria identification, enumeration and biovolume sample and a total microcystins and nodularins sample will be collected. Cyanotoxin monitoring for total microcystins and nodularins is prioritized during routine monitoring because this toxin most commonly exceeds recreational use thresholds. When a mat-forming bloom is present, an anatoxin-a sample will also be collected, as elevated concentrations of this toxin are commonly linked to such blooms. For rivers and streams, if no existing toxin advisories have been issued but an HCB is observed at a sample location, samples for cyanobacteria identification, enumeration, and biovolume, as well as for total microcystins and nodularins, and anatoxin-a will be collected. Both cyanotoxins will be collected because mat-forming blooms are common in streams and rivers.

One-Time Monitoring

One-Time Monitoring will occur once per waterbody during the monitoring season of July through October. For lake and reservoir sites, when an HCB is observed at a sample location, a cyanobacteria identification, enumeration and biovolume sample and a total microcystins and nodularins sample will be collected. Cyanotoxin monitoring for total microcystins and nodularins is prioritized during routine monitoring because this toxin most commonly exceeds recreational use thresholds. When a mat-forming bloom is present, an anatoxin-a sample will also be collected, as elevated concentrations of this toxin are commonly linked to such blooms. For rivers and streams, when an HCB is observed at a sample location, samples for cyanobacteria identification, enumeration, and biovolume, as well as for total microcystins and nodularins, and anatoxin-a will be collected. Both cyanotoxins will be collected because mat-forming blooms are common in streams and rivers.

Response Monitoring

Response monitoring can occur throughout the year and will be conducted at waterbodies that are not included as part of routine or one-time monitoring when a report of an HCB or related illness necessitates further evaluation. When investigating a reported HCB, samples for cyanobacteria and microcystin and nodularins will be collected where an HCB is observed at the reported waterbody. When a mat-forming bloom is present, an anatoxin-a sample will also be collected. When investigating a reported HCB-related illnesses, a cyanobacteria sample and two cyanotoxin samples (anatoxin-a, and microcystins and nodularins) will be collected regardless of whether an HCB is observed. Typically, response monitoring at a waterbody occurs only once.

Quality Assurance/Quality Control (QA/QC)

Environmental data quality assurance and quality control are achieved by adhering to the methods, procedures, and techniques found in this SAP, the Watershed Protection Section Quality Assurance Program Plan (WDEQ/WQD 2023), and applicable SOPs from Wyoming's Manual of Standard Operating Procedures for Sample Collection and Analysis (WDEQ/WQD 2024b).

Data Recording

Data and information collected in the field will be recorded on WDEQ/WQD's Harmful Cyanobacteria Bloom Electronic Field Forms, Harmful Cyanobacteria Bloom Field Data Sheets, or field logbooks (see SOPs for *Electronic Field Forms (Survey123)* and *Field Log Books*). Samples for laboratory analysis will be recorded on official chain of custody forms (see SOPs for *Harmful Cyanobacterial Blooms: Cyanobacteria Collection*, *Harmful Cyanobacterial Blooms: Cyanotoxin Collection*, and *Chain of Custody*).

Sample Containers and Labeling

Sample containers will be provided by the WDEQ/WQD or the contract laboratory. See SOPs for *Sample Labeling*, *Harmful Cyanobacterial Blooms: Cyanobacteria Collection*, and *Harmful Cyanobacterial Blooms: Cyanotoxin Collection*.

Data Quality Objectives (DQOs) and Reconciliation

Data collected under this SAP will be evaluated by the WDEQ/WQD QA Officer (QAO) to the data quality objectives (DQOs) listed in this SAP and those identified in the SOPs for *Precision*, *Completeness*, and the Watershed Protection Section Quality Assurance Program Plan (WDEQ/WQD 2023). If one or more DQOs are not met, the project manager and the Surface Water Quality Standards Supervisor will be informed and allowed to provide justification to the WDEQ/WQD QAO as to whether the DQO(s) should be qualified or rejected and if future DQOs should be modified.

Field Quality Control (QC)

Table 5 identifies the field quality control samples that will be collected under this SAP.

Table 5. Field Quality Control Samples and Frequency

Field QC Samples	Collection Frequency	Parameters
Field Blank	One for every 10 samples collected (10%)	All cyanotoxin parameters listed
Duplicate	One for every 10 samples collected (10%)	Cyanobacteria identification, enumeration, and biovolume
	One for every seven cyanotoxin samples collected (~14%). Collect duplicates where cyanotoxin concentrations are expected to be above laboratory reporting limits.	All cyanotoxin parameters listed

Corrective Action

Necessary modifications to the SAP during the life of the project will be completed by the project manager and the WDEQ/WQD QAO. Necessary modifications may include but are not limited to site location, number of samples per site, sampling event timing, number or type of quality control (QC) samples, sampling method or SOP, or the number of site locations. The project manager is responsible for notifying all associated personnel of amendments to this SAP. Sampling personnel are responsible for performing immediate corrective action in the field if a QC issue is identified during field QC checks. Typically, corrective actions will involve re-sampling. Field personnel will document any corrective action performed in the field on electronic survey forms, field data sheets, or logbooks. Corrective actions for any other deficiencies identified during the life of the project will be conducted in a timely and efficient manner with the approval of the project manager, Surface Water Quality Standards Program supervisor, and the WDEQ/WQD QAO.

Field Audits

A field audit by the WDEQ/WQD QAO will be accommodated upon request.

Safety

The health and safety of all personnel associated with this project is the highest priority. Sample personnel will follow protocols listed in the WDEQ/WQD SOPs *Safety and Safety Equipment* and *Waste Disposal, Field Sampling*, which includes but is not limited to:

- Use of personal protective equipment where appropriate;
- Disposal of waste (i.e., calibration standards, buffers, preservatives, etc.) to comply with all federal, state, and local regulations that govern waste management, particularly the hazardous waste identification rules and land disposal restrictions. Safety Data Sheets (SDS) will be available should emergency procedures need to be implemented;
- Personnel will carry cellular phones as an added precaution; and
- Use of best professional judgment to avoid potentially hazardous situations, such as high flows or dangerous travel conditions.

Laboratories

The following laboratories will provide analytical services for samples collected as part of the project described in this SAP:

- Wyoming Department of Environmental Quality, Water Quality Division Laboratory (WQD lab)
 - The WQD lab will be the provider of analytical services for cyanotoxin samples collected as part of this project. The WQD lab will provide customized packages of bottles, labels, preservatives, and chain of custody forms prior to samples being collected as requested by sampling personnel. Sampling personnel will hand-deliver or ship samples to the WQD lab within two-days of collection using United Parcel Service (UPS) or Federal Express (FedEx). The WQD lab will analyze samples in accordance with established standards for holding time, analytical method, and data quality assurance and control. The WQD lab will follow the Laboratory Quality Manual (WDEQ/WQD 2025), Watershed Protection Section standard operating procedures (WDEQ/WQD 2024b) and QAPP (WDEQ/WQD 2023).
- BSA Environmental Services, Inc.
 - BSA Environmental Services, Inc., out of Beachwood, Ohio will provide analytical services for cyanobacteria identification, enumeration, and biovolume samples collected as part of this project. Preserved cyanobacteria samples will be shipped to the contract laboratory within two days of collection. BSA will provide initial results to sampling personnel within 2-5 business days from receipt of samples. A composite flat file and associated deliverables will be provided to sampling personnel within 30 days from the end of the routine and one-time monitoring periods. BSA will subsample, sort, and identify specimens according to contract terms and relevant SOPs. Established standards for taxonomic identification will be followed as identified in the contract for services.
- Other Contract Laboratories, As Needed
 - Other contract laboratories may be utilized for sample analysis in the event that the WQD Lab or BSA Environmental Services, Inc. are unable to analyze samples. Any utilized contract laboratory

must follow the corresponding analytical methods listed in Table 5, receive specialized training, and follow a quality assurance manual (supplied upon request).

Data & Reporting

Data Management

Chemical and biological parameters collected and analyzed will be stored according to the SOP *Data Filing, Monitoring* and Table 6.

Table 6. Data Type, Storage, and Location

Data Type	Storage	Location
Chemical	WDEQ/WQD HCB Smartsheet, WDEQ/WQD Nutrient Database, WDEQ/WQD HCB SharePoint	WDEQ/WQD Cheyenne
Biological	WDEQ/WQD HCB Smartsheet, WDEQ/WQD Algae Database, WDEQ/WQD HCB SharePoint	WDEQ/WQD Cheyenne

Data Archival

Data collected under this SAP will be archived and stored in accordance with the SOP *Data Archiving* and Table 7.

Table 7. Data Archival and Storage

Data Item	Format	Location	Retention
Field Data Sheets	Electronic (.xlsx, .pdf, .gdb, .csv, .shp) or Paper	WDEQ/WQD Cheyenne	99 years
Photographs	Electronic (.jpg, docx)	WDEQ/WQD Cheyenne	99 years
Laboratory Results/QA/QC Reviews	Electronic (.pdf, .xlsx) & Paper	WDEQ/WQD Cheyenne	99 years
QAO QA/QC Reports	Electronic (.docx,.pdf) & Paper	WDEQ/WQD Cheyenne	99 years
Chain of Custody Forms	Electronic (.xlsx, .pdf) & Paper	WDEQ/WQD Cheyenne	99 years
Spreadsheets, other electronic files	Electronic (.xlsx, .rmp, .txt, .dbj)	WDEQ/WQD Cheyenne	99 years
Database	Electronic (.mdb, other)	WDEQ/WQD Cheyenne	99 years

All records are the property of the State, and therefore, subject to the Wyoming Public Records Act. Records are archived according to the procedures at the [Wyoming State Archives](#), the [State Agency Crosswalk Schedule](#) from the Wyoming State Archives, and the WDEQ/WQD associated policies.

Data Review, Verification, and Validation

See WDEQ/WQD SOPs for *Data Validation* and *Data Verification*, along with the QA/QC flow charts located in Appendix B of WDEQ/WQD (2023).

Data Analysis

Analytical methods used for this study include, but are not limited to, those outlined in in Table 8.

Table 8. Project Analytical Methods & Tools

Data Type	Data Analysis Methods
Chemical	Cyanotoxin data will be compared to applicable recreational use thresholds in Wyoming’s HCB Action Plan to determine whether a public health <i>Toxin Advisory</i> should be issued.
Biological	Cyanobacteria data will be compared to applicable recreational use thresholds in Wyoming’s HCB Action Plan to determine whether a public health <i>Bloom Advisory</i> should be issued. Cyanobacteria samples will also be evaluated to determine the presence of toxin-producing taxa.

Deliverables

Data and findings from this project will be shared with cooperators and the public to inform public health notifications, public water supply management, future HCB monitoring, illness investigations, etc. Results will address analytical deficiencies and field QC non-compliance and serve as the data verification and validation report.

References

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WDEQ/WQD. 2023. Watershed Protection Section Quality Assurance Program Plan. Wyoming Department of Environmental Quality, Water Quality Division, Watershed Protection Section, Cheyenne, Wyoming. <https://deq.wyoming.gov/water-quality/data-quality-assurance/>

WDEQ/WQD. 2024a. Harmful Cyanobacterial Bloom (HCB) Action Plan for Publicly Accessible Waterbodies in Wyoming. Wyoming Department of Environmental Quality, Water Quality Division, Watershed Protection Section, Cheyenne, Wyoming. <https://deq.wyoming.gov/harmful-cyanobacterial-blooms/>

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WDEQ/WQD. 2025. Laboratory Quality Manual. Wyoming Department of Environmental Quality, Water Quality Division, Watershed Protection Section, Cheyenne, Wyoming. <https://wyomingcloud.sharepoint.com/sites/020DEQ-WQD/Lab>

APPENDIX A

Process, Information, and Data Used to Prioritize Waterbodies for Routine Monitoring and Screening

Prioritization Process to Select Waterbodies for Routine and One-Time Monitoring

Publicly accessible waterbodies that pose elevated risks to public health from HCBs were prioritized for routine or one-time monitoring. Each waterbody was assigned one of seven risk levels (extremely high, very high, high, moderately high, moderate, moderately low, or low) based on combined *Access and Recreational Use* and *Toxin Bloom Potential* narrative assignments listed in [Table A-1](#) and integrated into a decision matrix ([Figure A-1](#)).

Access and Recreational Use Narrative Assignment

The following narrative assignments for *Access and Recreational Use* were determined based on the documented level recreational use, accessibility, and recreational amenities at each waterbody:

Very High: waterbodies where swimming or children playing in the water were observed during HCB monitoring in 2021-2024

High: waterbodies located in state parks, county parks, national recreation areas, or those with swimming beaches or areas for shoreline camping

Moderate: waterbodies where boating, wading, fishing, or hunting were observed during HCB monitoring in 2021-2024

Low: waterbodies without observed recreational use and with few or no recreational amenities

Toxic Bloom Potential Narrative Assignment

The following narrative assignments for *Toxic Bloom Potential* were determined based on past cyanotoxin and cyanobacteria density data collected at each waterbody:

Very High: waterbodies with past cyanotoxin concentrations that exceeded the following recreational use thresholds outlined in the Wyoming HCB Action Plan:

Microcystins and nodularins > 8 µg/L

Cylindrospermopsin > 15 µg/L

Anatoxin-a >15 µg/L

Saxitoxin > 30 µg/L

High: waterbodies with past cyanobacteria densities > 1,000,000 cells/mL and past cyanotoxin concentrations >1 µg/L but below the recreational use thresholds

Moderate: waterbodies with past cyanobacteria densities between 20,000 and 1,000,000 cells/mL and past cyanotoxin concentrations < 1 µg/L

Low: waterbodies with past cyanotoxin concentrations < 1 µg and past cyanobacteria densities < 20,000 cells/mL

Waterbodies with extremely high or very high rankings derived from the decision matrix in Figure A-1 were prioritized for routine monthly monitoring. These waterbodies exhibit high to very high *Access and Recreational Use* and *Toxic Bloom Potential*. Exceptions were made for Brooks Lake and Little Soda Lake, as these waterbodies were classified as very high priority due to significant public interest. Waterbodies with high rankings derived from the decision matrix in Figure A-1 were assigned to one-time monitoring. These waterbodies exhibit moderate to very high *Access and Recreational Use* and *Toxic Bloom Potential*. Exceptions were made for Guernsey Reservoir and Lower North Crow Reservoirs, as these waterbodies experience very high recreational use, which had not been accurately captured in past monitoring efforts.

Figure A - 1. Decision Matrix Used to Prioritize Waterbodies for Routine and One-Time Monitoring.

		Access and Recreational Use				
		Recreation Areas with Observed Swimming Use	Other State, County or City Parks, National Recreation Areas, Camping or Beach Area	Recreation Areas with Observed Boating, Wading, Fishing, or Hunting	Limited Recreational Improvements	
		<i>Priority</i>	<i>Very High</i>	<i>High</i>	<i>Moderate</i>	<i>Low</i>
Toxic Bloom Potential Cyanotoxins and Cyanobacteria Density	Cyanotoxins: MC ≥ 8 µg/L, CYL ≥ 15 µg/L, ATX ≥ 15 µg/L, or SAX ≥ 30 µg/L	<i>Very High</i>	Extremely High	Very High	High	Moderately High
	Cyanotoxins: MC, CYL, ATX, and SAX >1 µg/L and MC < 8 µg/L, CYL < 15 µg/L, ATX < 15 µg/L, and SAX < 30 µg/L Density: > 1,000,000 cells/mL	<i>High</i>	Very High	High	Moderately High	Moderate
	Cyanotoxins: < 1 µg/L; Density: <1,000,000 and >20,000 cells/mL	<i>Moderate</i>	High	Moderately High	Moderate	Moderately Low
	Density: <20,000 cells/mL	<i>Low</i>	Moderately High	Moderate	Moderately Low	Low

MC-microcystins and nodularins; CYL-cylindrospermopsin; ATX-anatoxin-a; SAX-saxitoxin

Table A - 1. Data and Rankings Used to Prioritize Waterbodies for Routine Monitoring in 2025.

Combined Risk / Use Ranking	Access and Recreation Use Ranking	Toxic Bloom Potential Ranking	2025 Priority	Waterbody Name	Max Density (cells/mL)	Max ATX (µg/L)	Max CYL (µg/L)	Max MC (µg/L)	Max SAX (µg/L)
Extremely High	Very High	Very High	1	Boysen Reservoir	238,632,049	20.17	<0.05	13,950.00	<0.02
	Very High	Very High	2	Saratoga Lake	149,863,732	0.18	<0.05	2,841.00	<0.02
	Very High	Very High	3	Pathfinder Reservoir	1,241,608,032	0.86	<0.05	11,550.00	<0.02
	Very High	Very High	4	Keyhole Reservoir	42,602,620	0.64	0.06	664.00	<0.02
	Very High	Very High	5	Alcova Reservoir	38,421,919	6.11	<0.05	375.00	<0.02
	Very High	Very High	6	Goshen Hole Reservoir	1,610,024	<0.17	<0.05	135.50	<0.02
	Very High	Very High	7	Flaming Gorge Reservoir	80,386,011	<0.17	<0.05	29.61	<0.02
	Very High	Very High	8	McKenzie Lake	21,763,511	<0.17	<0.05	45.80	<0.20
	Very High	Very High	9	Seminole Reservoir	6,924,662	4.57	<0.05	52.50	<0.02
Very High	Very High	High	10	Buffalo Bill Reservoir	4,831,908	<0.17	<0.05	4.52	<0.02
	Very High	High	11	Glendo Reservoir	13,862,773	<0.17	<0.50	2.40	
	Very High	High	12	Sloans Lake	4,345,790	<0.17	<0.05	0.35	<0.02
	High	Very High	13	Wind River	10,719,868	404.90	0.12	38.40	0.02
	High	Very High	14	Woodruff Narrows Reservoir	22,111,588	4.77	0.05	93.05	<0.02
	High	Very High	15	Viva Naughton Reservoir	48,996,600	0.77	<0.05	16.60	<0.02
	Very High	High	16	Lake De Smet	162,583,020	<0.17	<0.05	0.49	<0.02
	Very High	High	17	Wheatland Reservoir #1	6,001,402	0.20	0.26	2.85	<0.02
	Very High	High	18	West Granite Springs Reservoir	25,309,719	0.26	<0.05	0.34	0.05
	Very High	High	19	Bighorn Reservoir	2,696,293	0.20	<0.05	0.23	<0.02
High	High	20	Granite Springs Reservoir	1,133,126			<0.15		
High	High	21	Brooks Lake	29,227,469	0.24	<0.05	0.57	0.02	
Moderate	Moderate	Moderate	22	Little Soda Lake	565,762				

MC-microcystins and nodularins; CYL-cylindrospermopsin; ATX-anatoxin-a; SAX-saxitoxin

Table A - 2. Data and Rankings Used to Prioritize Waterbodies for One-Time Monitoring in 2025.

Combined Risk / Use Ranking	Access and Recreation Use Ranking	Toxic Bloom Potential Ranking	2025 Priority	Waterbody Name	Max Density (cells/mL)	Max ATX (µg/L)	Max CYL (µg/L)	Max MC (µg/L)	Max SAX (µg/L)
High	Moderate	Very High	23	Ocean Lake	69,117,486	0.31	0.06	5210.00	<0.02
	High	Very High	24	Fontenelle Reservoir	70,654,152	4.33	<0.05	132.80	<0.02
	Very High	Moderate	25	New Cody Reservoir	132,789			<0.15	
	High	High	26	Homesteader Park Pond	1,645,165				
	Moderate	Very High	27	Diamond Lake (Bosler Reservoir)	802,572	<0.17	0.82	>250	0.04
	High	High	28	Big Sandy Reservoir	9,970,420	<0.17	<0.05	0.31	<0.02
	High	High	29	Gillette Fishing Lake	3,462,911	0.18	0.17	0.35	0.05
	High	High	30	Kemmerer City Reservoir	44,183,127	0.48	<0.05	0.33	
	Very High	Moderate	31	Bighorn River	53,524	<0.17	<0.05	0.90	<0.02
	Moderate	Very High	32	Wheatland Reservoir #3	10,462,293	<0.17	0.06	37.05	<0.02
Moderately High	Very High	Low	33	Guernsey Reservoir		<0.17	<0.05	0.23	<0.2
	High	Moderate	34	Lower North Crow Reservoir	731,192		<0.05	<0.15	<0.02
	Low	Very High	35	Leazenby Lake	70,272,745	275.10	<0.05	0.63	0.02

MC-microcystins and nodularins; CYL-cylindrospermopsin; ATX-anatoxin-a; SAX-saxitoxin

Table A - 3. Waterbodies With Past Cyanobacteria or Cyanotoxin Data That Were Not Prioritized for Routine or One-Time Monitoring in 2025.

Combined Risk / Use Ranking	Access and Recreation Use Ranking	Toxic Bloom Potential Ranking	2025 Priority	Waterbody Name	Max Density (cells/mL)	Max ATX (µg/L)	Max CYL (µg/L)	Max MC (µg/L)	Max SAX (µg/L)
Moderately High	Low	Very High	36	Upper Brooks Lake	916,659	0.97	0.07	39.25	<0.02
	High	Moderate	37	Beck Lake	748,335			<0.15	
	High	Moderate	38	Miller Lake	31,875	<0.17	<0.05	<0.15	<0.2
	High	Moderate	39	Laramie River	97,360	<0.17		<0.15	
	Moderate	High	40	High Savery Reservoir	123,627,003	0.50	<0.05	0.34	<0.02
	Moderate	High	41	Pelham Lake	20,812,004	<0.17	<0.05	0.33	<0.02
	Low	Very High	42	NE Kisinger Lake	21,513,262	<0.17	<0.05	406.00	<0.2
	Low	Very High	43	Rainbow Lake	35,554,130	1.62	0.17	119.60	<0.02
	Low	Very High	44	Eden Reservoir	43,567,600	0.87	0.06	11.29	<0.02
	Moderate	High	45	Twin Butte Reservoir	825,702	<0.17	<0.05	6.27	0.07
Moderate	High	Low	46	Hawk Springs Reservoir	4,149			<0.15	
	Moderate	Moderate	47	Scouts Pond	885,564	<0.17	<0.05	<0.15	<0.2
	Moderate	Moderate	48	East Newton Lake	242,836	<0.17	<0.05	<0.15	<0.02
	Moderate	Moderate	49	Shoshone River	207,998	<0.17	<0.05	<0.15	<0.02
	Low	High	50	Festo Lake	5,891,612	<0.17	0.12	7.52	<0.02
	Low	High	51	Rainbow Lake (on Burroughs Loop)	41,321,991	0.34	<0.05	0.35	<0.02
	Low	High	52	Upper Jade Lake	21,831,204	0.20	<0.05	0.20	<0.02
	Low	High	53	Toltec Reservoir	14,513,811	<0.17	<0.05	<0.15	<0.02
	Low	High	54	Eikster Lake	10,134,495	<0.17	<0.05	0.03	<0.02
	Low	High	55	South Watkins Lake	6,876,540	<0.17		0.28	
	Low	High	56	Sodergreen Lake	6,136,374	<0.17	<0.05	0.29	<0.02
	Low	High	57	Brooks Lake Creek	3,017,076	<0.17	<0.05	0.188	<0.02
	Low	High	58	North Watkins Lake	2,529,831			<0.15	
	Low	High	59	Lower Jade Lake	1,427,692	<0.17	<0.05	0.244	<0.2
	Low	High	60	V Lake	1,167,464	<0.17	<0.05	0.36	<0.02

Combined Risk / Use Ranking	Access and Recreation Use Ranking	Toxic Bloom Potential Ranking	2025 Priority	Waterbody Name	Max Density (cells/mL)	Max ATX (µg/L)	Max CYL (µg/L)	Max MC (µg/L)	Max SAX (µg/L)
	Low	High	61	Jade Creek	1,131,118	<0.17	<0.05	0.17	<0.02
Moderately Low	Low	Moderate	62	Clendenning Lake	1,038,861	<0.17	<0.05	0.257	<0.02
	Low	Moderate	63	Anne's Pond	834,516			<0.15	
	Low	Moderate	64	Virgin Lake	736,322	<0.17	<0.05	0.172	<0.02
	Low	Moderate	65	Murray Lake	225,800	<0.17	<0.05	0.19	<0.2
	Low	Moderate	66	Weston Reservoir	164,785	<0.17	<0.05	<0.15	<0.02
	Low	Moderate	67	Wind River Lake	61,893			0.29	
	Low	Moderate	68	Shoshone Lake	25,334	<0.17	<0.05	<0.15	<0.02

MC-microcystins and nodularins; CYL-cylindrospermopsin; ATX-anatoxin-a; SAX-saxitoxin