# Wyoming Nutrient Criteria Development Plan

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Updated by:
Wyoming Department of Environmental Quality
Water Quality Division
Watershed Protection Program

Originally Prepared by:
WDEQ and Tetratech
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# 1.0 BACKGROUND

Nutrients (nitrogen and phosphorus) support primary producers essential for healthy, diverse, and productive aquatic ecosystems. Excessive nutrients, however, can result in abundant growth of periphyton, macrophytes, and/or phytoplankton that can lead to oxygen depletion, harmful algal blooms, imbalances in biological community composition, human health concerns, and a general decline in aquatic resources. The U.S. Environmental Protection Agency's (EPA's) national water quality summary reports to Congress consistently identify excessive nutrients as one of the top three leading causes of impairments of the nation's water (along with siltation and pathogens). Eutrophication of the nation's surface water resources (lakes, reservoirs, rivers, streams and wetlands) due to excessive nutrients is therefore recognized as a significant water quality problem.

Due to the natural variability associated with nutrient concentrations and potential responses to nutrient pollution, most states historically used narrative criteria as the primary means to protect surface waters from nutrient pollution. Beginning in the mid-1990's, however, in an effort to more effectively address nutrient pollution, EPA began to emphasize the importance of developing and adopting numeric nutrient criteria into state surface water quality standards. Numeric nutrient criteria, or concentrations of nitrogen and phosphorus, and response variables such as chlorophyll a, are expected to more effectively protect and restore surface water quality because they can be used to: identify waters that are meeting water quality standards and need to be protected; identify impaired waters that need to be restored; establish restoration targets for impaired waters; and develop effluent limits for point sources.

To encourage development and adoption of numeric nutrient criteria, EPA published the *National Strategy for the Development of Regional Nutrient Criteria* (USEPA 1998) in 1998 under section 304(a) of the Clean Water Act (66 *Federal Register* [FR] 1671). The document describes the national approach for developing nutrient criteria as well as EPA's intention to work with states in the development and adoption of nutrient criteria. Following this approach, EPA produced technical guidance documents for development of nutrient criteria for rivers and streams, lakes, estuaries, and wetlands (USEPA 2000a, 2000b, 2001a, 2008). In addition, EPA proposed recommended criteria for Nutrient Ecoregions for Rivers and Streams and for Lakes and Reservoirs in a series of documents in the early 2000s (USEPA 2000c, 2000d, 2000e, 2001b, 2001c, 2001d, 2001e, 2001f). The recommended criteria, based on nutrient ecoregions, were intended to serve as a springboard for states to develop more refined nutrient criteria, stating that "States and Tribes need to identify with greater precision the nutrient levels that protect aquatic life and recreational uses…" (USEPA 2000a, 2000b). EPA expected states to revise and adopt the recommended nutrient ecoregion criteria into state water quality standards by 2004, but recognized that the time and resources needed to develop standards differed significantly among states. WDEQ and a number of states have questioned the representativeness, applicability, and defensibility of EPA's recommended criteria and have pursued criteria development independent from EPA's recommendations.

In an effort to further assist states in developing numeric nutrient criteria, EPA released a memorandum from the director of EPA's Office of Science and Technology in 2001 that provided guidance on the development of nutrient criteria plans and described the role these plans play in the adoption of numeric nutrient criteria. EPA also restated its goal "...to work with states to establish

the necessary quantitative endpoints to reduce excessive nutrient inputs to the nation's waters...." and to prevent further water quality impairments due to excessive nutrients.

EPA has continued to emphasize the importance of numeric nutrient criteria and nutrient criteria development plans as part of states' broader strategies to address nutrient pollution. In a 2011 memorandum from the Office of Water Acting Assistant Administrator, Nancy Stoner, EPA recommended that states "establish a work plan and phased schedule for [nitrogen] and [phosphorus] criteria development for classes of waters (e.g., lakes and reservoirs, or rivers and streams)." The memo also outlined that the work plan and schedule contain interim milestones such as "data collection, data analysis, criteria proposal, and criteria adoption," with the expectation that states develop "numeric [nitrogen] and [phosphorus] criteria for at least one class of waters within the state within 3-5 years."

A 2016 memorandum from the Office of Water Deputy Assistant Administrator, Joel Beauvais, reiterated this point: "EPA continues to advocate the benefits of adopting numeric nutrient criteria because they provide measurable water quality-based goals that are easier to implement than narrative criteria statements in many state water quality standards." The memo also recommended that each state work expeditiously to "continue to develop numeric nutrient criteria that clearly identify nutrient levels that are consistent with state, tribe, or territory's uses of its waters under the Clean Water Act (CWA) and serve as clear guides for protecting and restoring those uses for its citizens."

Wyoming's Nutrient Criteria Development Plan was first drafted in 2008 by the Wyoming Department of Environmental Quality (WDEQ) and Tetratech in response to EPA's request for states to develop nutrient criteria development plans, develop numeric nutrient criteria, and adopt the numeric criteria into state water quality standards. The plan summarized existing data, laid out a general framework for developing and adopting criteria, and established timelines to achieve milestones.

As identified in the 2008 plan, WDEQ began a concerted effort to develop and adopt numeric nutrient criteria in 2013 by initially focusing on lakes and reservoirs. WDEQ updated the lake and reservoir nutrient database that was first compiled in 2008, identified data gaps, developed a sampling and analysis plan to fill data gaps, and began collecting, analyzing, and evaluating data for numeric nutrient criteria development. WDEQ has continued to collect data for numeric nutrient criteria development on an annual basis.

In addition, since 2012, WDEQ has improved the storage, processing, and analytical capabilities of the Water Quality Division laboratory so that all of the chemical laboratory analyses (total nitrogen, total phosphorus, chlorophyll a, and other nitrogen compounds) can be conducted in-house. These efforts have helped to improve consistency and maximize resources.

Recognizing that numeric nutrient criteria may impact many stakeholders in Wyoming and that the criteria will likely create implementation challenges, WDEQ formed the Wyoming Nutrient Work Group in 2014 to assist in developing and implementing numeric nutrient criteria as well as developing and implementing a strategy to address nutrient pollution in Wyoming. In 2016 and 2017, the Wyoming Nutrient Work Group drafted the Wyoming Nutrient Strategy, a set of priority

items and key next steps to assist the state in addressing nutrient pollution. The strategy provides guidance for addressing nutrient pollution from four main areas: criteria development, nonpoint sources, point sources, and education and outreach. WDEQ has updated the original 2008 Wyoming Nutrient Criteria Development Plan based on feedback received from the Wyoming Nutrient Work Group during development of the Wyoming Nutrient Strategy, with additional information on how the state intends to prioritize waters for criteria development as well as the process WDEQ will use to develop and adopt numeric nutrient criteria. The plan has also been updated to include WDEQ's recent efforts to collect data necessary for criteria development.

# 2.0 CURRENT STATUS OF WYOMING NUTRIENT CRITERIA

Wyoming's surface water quality standards (WDEQ 2013a) do not currently include numeric criteria for total nitrogen (TN), total phosphorus (TP), or response parameters such as chlorophyll a. The surface water quality standards do include numeric criteria for a handful of nitrogen compounds, total ammonia nitrogen, nitrite nitrogen, nitrate nitrogen, and nitrite+nitrate nitrogen (WDEQ 2013a). Ammonia is toxic to aquatic life under specific pH and temperature conditions and are applied to all Class 1 and 2 waters. Narrative ammonia criteria apply to Class 3 waters in the state[1]. Elevated nitrite and nitrate levels have the potential to impact human health and therefore apply to waters designated for drinking water. It is recognized that these numeric criteria are intended to protect against toxic effects and are therefore less stringent than would be necessary to protect against eutrophication. Wyoming's surface water quality standards also include turbidity, pH, and dissolved oxygen (DO) criteria. Turbidity has been included as a potential parameter for nutrient criteria development, while pH and DO are considered important surrogates for nutrient effects (USEPA 2000a).

Wyoming's surface water quality standards also include narrative standards for undesirable aquatic life (Section 28); taste, odor, and color (Section 17); floating and suspended solids (Section 16); toxic materials (Section 13); and biological criteria (Section 32) that can be used as part of a weight of evidence approach to identify impairments due to nutrient pollution. WDEQ uses macroinvertebrate and periphyton data as part of the weight of evidence in evaluating exceedances of Section 32 due to nutrients, but has not regularly evaluated other narrative criteria to determine designated use support. As outlined in the 2017 Wyoming Nutrient Strategy, WDEQ has committed to developing more detailed assessment methods for interpreting narrative criteria that will be included in a future revision of Wyoming's Methods for Determining Surface Water Quality Condition. Since numeric nutrient criteria will not be available for most surface waters in Wyoming for some time, WDEQ is hoping that the additional guidance will help to more

[1] Class 1 are those surface waters in which no further water quality degradation by point source discharges other than from dams will be allowed. Nonpoint sources of pollution shall be controlled by application of best management practices. Class 2 are waters, other than those designated as Class 1, that are known to support fish and/or drinking water supplies or where those uses are attainable. Class 3 are waters, other than those designated as Class 1, that are intermittent, ephemeral or isolated waters and because of natural habitat conditions, do not support nor have the potential to support fish populations or spawning, or certain perennial waters that lack the natural water quality to support fish. Waters not specifically designated as Class 1, 2, or 4, are designated Class 3 by default. Class 4 are waters, other than those designated as Class 1, where it has been determined that aquatic life uses are not attainable pursuant to the provisions of Section 33 of the Wyoming Surface WQS (WDEQ 2013a). Class 4 waters include waters that have an approved use attainability analysis (UAA) containing defensible reasons for not protecting aquatic life uses. See the Wyoming Surface Water Classification List for additional details (WDEQ 2013b).

effectively and consistently identify whether designated uses are not being met due to nutrient pollution so that restoration efforts can be planned and implemented. WDEQ also expects that narrative criteria will continue to be important once numeric nutrient criteria has been developed since numeric criteria may not be applicable to all waters.

# 3.0 CONCEPTUAL APPROACHES

Considering the state of the science and information from EPA guidance documents, there are five general approaches for establishing numeric nutrient criteria (USEPA 2000a): (1) reference-based, (2) stressor-response, (3) literature-derived values, (4) modeling, and (5) dose-response studies.

The reference approach uses two principal methods. The first method is to derive criteria from ambient nutrient concentrations observed at a population of reference sites that represent least-impacted or best attainable conditions. The second method estimates reference conditions by empirical modeling, which can be performed either by extrapolation of land cover/nutrient concentration models for the condition of zero percent human land cover (Dodds and Oakes 2004), or construction of regression models on the basis of multiple natural predictors (Smith et al. 2003; Sheeder and Evans 2004), among other methods. Either reference approach method requires grouping waterbodies to establish applicable criteria for different waterbodies (Detenbeck et al. 2004; Snelder et al. 2004; Wickham et al. 2005). To date, WDEQ has not identified any reference lakes and reservoirs, but has an existing network of over 200 stream reference stations in Wyoming (Figure 1) which represent least-impacted or best attainable ecological conditions. The stream reference stations have been used to develop benthic macroinvertebrate community expectations.

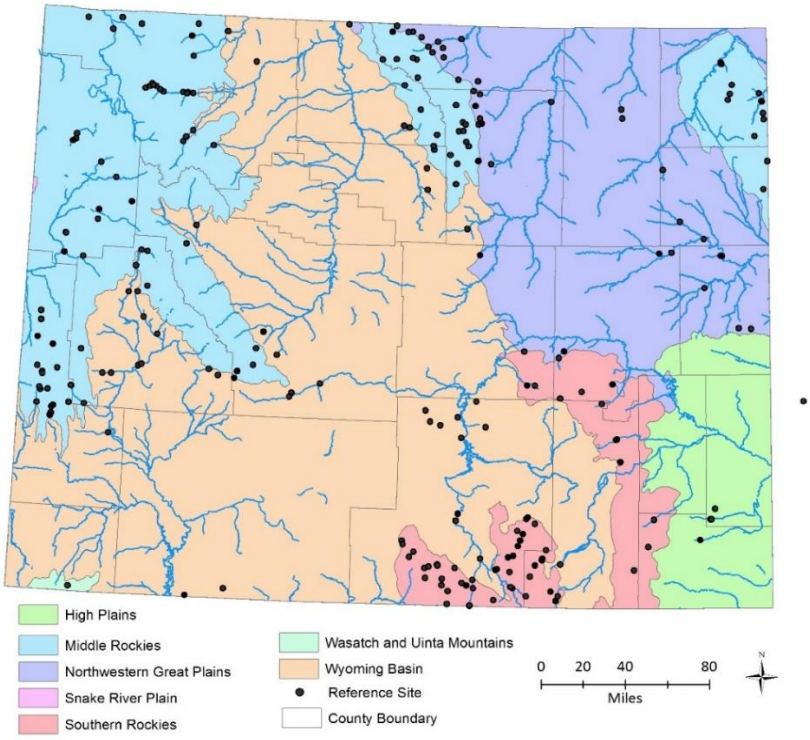


**Figure 1. Level III ecoregions and Wyoming Department of Environmental Quality (WDEQ) stream reference stations across Wyoming.**

Reference-based approaches can, however, lack a direct linkage to protection of designated uses (Dodds and Welch 2000; McMahon et al. 2003) if the criteria used to select reference sites does not specifically identify use condition. Consequently, it may be difficult to demonstrate clear evidence of use protection and/or use impairment by simply choosing distribution-based values from a reference network, using predictor variables, or from modeling zero percent human land cover.

Stressor-response approaches were designed to address the limitations of reference-based approaches by deriving nutrient criteria from relationships between designated use response indicators and nutrient concentrations. Since aquatic communities are directly impacted by nutrient pollution, aquatic life designated uses are among the most common targets for nutrient criteria. Fortunately, biological indicators (algae, macroinvertebrates, fishes) provide a direct measure of aquatic life use condition and have been used successfully in assessment of aquatic life designated uses (Barbour et al. 2000; King and Richardson 2003). As a result, statistical analyses that directly relate eutrophication (stressor) to biological indicators or other aquatic life use attributes can be used to develop ecologically meaningful nutrient criteria. Nutrient criteria that use stressor-response approaches have typically relied on algal biomass and community indicators as response variables (Welch et al. 1988; Stevenson 1997; Biggs 2000; Havens 2003). Stressor-response approaches may also provide links between nutrient concentrations and other designated uses.

The literature-derived approach is based on developing criteria from existing scientific literature for the same or similar waterbodies and regions. This approach recognizes that the impacts of nutrients have been well documented for many systems and that new data and analyses may not be necessary. In addition to providing the primary source of information for criteria development, literature can be used as a guide in developing nutrient criteria and can be used to evaluate criteria developed using other approaches.

Use of mechanistic and/or empirical models may also be a viable approach in development of nutrient criteria, particularly for waterbodies where the interactions among multiple factors are difficult to incorporate into more simplified techniques and/or nutrient data are limited or not available (Somlyody 1997, 1998; Reckhow et al. 2005). Such models may also be appropriate for watersheds with multiple point and nonpoint sources of nutrients, where predictions of pollutant loading and responses under different scenarios is important for nutrient criteria development. Mechanistic or empirical models developed as part of total maximum daily loads (TMDLs) could be used in this context and may also be helpful when deriving effluent limits for permitted facilities.

Dose-response studies are used to establish a relationship between observable changes in a designated use indicator (e.g., aquatic life) in response to varying concentrations of a nutrient under controlled field conditions. Such studies can provide direct stressor-response linkages, though unlike dose-response studies that involve toxins, these studies may present challenges in their findings since nutrients are generally not directly toxic to aquatic life and interactions with other abiotic variables may confound results. Nevertheless, findings from these studies may provide critical information at a site-specific scale in development of nutrient criteria.

# 4.0 WATERBODY PRIORITIZATION

Although WDEQ plans to develop numeric nutrient criteria for as many waters as is scientifically defensible, feasible, and appropriate, it should be noted that many waterbodies in Wyoming may not have the size, designated uses, or accessibility to warrant prioritization for nutrient criteria development. Further, because WDEQ does not have sufficient resources or data available to develop numeric nutrient criteria for all appropriate waters in the state at the same time, WDEQ must prioritize waters for both data collection and numeric criteria development.
During development of the 2008 Nutrient Criteria Development Plan, WDEQ and Tetratech included a general waterbody prioritization that was affirmed and refined by the Wyoming Nutrient Work Group during development of the 2017 Wyoming Nutrient Strategy. The revised waterbody prioritization is described below.

## 4.1 General Waterbody Prioritization

As outlined in the 2008 Nutrient Criteria Development Plan, Wyoming intends to develop numeric and/or narrative nutrient criteria for different waterbody types in the following order:

1. Lakes and reservoirs
2. Streams and rivers
3. Wetlands

There are fewer lakes and reservoirs in the state than streams and rivers. In addition, there is substantially more scientific literature to support development of appropriate lake and reservoir numeric nutrient criteria. Accordingly, it is anticipated that criteria development for lakes and reservoirs will be more straightforward relative to streams and rivers. Prioritizing lakes and reservoirs is also appropriate since these waterbodies often act as nutrient sinks and can therefore show more severe impacts from nutrient pollution. For example, lakes and reservoirs are more susceptible to harmful algal blooms, which can produce cyanotoxins and other irritants that can cause health effects in humans, pets, and livestock.

## 4.2 Prioritization for Short-Term Nutrient Criteria Development

WDEQ also recognizes that it is necessary to prioritize criteria development within waterbody types. In 2013, WDEQ conducted an evaluation of the existing data available for development of numeric nutrient criteria for lakes and reservoirs and determined that the most data were available for lakes and reservoirs in south-central Wyoming (Wyoming Basin, Figure 2). Since it would take the least amount of additional data collection to have sufficient information for criteria development, WDEQ began focusing on collecting the necessary additional data for Wyoming Basin lakes and reservoirs. Since that time, WDEQ has also conducted data collection for nutrient criteria development in the Bighorn Basin and Southeast Wyoming (Figure 2) along with several large reservoirs (e.g. Boysen and Seminoe Reservoirs) in the state. WDEQ prioritized data collection in these areas because it is anticipated that a similar approach to criteria development can be used for these lakes and reservoirs as those in the Wyoming Basin.

In 2015, WDEQ also began focusing some of the WDEQ - United States Geological Service cooperative monitoring network toward data collection for numeric nutrient criteria development on large reservoirs in the state. The data collection has included monthly sampling on tributaries to

and outlets from Boysen and Seminoe Reservoirs, as well as periodic sampling on major tributaries to Buffalo Bill, Bighorn, Pathfinder, and Alcova Reservoirs.

During development of the 2017 Wyoming Nutrient Strategy, the Wyoming Nutrient Work Group affirmed WDEQ's approach to prioritize lakes and reservoirs that have sufficient or nearly-sufficient data for numeric criteria development. As a result, criteria development will focus in the short term on the lakes and reservoirs included in Table 3.

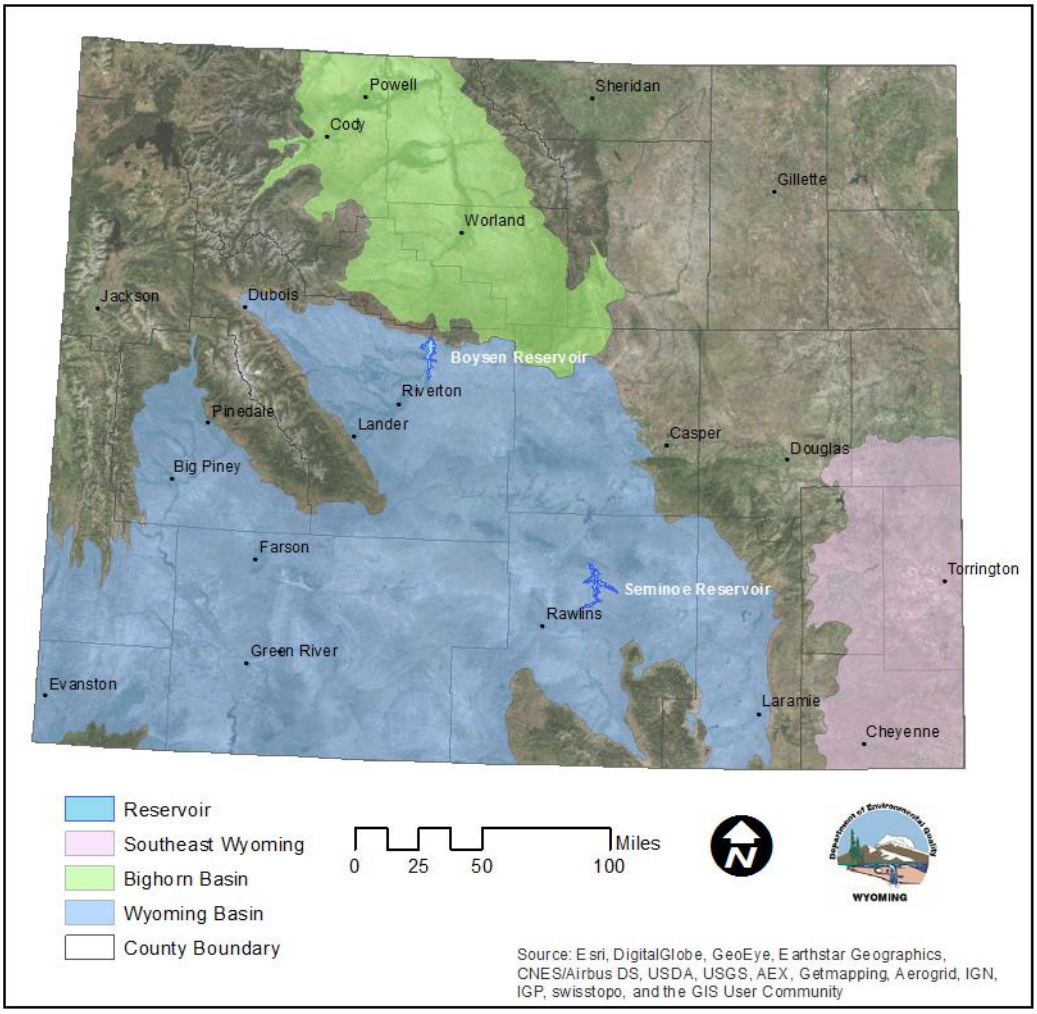


**Figure 2. Lakes and reservoirs prioritized for short-term numeric nutrient criteria development.**

**Table 3. Prioritization for Short-Term Nutrient Criteria Development in Wyoming**

| Priority for Criteria Development | Lakes/Reservoir Group | Criteria Development Status as of Jan. 2018 |
|---|---|---|
| 1 | Wyoming Basin | Under Development |
| 2 | Bighorn Basin | Continued Supplemental Data Collection |
| 3 | *Boysen Reservoir | Continued Supplemental Data Collection |
| 4 | Southeast Wyoming | Continued Supplemental Data Collection |
| 5 | *Seminoe Reservoir | Continued Supplemental Data Collection |

*May include numeric nutrient criteria development for flowing waters tributary (inputs and outputs) to the reservoir

## 4.3 Prioritization of Other Waters for Criteria Development

Once WDEQ has developed numeric nutrient criteria for the lakes and reservoirs included in Table 3, the Wyoming Nutrient Work Group recommended that WDEQ prioritize waters based on potential impacts to public health, followed by potential economic impacts. WDEQ and the Wyoming Nutrient Work Group further refined this feedback in the Wyoming Nutrient Strategy to prioritize waters for criteria development based on waterbody use (i.e., how waters are used by the public – drinking water, immersion recreation, boating, fishing, wading, agriculture, etc.) and nutrient potential risk (i.e., those waters most likely to have nutrient problems that may impact waterbody use). WDEQ combined these two factors into a waterbody use and nutrient potential risk matrix, as outlined in Figure 3.

| | | | Waterbody Use | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Tier 1 - Public Health | | Tier 2 - Commerce | | Tier 3 - Other | |
| | | | Drinking Water | Public Recreation (Swimming, Water Skiing) | Public Recreation (Boating, Fishing, Wading) | Public Recreation (Fishing, Wading) | Non-game Fisheries & Other Aquatic Life | Agriculture, Industry, Wildlife |
| | | *Priority* | *High* | | *Moderate* | | *Low* | |
| Nutrient Risk | High HABS Risk High Chlorophyll-a | *High* | Very High | Very High | High | High | Moderate | Moderate |
| | High TP or TN and Variable Chlorophyll-a | *Moderate* | High | High | Moderate | Moderate | Moderate | Moderate |
| | Low Chlorophyll-a, TP and TN | *Low* | Moderate | Moderate | Moderate | Moderate | Low | Low |

**Figure 3. Combined waterbody use and nutrient risk matrix for prioritization of waters for numeric nutrient criteria development.**

WDEQ will use this system to prioritize:

a) Lakes/reservoirs without numeric nutrient criteria;

b) Streams/rivers that are direct tributaries to lakes/reservoirs; and

c) Other streams and rivers.

WDEQ will evaluate waterbody use and nutrient potential risk using data from WDEQ and other agencies. Waterbody uses are categorized into three tiers, with impacts to public health receiving the highest level of importance (tier 1), followed by impacts to commerce (tier 2), and other uses (tier 3). Similarly, nutrient potential risk were given three levels, with a high likelihood for harmful algal blooms (HABs) or high chlorophyll a values receiving the highest level of importance, waters with high total phosphorus or total nitrogen and variable chlorophyll a receiving a moderate level of importance, and waters with low chlorophyll a, total phosphorus, and total nitrogen receiving a low level of importance. Waterbodies (either individually or as a group) that receive a combined waterbody use and nutrient stressor/response assignment of ‘very high’ receive the highest priority for numeric nutrient criteria development, while assignments of ‘high’ receive second priority, ‘moderate’ receive third priority, and ‘low’ are fourth priority. WDEQ will also prioritize waters within these broader categories (i.e., very high, high, moderate, and low) to ensure that waters with

potential nutrient problems and sensitive uses are prioritized over other waters. That said, special water designations such as blue-ribbon fisheries, Class 1 waters, or Wild and Scenic Rivers may be elevated for numeric nutrient criteria development.

# 5.0 CONSIDERATIONS FOR DEVELOPING NUMERIC NUTRIENT CRITERIA IN WYOMING

WDEQ plans to evaluate all five of the conceptual approaches described in the previous section and will likely use a combination of these approaches (i.e., multiple lines of evidence) to develop nutrient criteria. Using multiple lines of evidence will allow WDEQ to weigh the technical merits and limitations of each approach as well as maximize the amount of information that can be used to develop nutrient criteria. In addition, WDEQ anticipates that different approaches or different combinations of approaches will be used for specific waterbodies or waterbody types.

## 5.1 Variables for Nutrient Criteria Development

EPA recommends that nutrient criteria be developed for primary water quality variables: two causative variables (i.e., TP and TN) and response variables (e.g., chlorophyll *a*, algal metrics, turbidity, Secchi depth). A number of secondary variables such as DO, pH, algae and benthic macroinvertebrates may also be considered, but principally for use in identifying appropriate criteria for the primary variables. Secondary variables can be used to help evaluate causes and effects of nutrient enrichment in waterbodies and to help establish nutrient criteria and benchmarks for specific regions and waterbodies.

For many waterbodies, WDEQ has monitoring data on the four primary water quality variables, plus a number of secondary variables including DO, pH, and conductivity. In addition, WDEQ has collected benthic macroinvertebrates and periphyton at a large number of stream and river sites. Since 2007, periphyton chlorophyll *a* has been monitored at river and stream sites. Since 2002, WDEQ has monitored phytoplankton chlorophyll *a* and Secchi depth at several lakes and reservoirs. Beginning in 2013, WDEQ has collected phytoplankton samples to determine densities and community composition in several lakes and reservoirs. Variables for wetland monitoring and potential nutrient criteria development will be addressed at a later date.

For lakes and reservoirs, WDEQ will examine TN, TP, phytoplankton chlorophyll *a*, and phytoplankton metrics, among others, as possible causative and response variables. WDEQ will also evaluate phytoplankton community attributes as a means to link proposed criteria to designated uses. For streams and rivers, criteria could be developed for TN and TP and possibly periphyton chlorophyll *a* and/or periphyton metrics. WDEQ may also be able to evaluate the use of macroinvertebrate community composition as a potential indicator of nutrient pollution in streams and rivers.

As a general conceptual approach, where defensible nutrient criteria can be developed, numeric translators of narrative criteria may be established first, followed by actual numeric criteria. Numeric translators of narrative criteria may include, for example, concentrations of total nitrogen, total phosphorus, and response parameters that indicate a designated use is likely not supported. If defensible numeric criteria cannot be developed, either narrative criteria or numeric translators of narrative criteria may be used in lieu of numeric criteria.

## 5.2 Waterbody Stratification

Waterbody stratification, or the grouping of waterbodies into groups based on common characteristics, reduces the natural variability of nutrient parameters within a region and allows nutrient criteria to be developed on a broader, rather than site-specific scale. Stratification can be based on a number of characteristics, including but not limited to, lake and stream types, ecoregions, bioregions, geology, stream order, designated uses, lake depth, and watershed area. In addition to considering natural waterbody stratification schemes, WDEQ may explore statistical approaches to relate nutrient criteria to ecological attributes, designated uses, and/or management goals.

## 5.3 Wyoming's Approaches to Nutrient Criteria Development

*Lake and reservoir criteria*

WDEQ will use multiple approaches or lines of evidence combined with input from the Wyoming Nutrient Work Group to develop lake and reservoir nutrient criteria at the regional and/or local scale that includes, but is not limited to, the following:

(1) Evaluation of raw data used to develop percentile-based recommended nutrient criteria using reference and non-reference sites. WDEQ does not have a reference network for lakes and reservoirs. In absence of such a network, Setzler and Richards (2003) compiled nutrient data of lakes and reservoirs in EPA Region 8. Their data, as well as comparable analyses using updated data sets, could be used as one of several lines of evidence for Wyoming's lake and reservoir nutrient criteria development.

(2) Applying and/or modifying established nutrient thresholds (e.g., nutrient effect thresholds or algal limits) and stressor-response relationships found within the available scientific literature for specific lake/reservoir groups. These literature-derived thresholds could be evaluated as part of nutrient criteria development.

(3) New nutrient thresholds and empirical stressor-response relationships for lake/reservoir groups could be established from available chlorophyll a, TN, TP, phytoplankton and other applicable data for possible development of nutrient criteria.

(4) Candidate criteria developed from applicable dose-response studies could be applied and/or modified for consideration as one line of evidence in nutrient criteria development.

(5) Integration or consideration of thresholds and target endpoints developed as part of a TMDL to address nutrient-related pollutants.

*Stream and river criteria*

WDEQ also intends to use a multiple lines of evidence combined with input from the Wyoming Nutrient Work Group to develop numeric nutrient criteria for streams and rivers at the regional and/or local scale. The approaches WDEQ will consider include, but are not limited to, reference-based methods, existing and new empirical stressor-response relationships using periphyton and/or benthic macroinvertebrates, application and/or modification of established thresholds, scientific literature, and TMDLs.

### 5.4 Downstream Uses and Cross-Jurisdictional Waterbodies

The purpose of developing numeric nutrient criteria is to protect applicable designated uses assigned to Wyoming surface waters. However, downstream uses will also be considered when evaluating numeric nutrient criteria to ensure that recommended criteria are sufficiently protective and do not result in adverse nutrient loadings to downstream waterbodies. This may require evaluation of downstream and upstream water quality standards for surrounding states and tribes.

Upon development of preliminary nutrient criteria, the WDEQ and the Wyoming Nutrient Work Group will evaluate whether the criteria are sufficiently protective of waters is adjacent states and tribal lands. WDEQ will also continue to attend regional and national nutrient criteria meetings, when possible, to learn about approaches used by other states and tribes, share progress on Wyoming's efforts to develop numeric nutrient criteria, and potentially incorporate findings and feedback where appropriate.

## 6.0 DATA CONSIDERATIONS

### 6.1 Compilation of Data

In 2008, TetraTech compiled a database (i.e., Wyoming Nutrient Database) to store existing nutrient and associated variable data for use in development of nutrient criteria. The database included data from WDEQ, EPA, legacy STORET, modernized STORET and U.S. Geological Survey (USGS) National Water Information System (NWIS). Stream reference sites (which correspond to those identified by WDEQ) were also identified in the database.

Although the number of samples in the databases was large, the spatial and temporal resolution of the data reduced the number of samples that could be used for numeric criteria development. In addition, data collected prior to 2007 were analyzed with higher laboratory reporting limits, which further limits their usefulness for criteria development.

In 2012, WDEQ updated the database with additional lake and reservoir data collected by WDEQ and EPA. WDEQ has continued to update the database as more data become available. WDEQ currently stores stream and river data in a separate database, Surface Water Monitoring (SWM), which is regularly updated. Data from SWM can easily be combined with the existing nutrient database to use for criteria development for streams and rivers.

### 6.2 Efforts to Fill Data Gaps

*Lakes and reservoirs*

More than 70% of the records in the 2008 Wyoming Nutrient Database were collected prior to 1990. In 2012, the database contained limited nutrient data for lakes and reservoirs in Wyoming, particularly for natural lakes and among Wyoming's five level III ecoregions, the data quantity and spatial distribution were best represented within the Wyoming Basin of southern Wyoming. This information, combined with the large number of publically accessible lakes in the Wyoming Basin with established fisheries, recreational, and/or drinking water uses, prompted WDEQ to prioritize nutrient criteria development efforts for lakes in the Wyoming Basin.

In 2013, the WDEQ Monitoring Program (with assistance from EPA) implemented a focused monitoring effort to collect additional data for new and previously sampled Wyoming Basin lakes and reservoirs. Overall, 25 lakes and reservoirs were sampled three times (spring, summer, and fall), along with two larger reservoirs, Boysen and Seminoe. In 2014, 21 additional Wyoming Basin lakes and reservoirs were sampled, along with resampling of 14 lakes from the 2013 season. The 2014 sampling also included 8 lakes and reservoirs in the Bighorn Basin as well as Boysen and Seminoe Reservoirs.

Data collection in 2015 and 2016 focused on 10 lakes in the northern portion of the Wyoming Basin, six lakes in the Bighorn Basin that were sampled during the 2014 season, and eight lakes in southeast Wyoming. In addition, five larger reservoirs were sampled, including Bighorn, Buffalo Bill, Boysen, Seminoe, and Fontenelle Reservoirs.

In 2017, data collection focused on approximately 13 reservoirs that are drinking water storage reservoirs or public reservoirs with high immersion recreation uses for which limited or no nutrient data had been collected; this sampling effort included the larger Keyhole, Glendo, and Pathfinder Reservoirs, where phytoplankton had not previously been sampled.

As part of the WDEQ/USGS Cooperative Monitoring Network, quarterly or monthly nutrient data collections were initiated at a suite of USGS stations throughout the state. This effort focuses primarily on major tributaries to and outlets from a handful of large reservoirs and includes monthly sampling at Boysen, Seminoe, and Pathfinder Reservoirs and quarterly sampling at Alcova, Bighorn, and Buffalo Bill reservoirs.

Additional data will be collected in subsequent years as time, need, and resources allow. Data collection for criteria development will be prioritized to fill data gaps using the system described in Section 5.

*Streams and rivers*

Since the nutrient database was first compiled in 2008, WDEQ's Monitoring Program has collected additional nutrient related data at both new and previously monitored sites. This has included over 200 probabilistic sites as part of the Bighorn/Yellowstone, Northeast, Green, and Platte superbasin probabilistic surveys conducted in 2010, 2011, 2015 and 2016, respectively. Monitoring as part of numerous targeted studies for designated use support and best management practice effectiveness, TMDL development, reference site re-visits and new reference site identification has also occurred on multiple streams and rivers since 2007.

WDEQ will collect additional data on streams and rivers as time, need, and resources allow. Monitoring for criteria development for streams and rivers will be prioritized to fill data gaps using the system described in Section 5. Initially, WDEQ anticipates that monitoring on streams and rivers for numeric nutrient criteria development will focus on major tributaries to reservoirs.

## 6.3 Additional Data Collection

WDEQ's Monitoring Program will continue to collect nutrient data as part of fixed, targeted, and probabilistic reference and non-reference sites for various waterbody types and groups. A suite of

associated chemical, physical, and biological variables will continue to be measured concurrently as part of this monitoring. Data available from the WDEQ's Monitoring Program in addition to data from other federal, state, and local sources will be periodically compiled and populated into Wyoming's Nutrient and SWM Databases. Additional data collections combined with existing data will help to address/develop, but not limited to, the following items:

(1) Stressor-response relationships between nutrient causative and response variables and to establish linkages between proposed nutrient thresholds and designated uses;

(2) Seasonal patterns in nutrients;

(3) Importance of other parameters on nutrient enrichment;

(4) Refinement of existing data collections;

(5) Enhancement of WDEQ's stream and river reference network; and

(6) Understanding natural sources and variability of nutrients.

### 6.4 Data Quality Objectives

Samples have been and will continue to be collected and processed in accordance with methods documented in an approved Quality Assurance Project Plan (QAPP) and associated Standard Operating Procedures (SOP). The quality assurance and quality control (QA/QC) procedures in the QAPP will include the collection and analysis of replicate water samples, adherence to calibration methods, and taxonomic verification of a subset of periphyton, phytoplankton, and benthic macroinvertebrate samples. More detailed data quality objectives (DQOs) will be developed as needed for nutrient criteria development projects. Samples will be analyzed to the lowest and most currently achievable laboratory reporting limits.

## 7.0 MILESTONES AND PROCESS FOR DEVELOPMENT AND ADOPTION OF NUMERIC NUTRIENT CRITERIA

The milestones below outline general steps for developing nutrient criteria for lakes and reservoirs and streams and rivers. Due to the complexity of developing nutrient criteria, variability among water bodies, and resource limitations, criteria development will be an ongoing and iterative process. As such, schedules may be adjusted to reflect these considerations (i.e., criteria may be refined as more data become available; criteria may be developed for a sub-category of lakes and reservoirs or streams and rivers based on data availability and analysis; criteria development may take longer than the timeframes outlined due to resource limitations).

### 7.1 Milestones for Lakes and Reservoirs

2008- Ongoing

- Inventory of existing lake and reservoir data
- Data compilation into integrated database (ongoing as more data are collected)

- Literature review for lake and reservoir nutrient criteria (ongoing as criteria are developed)

2012- Ongoing

- Increase and/or improve storage, processing, and analytical capabilities of the Water Quality Division laboratory for nutrient and response parameters
- Evaluation of existing lake and reservoir data (ongoing as data are collected)
- Design and implementation (including evaluation) of additional data collection for lakes and reservoirs (ongoing as data are collected and analyzed)
- Develop proposed lake and reservoir nutrient criteria for first sub-category of lakes with input from the Wyoming Nutrient Work Group
- Adopt proposed lake and reservoir nutrient criteria for first sub-category of lakes into water quality standards
- Develop proposed lake and reservoir nutrient criteria for second sub-category with input from the Wyoming Nutrient Work Group
- Adopt proposed lake and reservoir nutrient criteria for second sub-category of lakes into water quality standards
- Continue to develop and adopt lake and reservoir nutrient criteria

## 7.2 Milestones for Streams and Rivers

2008- Ongoing

- Inventory of existing data
- Data compilation into an integrated database (ongoing as data are collected)
- Increase and/or improve storage, processing, and analytical capabilities of the Water Quality Division laboratory for nutrient and response parameters
- Design and implementation (including evaluation) of additional data collection for streams and rivers
- Literature review for stream and river nutrient criteria (ongoing as data are collected and analyzed)
- Analysis of existing data (ongoing as data are collected)
- Develop proposed nutrient criteria for a sub-category of wadeable streams and rivers with input from the Wyoming Nutrient Work Group
- Adopt nutrient criteria for sub-category of wadeable streams and rivers with input from the Wyoming Nutrient Work Group
- Develop proposed nutrient criteria for other categories of streams and rivers with input from the Wyoming Nutrient Work Group
- Continue to develop and adopt stream and river nutrient criteria

## 7.3 General Process for Criteria Development

Although the approach for developing criteria may differ between waterbodies, once sufficient data has been collected to derive numeric nutrient criteria, WDEQ will follow the general process described below:

Phase1: Develop and refine draft numeric nutrient criteria and implementation recommendations

- Develop draft numeric nutrient criteria based on one or more of five standard approaches

- Document draft numeric nutrient criteria development and implementation recommendations within a technical support document
- Obtain external peer-review of draft numeric nutrient criteria
- Share draft numeric nutrient criteria with the Wyoming Nutrient Work Group and obtain feedback
- With Wyoming Nutrient Work Group guidance and review, finalize draft numeric nutrient criteria, statement of principal reasons, and updates to technical support document

Phase 2: Formal adoption of numeric nutrient criteria

- Initiate and follow rulemaking process (public scoping, Water and Waste Advisory Board review, Environmental Quality Council approval, Legislative Service Office review, etc.)
- Submit for Governor's signature
- Submit to EPA pursuant to the federal Clean Water Act

Phase 3: Implementation

- Develop draft methods on use of numeric nutrient criteria in assessment, permitting, TMDLs, etc., followed by nutrient criteria support group review
- Propose revision to "Wyoming's Methods for Determining Surface Water Quality Condition" and any other necessary documents, respond to comments, and make necessary changes
- Finalize "Wyoming's Methods for Determining Surface Water Quality Condition" and any other necessary documents

# 8.0 OTHER CONSIDERATIONS

## 8.1 Administrative Procedures and Processes

Adopting criteria into the Wyoming Surface WQS requires formal rulemaking, which is an involved process (see Appendix A). Numerous public meetings and hearings before the Water and Waste Advisory Board and the Environmental Quality Council (EQC) typically require more than two years before a proposed rule is finalized. After the EQC adopts the rule, it is sent to the attorney general (AG) for a letter of compliance. The AG submits the rule and letter of compliance to the governor. If he or she approves the rule, the governor signs it, and the rule package is sent to the secretary of state for certification. The rule is then formally submitted to EPA Region 8 pursuant to the federal Clean Water Act.

## 8.2 Public Participation

Public participation is a regular part of the process for development of criteria to be included in Wyoming's water quality standards (see Appendix A). The public will be encouraged to participate at various stages of standards development through mailings, newspaper notices, and by posting drafts of any changes to the standards on the WDEQ web site. The activities of the Wyoming Nutrient Work Group will also be made available to the public through these same means.

### 8.3 National and Regional Coordination

WDEQ has and will continue to participate in regional and national meetings and webinars regarding development of numeric nutrient criteria. In addition, WDEQ will continue to communicate and coordinate with EPA Region 8 staff.

### 8.4 Scientific Review

Scientific peer review will be conducted for all subsequent nutrient criteria development, as stated in the analytical approaches above. Wyoming will likely obtain assistance from EPA Region 8 and possibly arrange for a review of criteria from national nutrient experts.

### 8.5 Other Issues

The availability of resources for monitoring, lab analysis, and data analysis will affect nutrient criteria development in Wyoming. WDEQ will continue to seek support from EPA to fund some of the monitoring and data analysis. WDEQ will use EPA staff and labs as needed to collect and analyze samples. WDEQ will also want to ensure that implementation issues (such as permit limits) are addressed prior to adopting nutrient criteria into Wyoming's surface water quality standards.

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# Appendix A. WDEQ Rules Promulgation Process

Procedures for promulgating rules proposed by WDEQ are outlined in the Environmental Quality Act, Administrative Procedures Act, and WDEQ's Rules of Practice and Procedure. The process for promulgating a rule includes making the proposed rule available for public comment before advancing through the Water and Waste Advisory Board (WWAB), the Environmental Quality Council (EQC) and being signed by the governor. Below is a summary of the process that would be followed upon developing recommended numeric nutrient criteria.

All rules begin by preparing the draft rule and a statement of principal reasons (SOPR) for review and comment by the program administrator and director and may also go to the division assistant attorney general for additional consultation.

After the director approves of the draft rule and the SOPR, public outreach generally follows. An outreach document is prepared and shared with the public via WDEQ's website and listserv. The public is provided approximately 30-days to provide comments. A public meeting may be held during or after the 30-day comment period to provide an additional opportunity to comment. WDEQ will respond to the comments received and make any necessary changes to the proposal. Revisions to the rule package are then approved by the division administrator before going to the WWAB for review.

WDEQ provides notice to the public at least 30-days before the WWAB meeting. The notice is mailed, or e-mailed to each interested party, posted on the WDEQ's website, and placed in a public newspaper with state wide distribution. At the meeting, the WWAB hears WDEQ's recommended changes to the rules, takes public comment, and determines whether the recommended rule and SOPR should be advanced to the EQC or revised and brought back for additional consideration. If the WWAB recommends changes and/or additional review, comments from the public and WWAB comments are considered, the proposed rule may be modified. A new meeting is scheduled and additional public notice is given.

Once the WWAB has recommended advancing the proposed rule to the EQC, the administrator will prepare a memo to proceed with formal rule adoption. The proposed rule is then sent to the governor for consideration. After the governor's comments are incorporated into the rule, the director recommends adoption of the proposed rule to the chairman of the EQC.

The EQC will hold a public hearing to take public comments and consider the proposed rule after providing at least 45-days' notice to the public. At the end of the hearing, the EQC may choose to keep the record open for additional comments or to close the record and adopt, reject, or modify the rule and SOPR.

Upon adoption and signature of the rule and SOPR by the EQC, a final rule package is completed for review by the Legislative Services Office (LSO) and the governor. If the rule package is approved by the governor after consideration is given by the LSO, the rule package is then sent to the secretary of state's office to be filed. During this process, the governor can choose to approve the rule as submitted, veto the rule, or veto portions of the rule within 75 days from the time the director signs the certification page. The rule becomes effective after the governor signs the certification page and it is stamped by the secretary of state's office.

The entire process generally takes at least 2 years and often more than 3 years for controversial rulemakings.