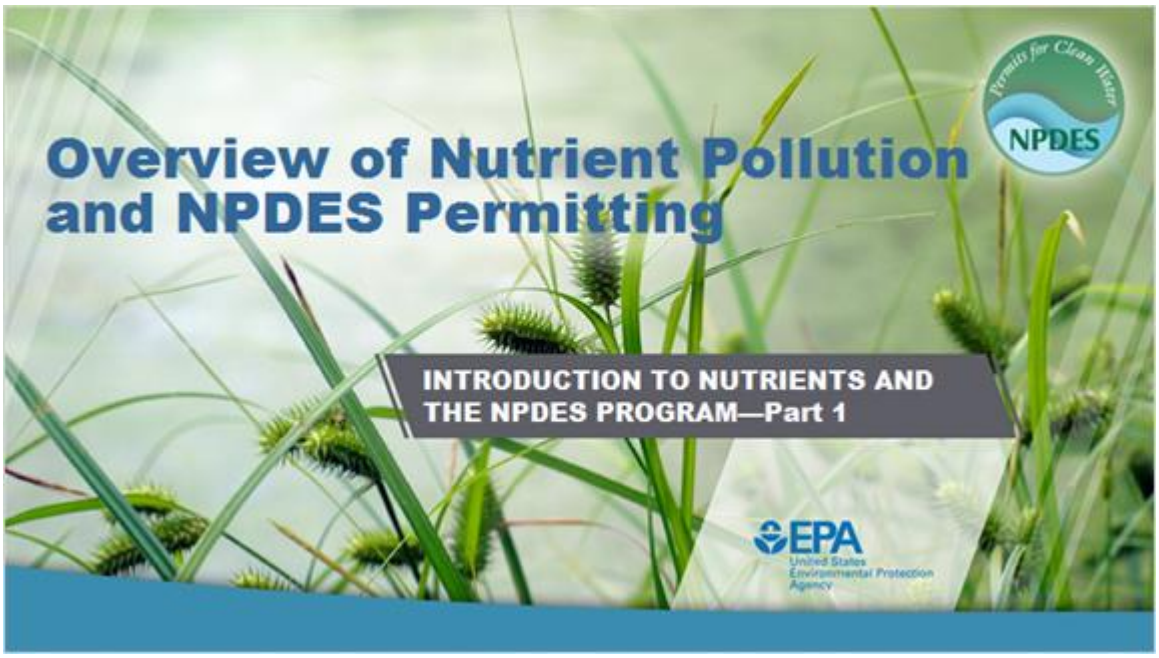
Overview of Nutrient Pollution and NPDES Permitting

1. Introduction Part 1: Overview of Nutrient Pollution and NPDES Permitting

1.1 Overview of Nutrient Pollution and NPDES Permitting



Notes:

Welcome to the National Pollutant Discharge Elimination System, or NPDES, Permit Writers' Specialty Training series on addressing nutrient pollution in NPDES permits. This training is part of an online curriculum for permit writers developed by the United States Environmental Protection Agency's Water Permits Division. It builds on the basic NPDES Permit Writers' Course, but adapts the concepts presented in that course to consider issues permit writers may face when permitting discharges of nutrients. If you have not yet completed the basic NPDES Permit Writers' Course, we strongly recommend that you do so before taking this course. An online version is available through the link in the Resources tab.

In this training, we will begin with a section that provides an overview of nutrient pollution and why it's important to address in NPDES permits.

Before we get started, I will make some introductions and address one housekeeping item.

1.2 Presenters

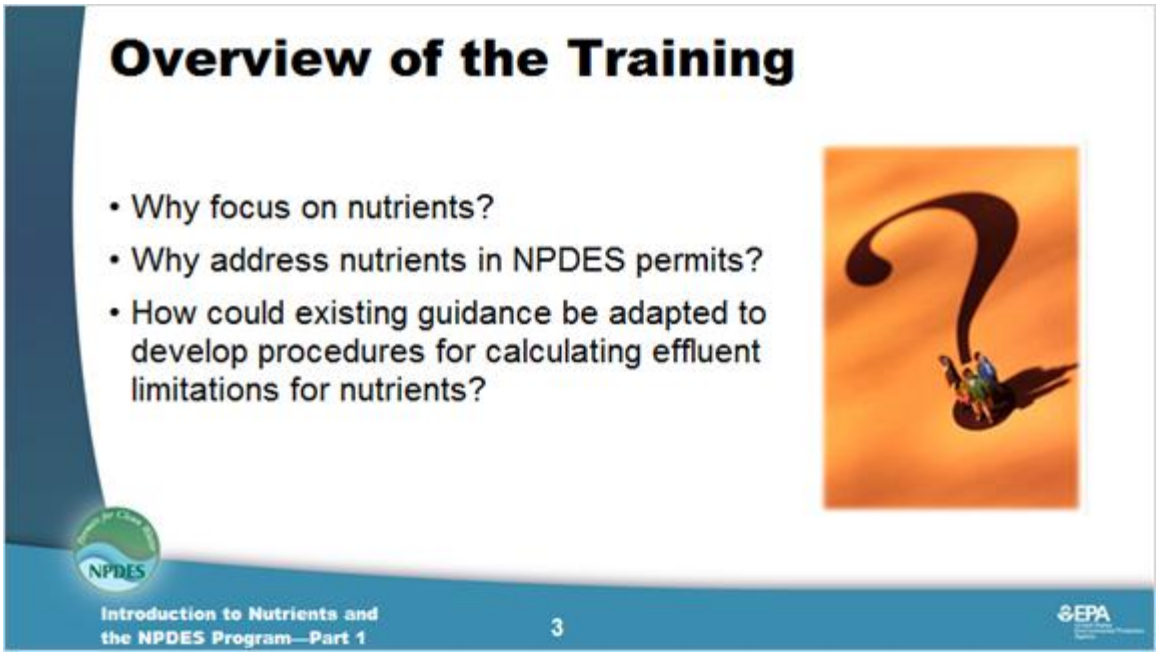
Notes:

Your speakers for this presentation are Frank Sylvester and me, Danielle Stephan. We are both with the Water Permits Division of the United States Environmental Protection Agency in Washington, DC.

With regard to that housekeeping item, I need to let you know that the materials used in this presentation have been reviewed by USEPA staff for technical accuracy; however, the views of the speakers are their own and do not necessarily reflect those of USEPA. NPDES permitting is governed by the existing requirements of the Clean Water Act and USEPA's NPDES implementing regulations. These statutory and regulatory provisions contain legally binding requirements. The information in this presentation is not binding. Furthermore, it supplements, and does not modify, existing USEPA policy, guidance, and training on NPDES permitting. USEPA may change the contents of this presentation in the future.

Now, let's get started with the presentation.

1.3 Overview of the Training



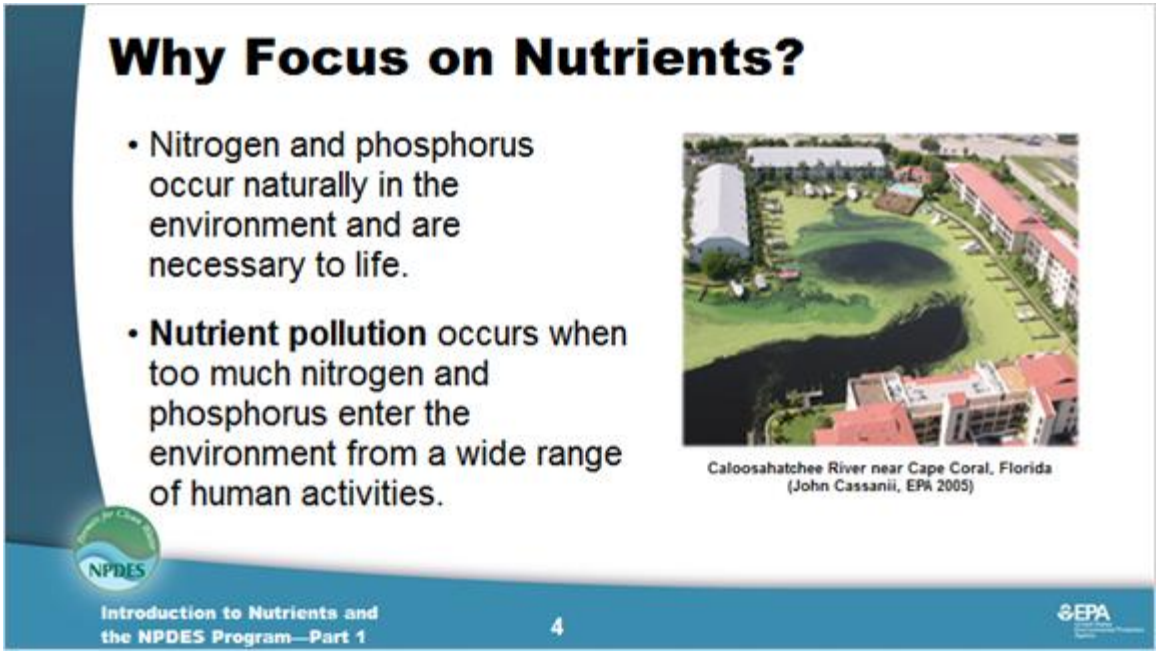
Notes:

EPA developed this training to supplement existing EPA guidance and training on the NPDES program by considering specific challenges permit writers face when developing permit requirements to address nutrient pollution.

In this introductory presentation, we are aiming to answer three questions:

- Why focus on nutrients when there are so many other pollutants to worry about?
- Why should NPDES permits address nutrient pollution problems? and
- Are there ways to adapt existing guidance that permit writers already understand and use for other pollutants to help us calculate effluent limits for nutrients?

1.4 Why Focus on Nutrients?



Notes:

The first question we want to answer is "Why is EPA focusing on nutrients?" To answer that question, we first need to consider the role that nutrients play in aquatic systems.

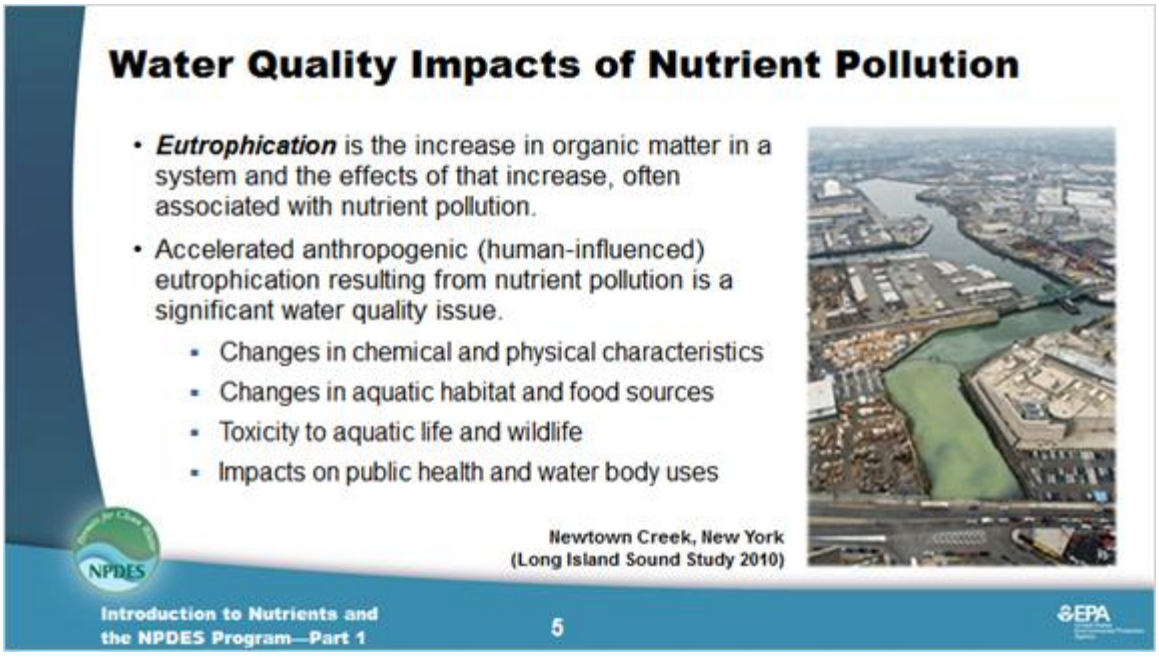
Nitrogen and phosphorus occur naturally in the environment and are necessary to life. In surface water, these nutrients support the growth of plants and algae, which produce habitat to support growth and reproduction of aquatic organisms across the food web, including fish and shellfish.

Nutrients also support decomposer organisms that are essential to breaking down organic matter and that serve as food for higher trophic levels. At natural conditions, nutrients in water bodies are not harmful and are, in fact, essential to the health and diversity of aquatic ecosystems.

When excess nitrogen and phosphorus from human activities enter surface waters, however, they can cause an imbalance in an ecosystem and lead to significant water quality degradation and related impacts. Excess nutrient loading to water bodies beyond levels needed to maintain the health of an indigenous aquatic ecosystem is commonly referred to as nutrient pollution. Nutrient pollution occurs when too much nitrogen and phosphorus enter the environment from

a wide range of human activities. The effects of nutrient pollution are diverse and far-reaching.

1.5 Water Quality Impacts of Nutrient Pollution



Notes:

Among the most significant and widespread effects of nutrient pollution are accelerated *eutrophication* and the resulting water quality and economic impacts, which have been identified as significant water quality concerns for decades.

Accelerated anthropogenic, or human-influenced, eutrophication can cause water quality impacts including:

- Changes in chemical and physical characteristics of a water body, such as lower dissolved oxygen concentrations and hypoxia;
- Changes in aquatic habitat and food sources, such as excess algae in the water column blocking sunlight needed by submerged aquatic plants;
- Toxicity to aquatic life and wildlife, including direct toxic impacts of some forms of nitrogen or from toxic algal blooms;
- Impacts on public health, such as impacts from seafood contamination or direct

exposure to algal toxins; and

- Impacts on water body uses, such as recreational uses.

1.6 Assessing Water Quality Impacts of Nutrient Pollution

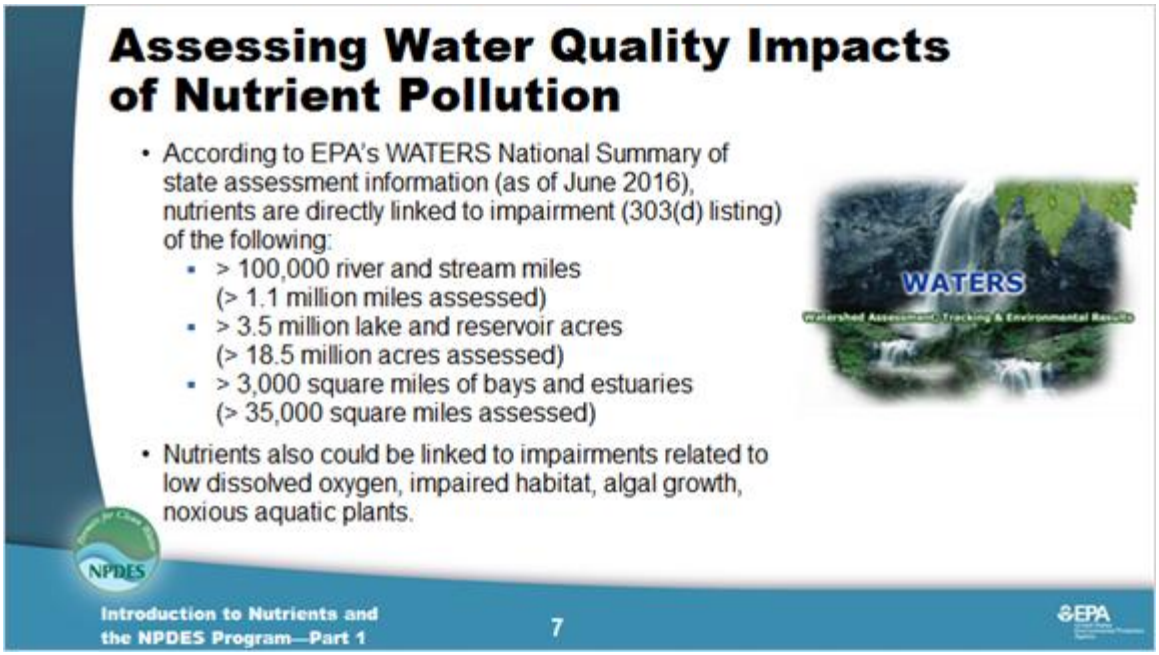
Notes:

Nitrogen and phosphorus are transported to water bodies through direct discharges and surface runoff. Once in a water body, nitrogen or phosphorus can occur as dissolved organic, dissolved inorganic or particulate forms with transformations occurring among these forms.

Because nutrients cycle among various forms, nitrogen and phosphorus pollution in water bodies generally is measured in terms of total nitrogen and total phosphorus. When speaking of nutrients and nutrient pollution in water bodies, we will refer to total nitrogen and total phosphorus as *causal variables*. These causal variables are related to *response variables*, such as algal biomass as chlorophyll *a*, dissolved oxygen, and turbidity or transparency.

Both causal variables and response variables are measured as indicators of nutrient pollution and are widely used to evaluate the degree of eutrophication and associated water quality impacts in various types of water bodies.

1.7 Assessing Water Quality Impacts of Nutrient Pollution

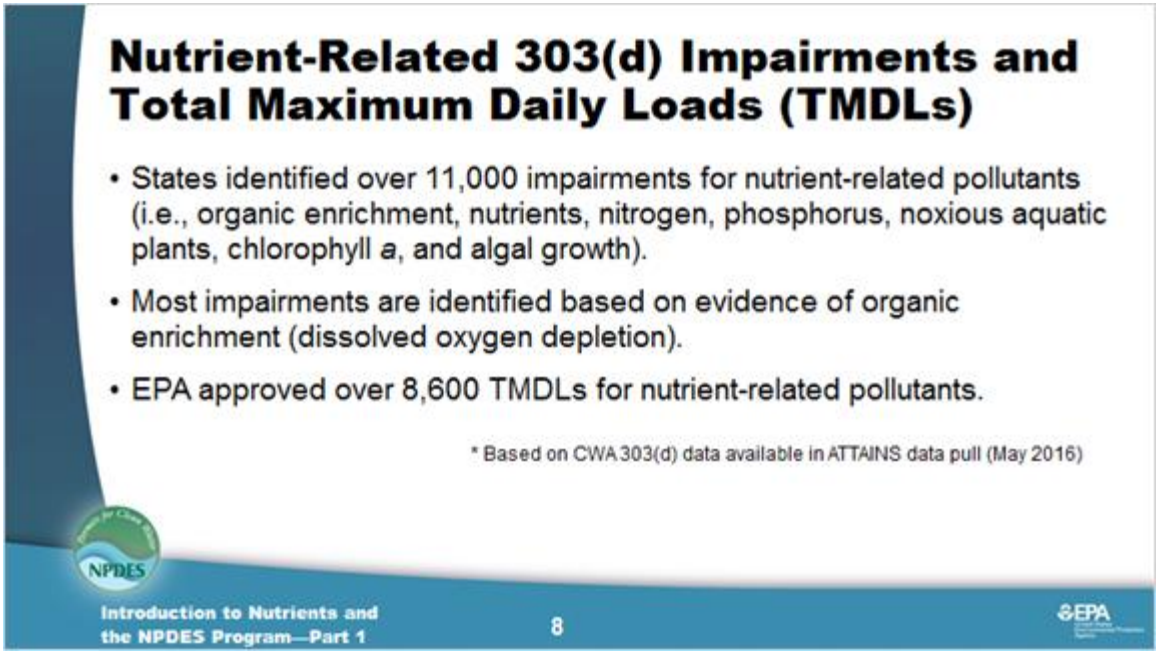


Notes:

Several sources of information point to the water quality impacts of eutrophication nationwide. The first example we will highlight in this presentation is EPA's national summary of state water quality assessment data. These data show that, for assessed waters, nutrients are directly linked to more than 100,000 impaired river and stream miles, more than 3.5 million impaired lake or reservoir acres, and more than 3,000 impaired square miles of bays and estuaries.

Nutrients also could be linked to additional impairments related to low dissolved oxygen, impaired habitat, algal growth, and noxious aquatic plants.

1.8 Nutrient-Related 303(d) Impairments and Total Maximum Daily Loads (TMDLs)



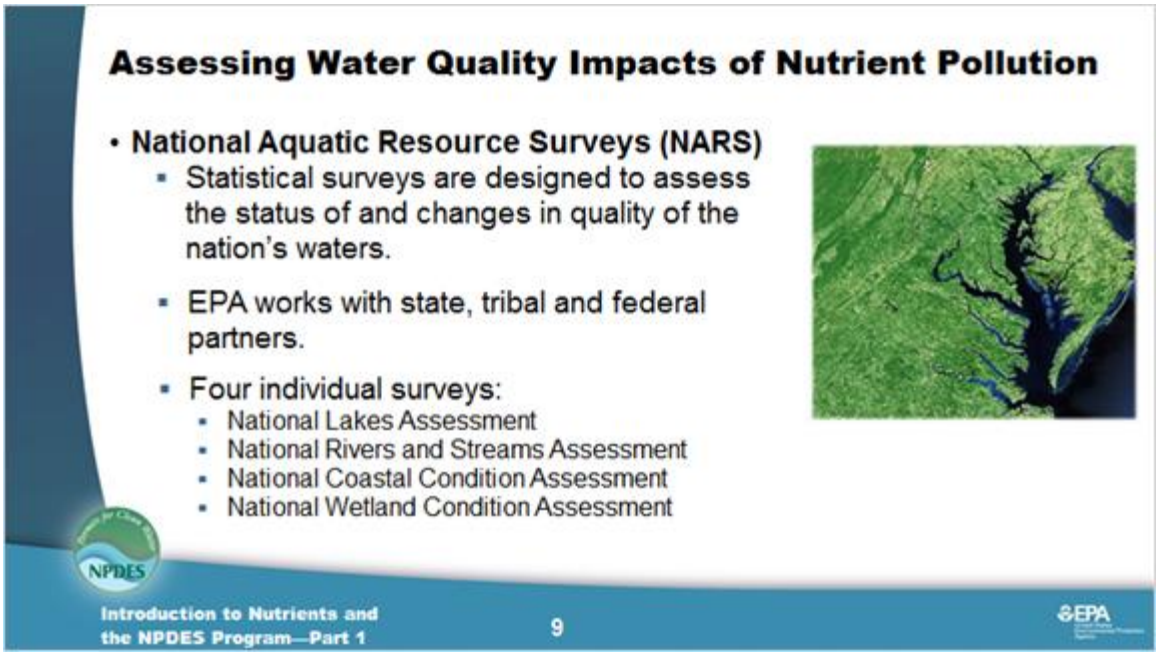
Notes:

Another indication of the extent of the water quality impacts of nutrient pollution is the Clean Water Act 303(d) list. Under section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. Impaired waters are waters that do not meet the water quality standards set for them, even after point sources of pollution have installed the minimum required levels of pollution control technology.

The law requires that the responsible jurisdictions establish priority rankings for waters on their 303(d) lists and develop total maximum daily loads, or TMDLs, for these waters. A TMDL is a calculation of the maximum amount of a single pollutant that a water body can receive and still meet water quality standards and an allocation of that amount to the pollutant's sources, plus a margin of safety.

As of May 2016, states had identified over 11,000 impairments for nutrient related pollutants, largely based on evidence of organic enrichment. In addition, EPA had approved over 8,600 TMDLs developed for nutrient-related pollutants.

1.9 Assessing Water Quality Impacts of Nutrient Pollution



Notes:

The National Aquatic Resource Surveys, or NARS, are statistical surveys designed to assess the status of and changes in quality of the nation's coastal waters, lakes and reservoirs, rivers and streams, and wetlands. Using sample sites selected at random, these surveys provide a snapshot of the overall condition of the water. Because these surveys use standardized field and lab methods, we can compare results from different parts of the country and over time.

EPA works with state, tribal and federal partners to design and implement the NARS.

The surveys evaluate a suite of physical, biological, and chemical indicators, including nitrogen and phosphorus, to assess biological integrity, trophic state, recreational suitability, and key stressors impacting water quality.

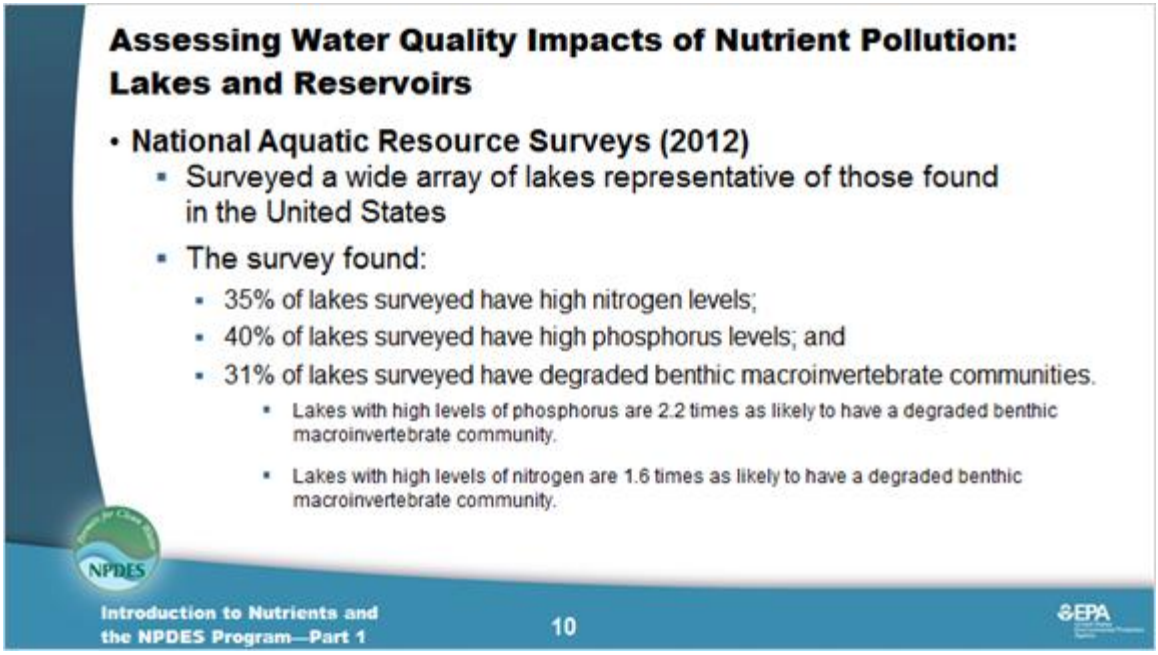
The NARS are made up of four individual surveys that are implemented on a rotating basis, including:

- The National Lakes Assessment,
- The National Rivers and Streams Assessment,
- The National Coastal Condition Assessment, and

- The National Wetland Condition Assessment.

Let's look at the results of a couple of these studies in more detail.

1.10 Assessing Water Quality Impacts of Nutrient Pollution: Lakes and Reservoirs



Notes:

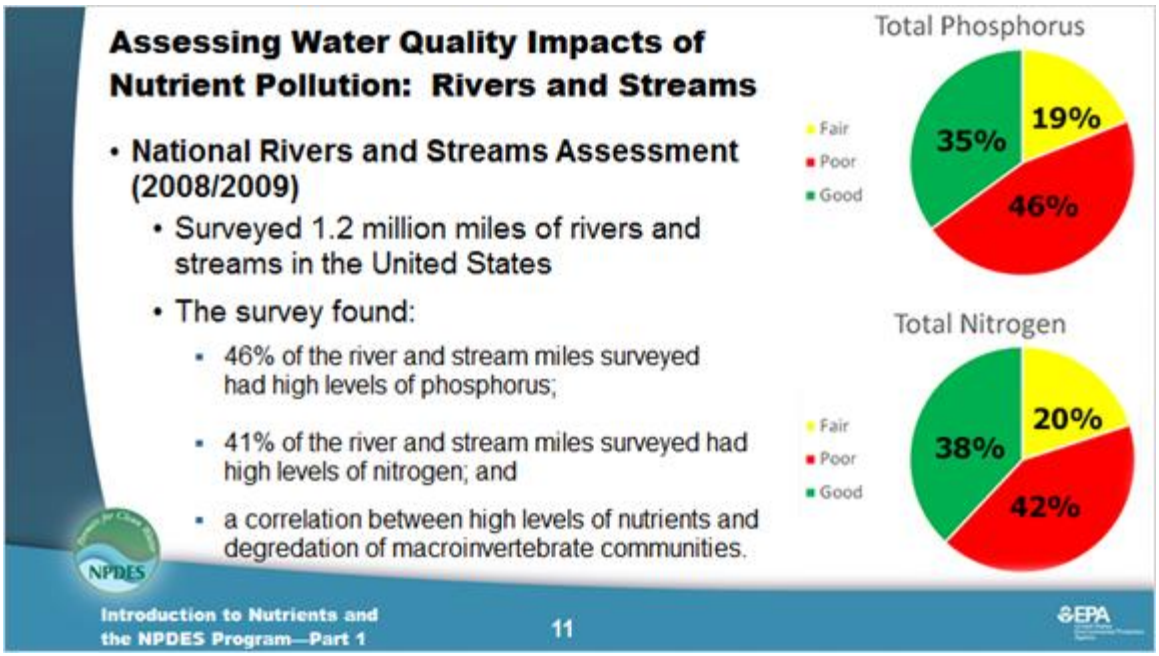
The National Lakes Assessment is a statistical survey of the condition of our nation's lakes, ponds, and reservoirs. It is designed to provide information on the extent of lakes that support healthy biological condition and recreation. It also estimates how widespread major stressors are that impact lake quality. Finally, it provides insight into whether lakes nationwide are getting cleaner.

According to the 2012 assessment, survey results showed that about 35 percent of lakes surveyed in the United States have high levels of nitrogen, 40 percent have high levels of phosphorus, and 31 percent have degraded benthic macroinvertebrate communities.

Analyses also show an association between nutrients and the biological condition of lakes. Those with high levels of phosphorus are 2.2 times more likely to have a degraded benthic macroinvertebrate community. Those with high levels of nitrogen are 1.6 times more likely to

have a degraded benthic macroinvertebrate community.

1.11 Assessing Water Quality Impacts of Nutrient Pollution: Rivers and Streams



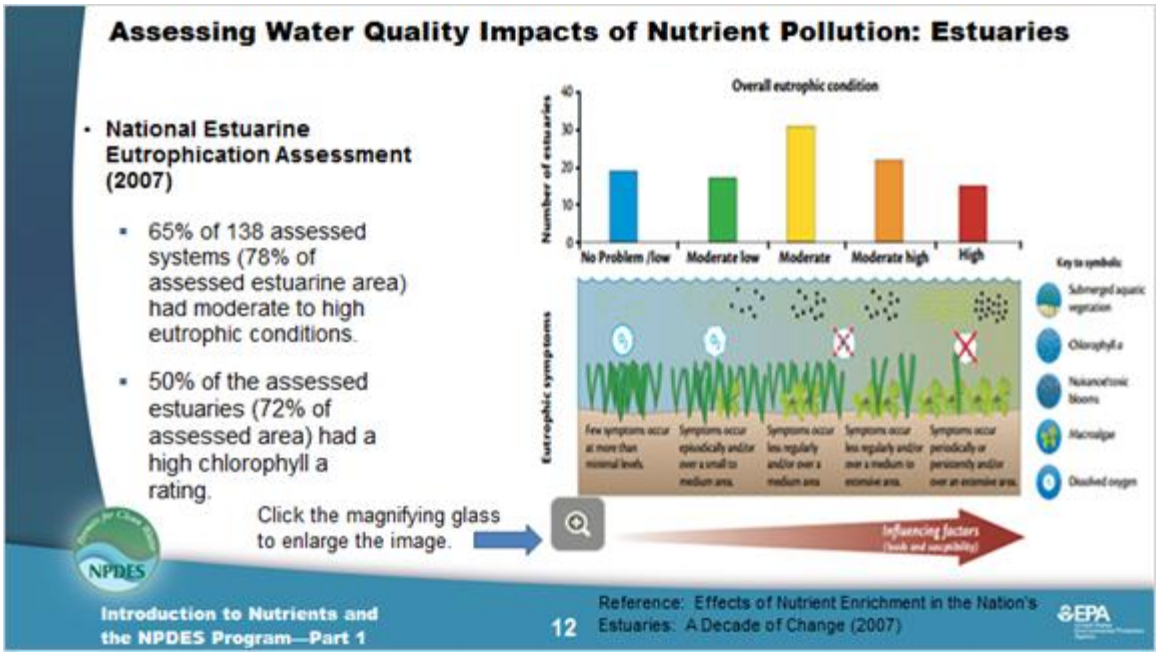
Notes:

The National Rivers and Streams Assessment is another assessment in the NARS series. This study provides information on the ecological condition of the nation's rivers and streams and the key stressors that affect them, both on a national and ecoregional scale. 1.2 million miles of rivers and streams in the U.S., from the largest river to the smallest headwater stream were surveyed.

In the 2009 study, excess nutrients and poor habitat were found to be widespread problems in the rivers and streams across the country. The study showed that over 40 percent of the river and stream miles surveyed had levels of nutrients that were too high.

Like the 2012 lakes assessment, the study also found a correlation between high levels of nutrients in rivers and streams and degradation of the macroinvertebrate communities. Rivers and streams with high levels of nutrients and streambed sediments were about twice as likely to have poor macroinvertebrate communities.

1.12 Assessing Water Quality Impacts of Nutrient Pollution: Estuaries



Notes:

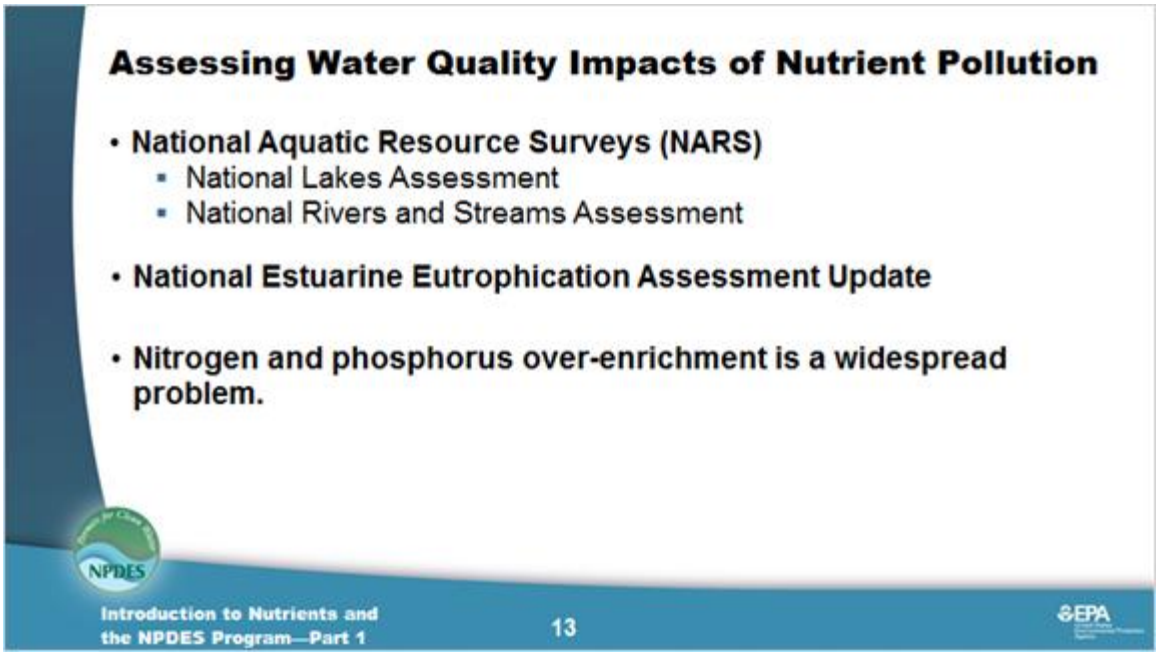
The National Estuarine Eutrophication Assessment describes the scale, scope, and characteristics of nutrient enrichment and eutrophic conditions in the nation's estuaries. This national-level study was first released in 1999 and updated in 2007 to look at changes that occurred in the past decade related to nutrient pollution. This assessment evaluated the following for each estuary:

- influencing factors, for example, land use and nutrient loads;
- overall eutrophic condition;
- extent of dissolved oxygen problems;
- loss of submerged aquatic vegetation; and
- the future outlook.

The study showed that 65 percent of the 138 systems assessed had moderate to high overall eutrophic conditions. The most common symptoms of eutrophication were high spatial coverage and frequency of elevated chlorophyll a, with 50 percent of the assessed estuaries having a high chlorophyll a *r*ating.

Survey participants predicted worsening conditions by 2020 in 65% of the estuaries.

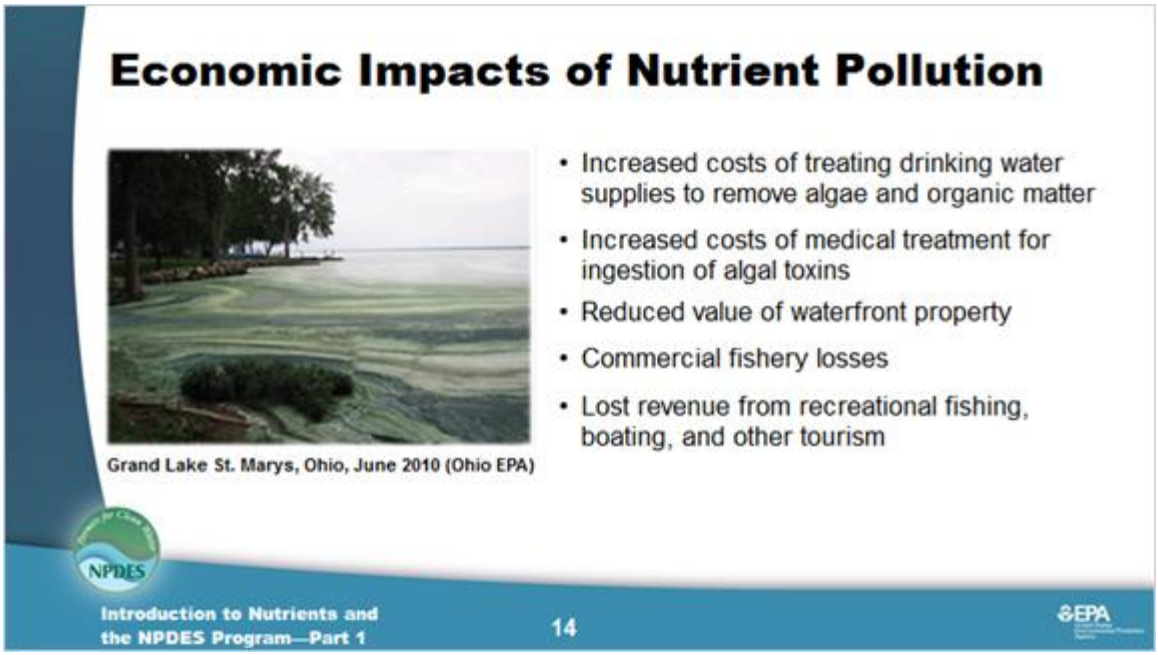
1.13 Assessing Water Quality Impacts of Nutrient Pollution



Notes:

As these three assessments indicate, nitrogen and phosphorus over-enrichment is a widespread problem. Eutrophication and its associated water quality impacts affect various types of water bodies, from small streams to large bays and estuaries, and are present in waters throughout the nation.

1.14 Economic Impacts of Nutrient Pollution



Notes:

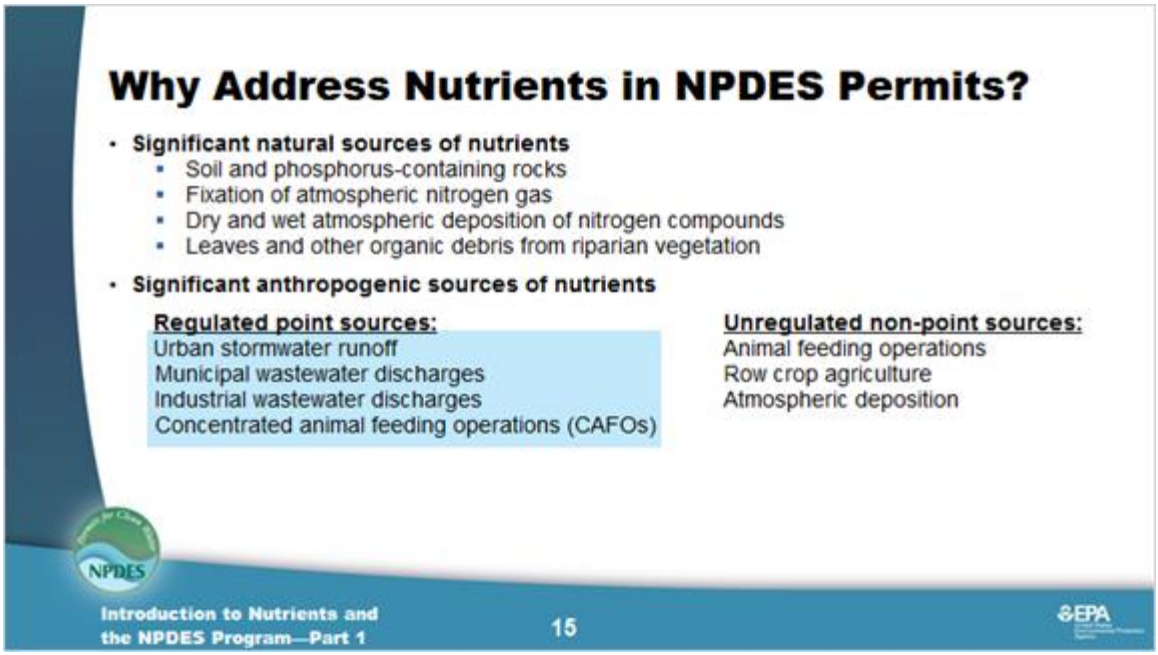
The ecosystem effects of nutrient pollution ultimately can result in economic impacts to communities dependent on the affected water resources.

Eutrophication can lead to reactive costs, such as the costs of treating drinking water supplies to remove algae and organic matter and the costs of providing medical treatment for humans who ingest toxics produced by harmful algal blooms.

Algal blooms can also lead to reduced property values for lakefront areas, commercial fishery losses, and lost revenue from recreational fishing, boating, and other tourism business. For example, the photograph on the slide depicts a rapidly occurring, severe algal bloom in Grand Lake St. Marys, Ohio. In June 2010, the event decimated the area's $150 million lake-based recreation and tourism industry.

Now I'll turn it over to Frank to talk to us about the implications for NPDES permitting.

1.15 Why Address Nutrients in NPDES Permits?



Notes:

Thanks, Danielle. That brings us to the second question we set out to answer in this presentation: "Why address nutrients in NPDES permits?"

We know that sources of nutrients present in water bodies are both natural and anthropogenic. Soil and, ultimately, phosphorus-containing rocks are the most significant natural sources of phosphorus in surface waters. Significant natural sources of nitrogen include fixation of nitrogen gas, dry and wet deposition of nitrogen compounds from the atmosphere, and leaves and other organic debris from riparian vegetation.

Human-induced nutrient pollution comes from a number of sources. Four of these sources are point sources that are addressed by NPDES permits. These four sources are:

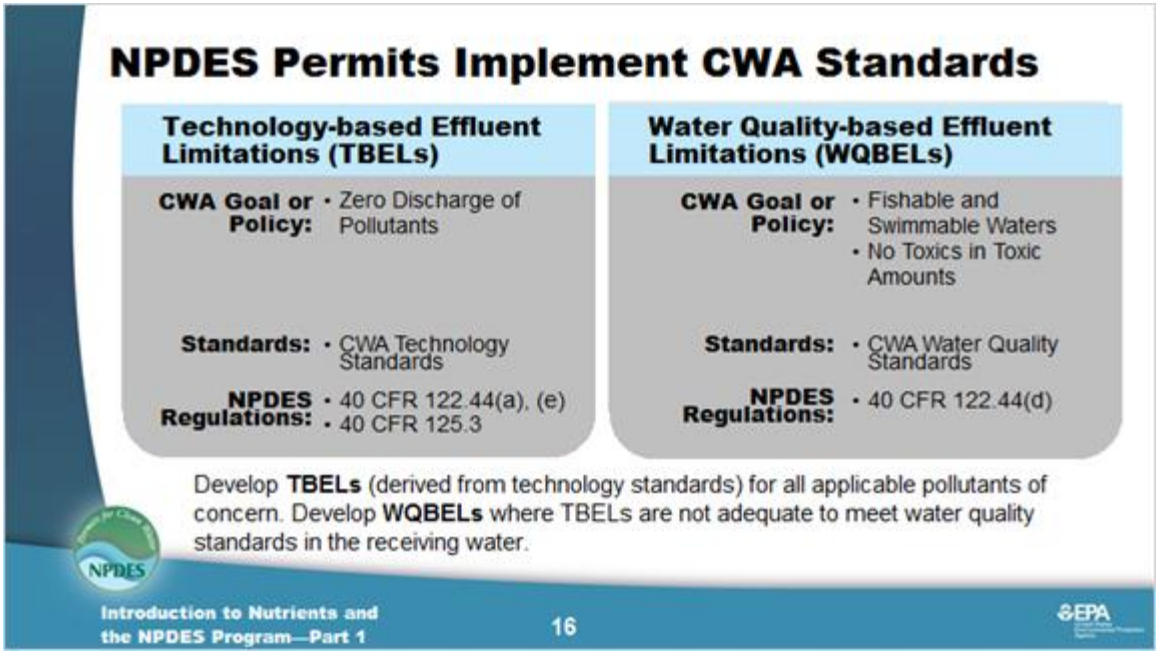
- Urban areas and their impervious surfaces, which produce a large amount of runoff. Urban stormwater runoff contains nitrogen and phosphorus from fertilizers (especially those applied in excess or before a storm), yard clippings, leaves, and pet wastes that are washed away to local water bodies or conveyed through storm sewer systems.
- Municipal wastewater discharges, which process billions of gallons of wastewater every day. Municipal wastewater contains nitrogen and phosphorus from human waste, food,

and certain soaps and detergents.

- Wastewater discharges from industrial facilities, such as food processing and fertilizer manufacturing facilities.
- Concentrated animal feeding operations, which are sources of nutrients from animal waste and from gaseous, nitrogen-based compounds like ammonia and nitrogen oxides that can be deposited to surface waters.

Because these are often significant sources of nutrient discharges to water bodies, NPDES permitting plays an important role in reducing the impacts of nutrient pollution. This presentation focuses on addressing nutrients from municipal and industrial wastewater discharges, but the concepts from this presentation may also be appropriate for other applications.

1.16 NPDES Permits Implement CWA Standards



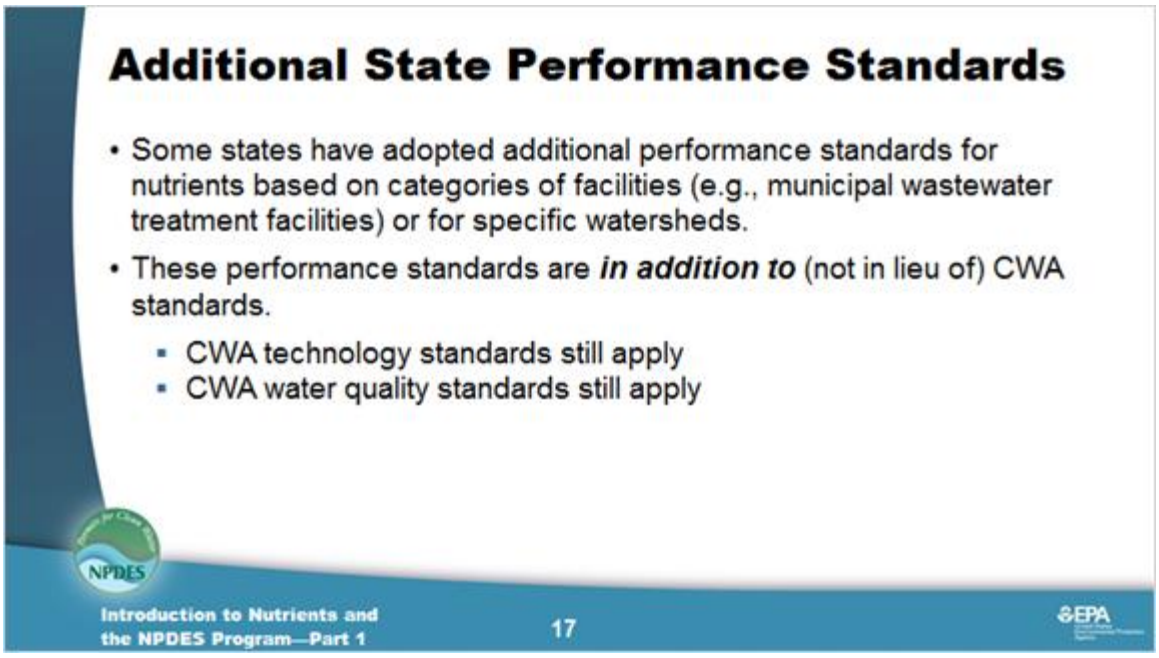
Notes:

Addressing nutrient pollution through NPDES permits means, in part, including effluent limitations as needed to implement Clean Water Act standards. When developing effluent limitations for an NPDES permit, a permit writer must consider both:

- Limitations based on technology standards that account for technologies available to remove the pollutants from the discharge, called technology-based effluent limitations, or TBELs, and
- Limitations that are derived from and comply with the applicable water quality standards for the receiving water, called water quality-based effluent limitations, or WQBELs.

Permit writers develop technology-based effluent limitations derived from technology standards for nutrients, where such standards apply, and develop water quality-based effluent limitations where the technology-based effluent limits are not adequate to meet water quality standards in the receiving water.

1.17 Additional State Performance Standards



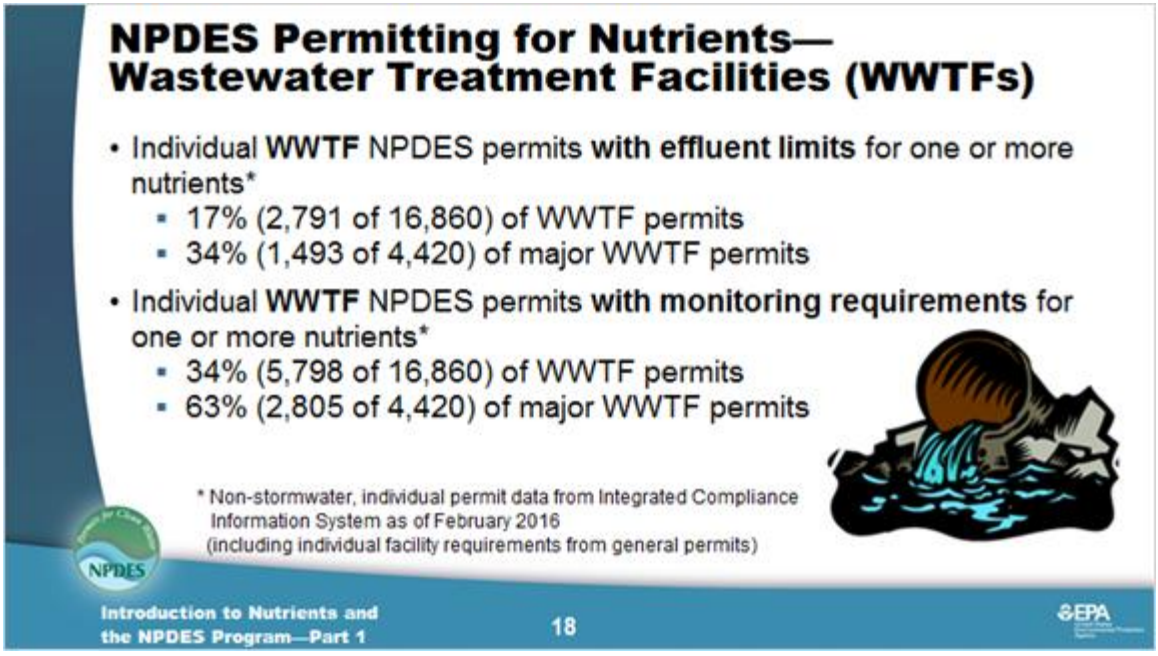
Notes:

As we will discuss in a later presentation, there are few Clean Water Act technology standards for nutrients. As a result, some states have adopted additional performance-based standards for nutrients that they apply in NPDES permits. These performance standards might apply to certain categories or classes of facilities, for example, wastewater treatment facilities, or apply to facilities in specific watersheds, such as facilities discharging to water bodies that are tributaries to a certain lake.

These state performance standards for nutrients are similar to and supplement the minimum technology-based requirements of the Clean Water Act. They often are associated with protection of specific water bodies or types of water bodies; yet, they are separate from the state's water quality standards.

Implementing state performance standards is in addition to implementing Clean Water Act technology standards and water quality standards and does not take the place of implementing the Clean Water Act standards.

1.18 NPDES Permitting for Nutrients—Wastewater Treatment Facilities (WWTFs)



Notes:

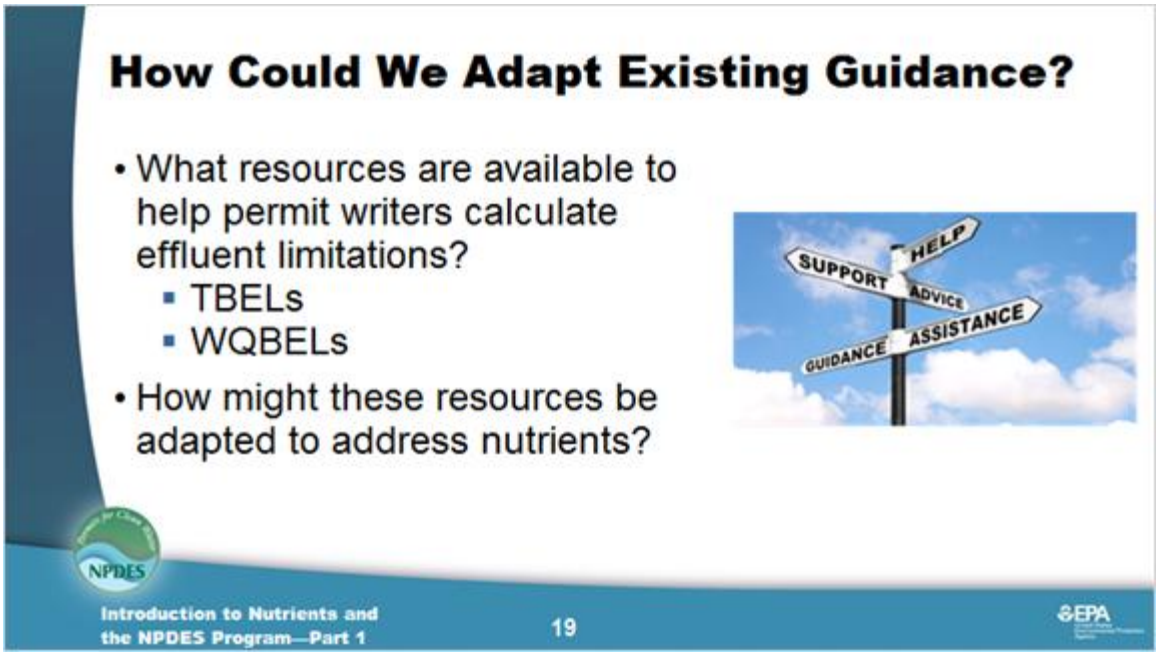
On the previous slide we introduced the types of standards that may apply to NPDES-permitted facilities. So, how many NPDES permits have requirements for nutrients?

Wastewater treatment facilities are one category of NPDES permitted facilities where we would expect to find discharges of nutrients. This slide summarizes data on the number of NPDES permits for wastewater treatment facilities that include effluent limits and monitoring requirements for nutrients.

Based on data collected from the EPA's Integrated Compliance Information System, as of February 2016, about 17% of all individual permits for wastewater treatment facilities and 34% of individual permits for major facilities, which generally are those with a design flow of one million gallons per day or greater, have limits for at least one nutrient.

Also, 34% of all individual NPDES permits and 63% of individual permits for major facilities have monitoring requirements for at least one nutrient.

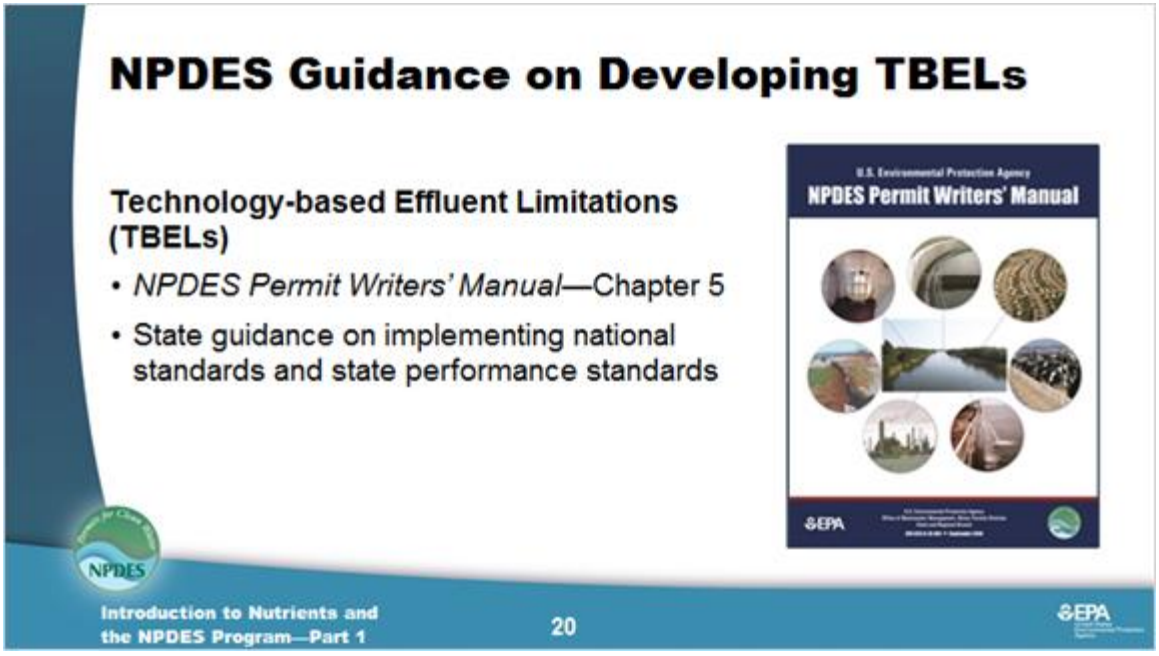
1.19 How Could We Adapt Existing Guidance?



Notes:

That leads us to our third and final question: "How could existing NPDES permitting guidance be adapted to help us calculate effluent limitations for nutrients?" As permit writers consider how to develop effluent limitations for nutrients in NPDES permits, what resources are available to help?

1.20 NPDES Guidance on Developing TBELs

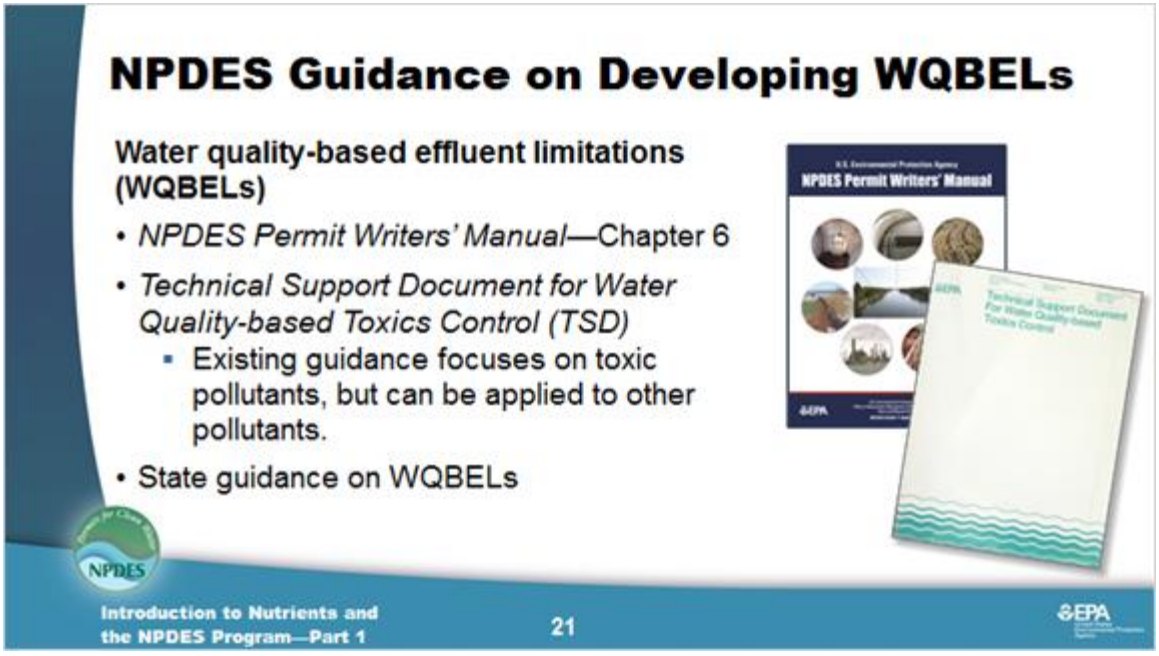


Notes:

EPA has existing NPDES permitting guidance, such as the *NPDES Permit Writers' Manual*. Chapter 5 of this manual provides guidance on developing technology-based effluent limitations that apply to any type of pollutant, including nutrients.

States might also have their own guidance, especially for addressing state performance standards.

1.21 NPDES Guidance on Developing WQBELs



Notes:

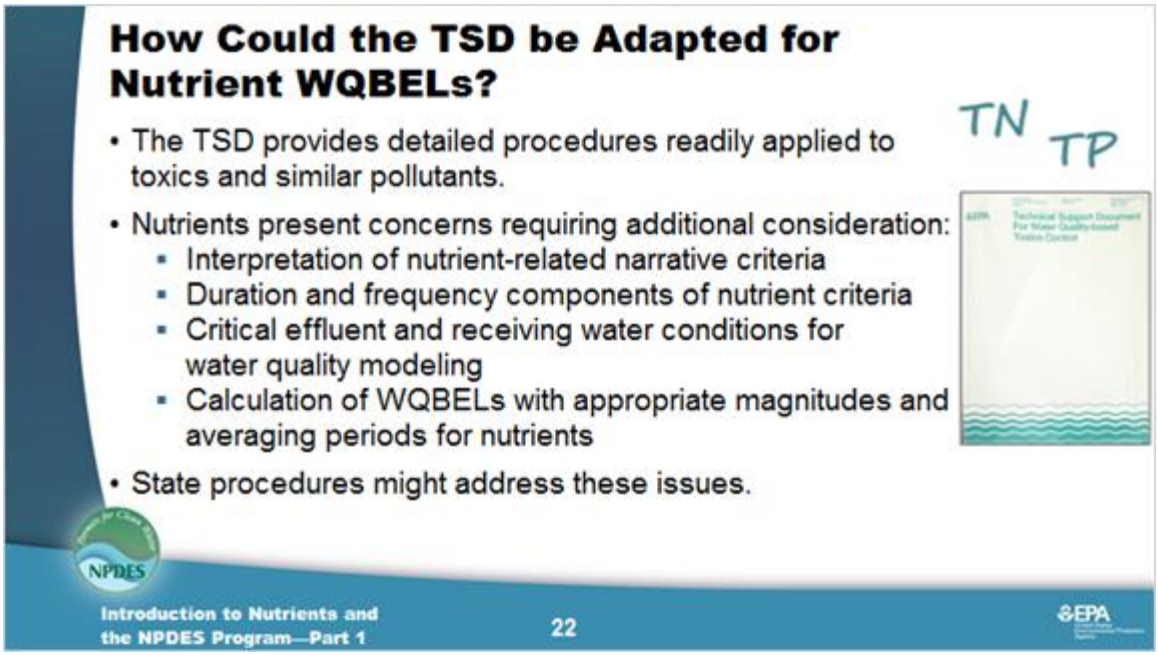
In addition, Chapter 6 of the *NPDES Permit Writers' Manual* presents steps for implementing water quality standards through water quality-based effluent limitations. These are the same basic steps that we are presenting in this training, only here we are specifically considering how they apply to nutrients. Chapter 6 also refers the reader to more detailed EPA guidance in EPA's *Technical Support Document for Water Quality-based Toxics Control* (or the TSD for short).

EPA developed the TSD in 1991 specifically to address control of toxic pollutants. The TSD provides detailed procedures for predicting water quality effects from point source dischargers and calculating NPDES permit limits for toxic pollutants. In addition to toxic pollutants, these procedures often are applied to other pollutants that exhibit similar characteristics over a similar temporal and spatial scale of concern. For such pollutants, water quality-based effluent limitations are written primarily to address impacts on the receiving water in the vicinity of the discharge, rather than farther downstream.

Many states have developed their own procedures for water quality-based permitting and include those procedures in regulations, policies, guidance, or their water quality management plans. State procedures often rely on the same basic approach established in the TSD with a few

modifications.

1.22 How Could the TSD be Adapted for Nutrient WQBELs?



Notes:

As we have noted, the process of determining the need for and calculating water quality-based effluent limitations for nutrients presents unique issues that are not comprehensively addressed by the TSD or other existing EPA national guidance.

Several of these issues can hamper progress in developing water quality-based effluent limits for nutrients. Such issues include:

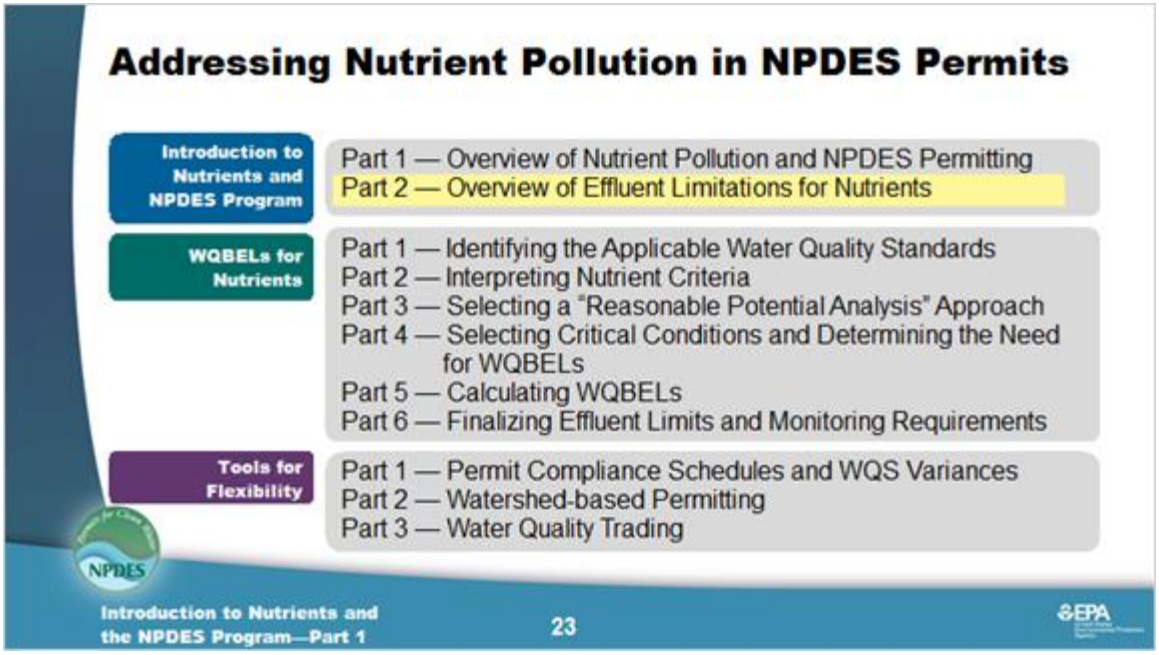
- Interpretation of nutrient-related narrative criteria when numeric criteria for nitrogen and phosphorus are not included in state water quality standards;
- Lack of clarity in state water quality standards concerning the appropriate duration and frequency of concern for implementing nutrient criteria;
- Lack of guidance on critical effluent and receiving water conditions for analyzing the impact of nutrient discharges; and
- The absence of methods for calculating water quality-based effluent limits for nutrients

that address the potential for both short-term, near-field effects and long-term, downstream impacts.

In this training, we will consider how the procedures in the TSD might be adapted to provide tools for developing water quality-based effluent limitations for nutrients. Of course, in states that already have procedures for nutrients, permit writers should follow them. In parts of this training, we will highlight some of the approaches taken by states and EPA Regions to address the complex permitting issues associated with nutrients.

For states that have not developed procedures specifically for nutrients, the concepts presented here provide some considerations for how they might think about adapting existing procedures when developing requirements for nitrogen and phosphorus.

1.23 Addressing Nutrient Pollution in NPDES Permits



Notes:

As we conclude this presentation, let's take a look at the outline of the training and where we will go from here.

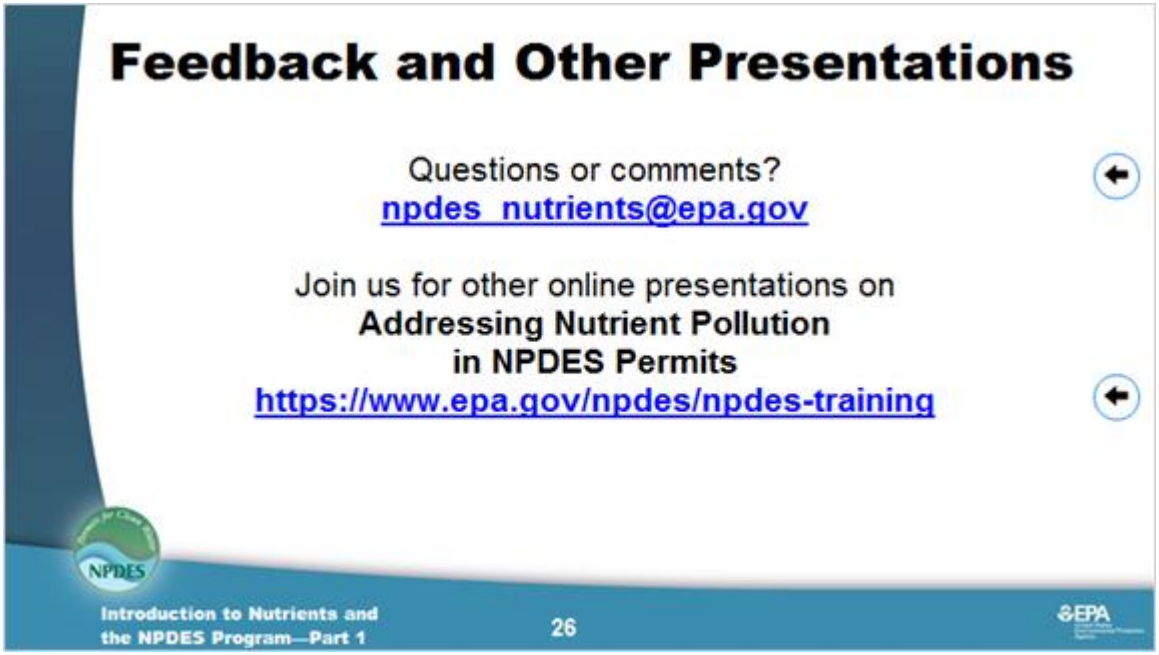
A second presentation in this introductory section of the training will provide an overview of effluent limitations for nutrients in NPDES permits.

In a six-part section on water quality-based effluent limitations for nutrients, we will take a much more detailed look at the process for developing water quality-based limits and special conditions for addressing nutrients. We also consider issues related to determining the final effluent limitations for a permit and establishing monitoring and reporting requirements.

Our final section of the training looks at several tools for flexibility, including permit compliance schedules and water quality standards variances, watershed-based permitting, and water quality trading.

We hope that you will join us for these other presentations.

1.31 Feedback and Other Presentations



Notes:

Congratulations on completing the quiz and this presentation!

If you have any questions or comments on this presentation or any part of this training curriculum, you can send an email to npdes_nutrients@epa.gov.

Remember, you will find all NPDES online training presentations under the "Training" section of USEPA's NPDES website.

Thanks again for joining us!