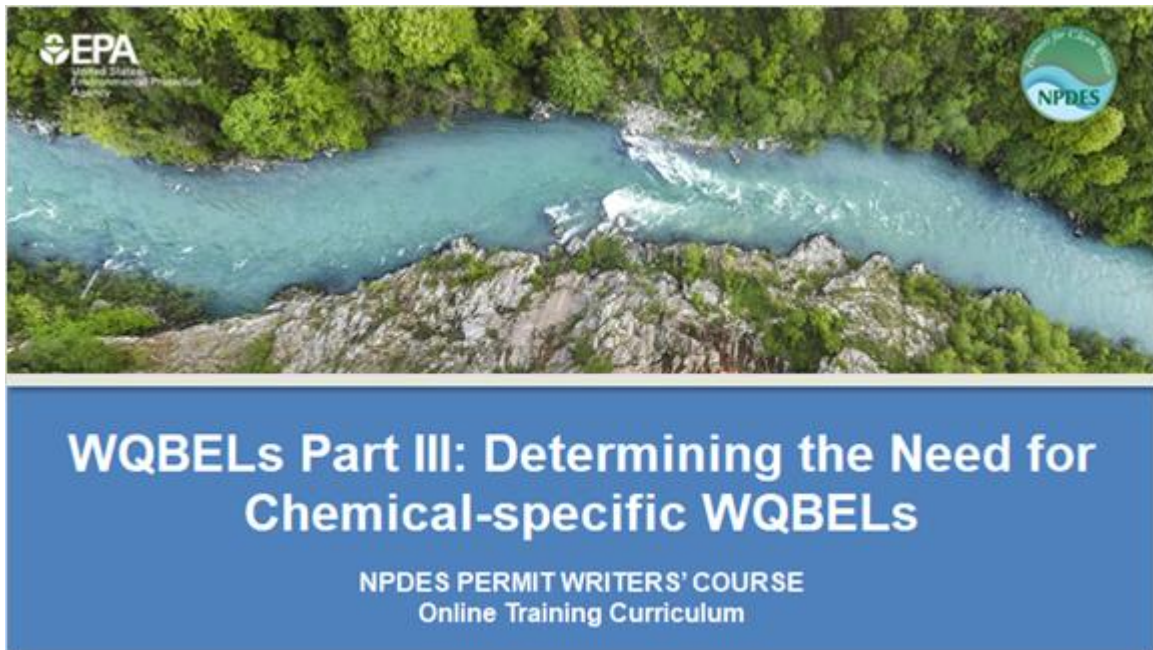


WQBELs Part III: Determining the Need for Chemical-specific WQBELs

1. NPDES Permit Writers' Course Online Training Curriculum

1.1 WQBELs Part III: Determining the Need for Chemical-specific WQBELs



Notes:

Welcome to this presentation on the Scope and Regulatory Framework of the NPDES Program. This presentation is part of a Web-based training series on the NPDES program sponsored by the Environmental Protection Agency's Water Permits Division.

You can view this as a stand-alone presentation, or, if you have not already done so, you might be interested in also viewing the first presentation in the series, which provides an overview of the Clean Water Act and the statutory history of the NPDES program.

Before we get started with this presentation, I'll make some introductions and cover one important housekeeping item.

1.2 Presenters



Presenters

- **David Hair**
Environmental Engineer
US Environmental Protection Agency
Washington, DC
- **Greg Currey**
Environmental Engineer
Tetra Tech, Incorporated
Fairfax, Virginia



Notes:

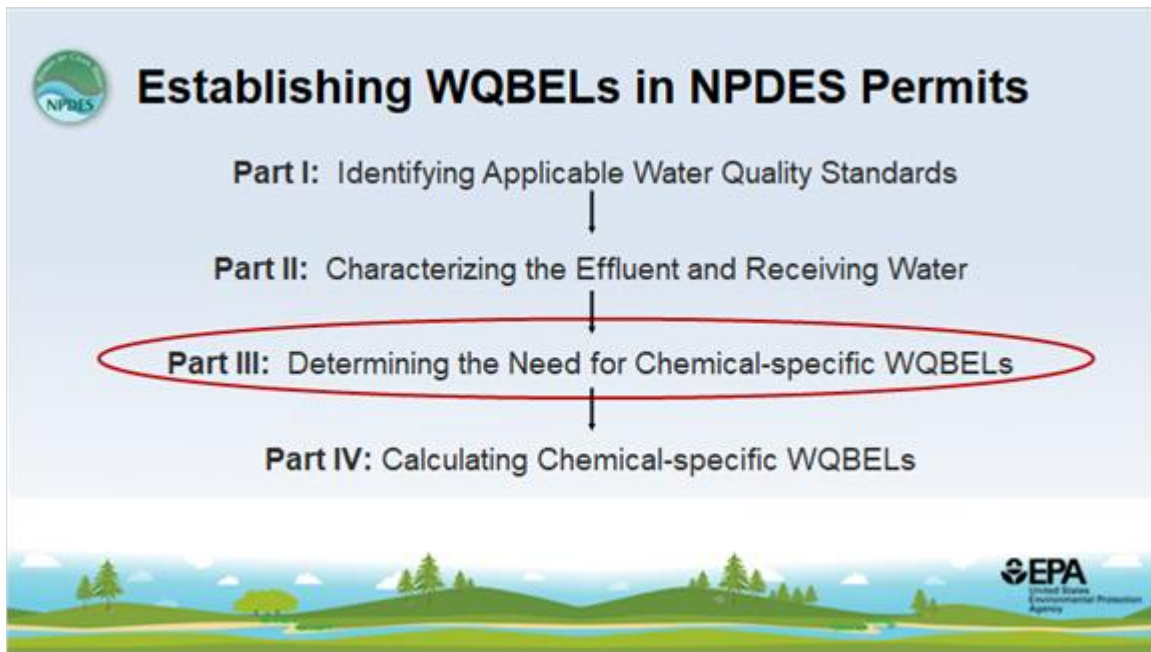
First the introductions.

Your speakers for this presentation are David Hair, an environmental engineer with the Water Permits Division of USEPA in Washington, DC, and me, Greg Currey, an environmental engineer with Tetra Tech, Incorporated in Fairfax, Virginia.

Now for that housekeeping item. You should be aware 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 begin.

1.3 Establishing WQBELs in NPDES Permits



Notes:

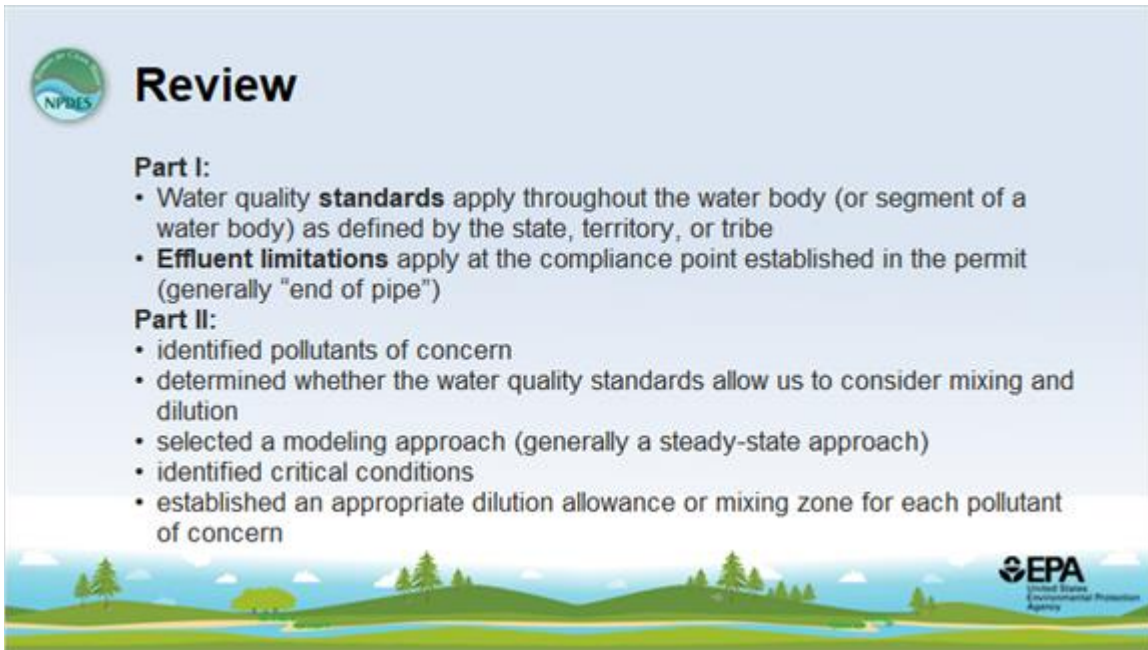
As I already mentioned, this presentation is Part III of a four-part series on establishing water quality-based effluent limitations in NPDES permits.

So, let's start with a brief review some of the important concepts that we learned in Parts I and II of this series. If you're not familiar with these topics and issues, we highly recommend that you complete Parts I and II before continuing with this presentation.

You can find them on the "Training and Meetings" page of USEPA's NPDES Web site.

It's all yours, Dave.

1.4 Review



The slide features a light blue background with a white horizontal band at the bottom. On the left, there is a circular logo with a green and blue design and the text 'NPDES'. To the right of the logo is the word 'Review' in a large, bold, black font. Below the title, there are two sections: 'Part I:' and 'Part II:'. 'Part I:' contains two bullet points: 'Water quality standards apply throughout the water body (or segment of a water body) as defined by the state, territory, or tribe' and 'Effluent limitations apply at the compliance point established in the permit (generally "end of pipe")'. 'Part II:' contains four bullet points: 'identified pollutants of concern', 'determined whether the water quality standards allow us to consider mixing and dilution', 'selected a modeling approach (generally a steady-state approach)', and 'identified critical conditions'. Below the text, there is a decorative landscape illustration with green hills, trees, and a blue sky. In the bottom right corner of the slide, the EPA logo is visible, with the text 'EPA United States Environmental Protection Agency'.

Review

Part I:

- Water quality **standards** apply throughout the water body (or segment of a water body) as defined by the state, territory, or tribe
- **Effluent limitations** apply at the compliance point established in the permit (generally "end of pipe")

Part II:

- identified pollutants of concern
- determined whether the water quality standards allow us to consider mixing and dilution
- selected a modeling approach (generally a steady-state approach)
- identified critical conditions
- established an appropriate dilution allowance or mixing zone for each pollutant of concern

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Notes:

Thanks, Greg.

In Part I of our series on water quality-based effluent limitations, we looked at how we identify the water quality standards that we implement through NPDES permits.

One of the important concepts that we need to remember is the relationship between water quality standards and effluent limitations. Water quality standards are developed and adopted by a state, territory, or tribe and define the designated uses of a waterbody, the criteria necessary to support those uses, and an antidegradation policy. These water quality standards apply throughout the water body as defined by the State, territory or tribe.

Water quality-based effluent limitations, on the other hand, apply at the compliance point for a point source discharge, which is usually the point where the discharge enters the receiving water.

We often refer to this location as the "end of pipe." Thus, the permit writer will need a process for predicting how the point source discharge will interact with and affect the quality of the receiving water in order to see if the applicable water quality standards are met.

In Part II of this training series, we reviewed the process for characterizing the effluent and receiving water.

The first step in this process identified the pollutants of concern, in other words those pollutants present in the discharge that could possibly impact water quality.

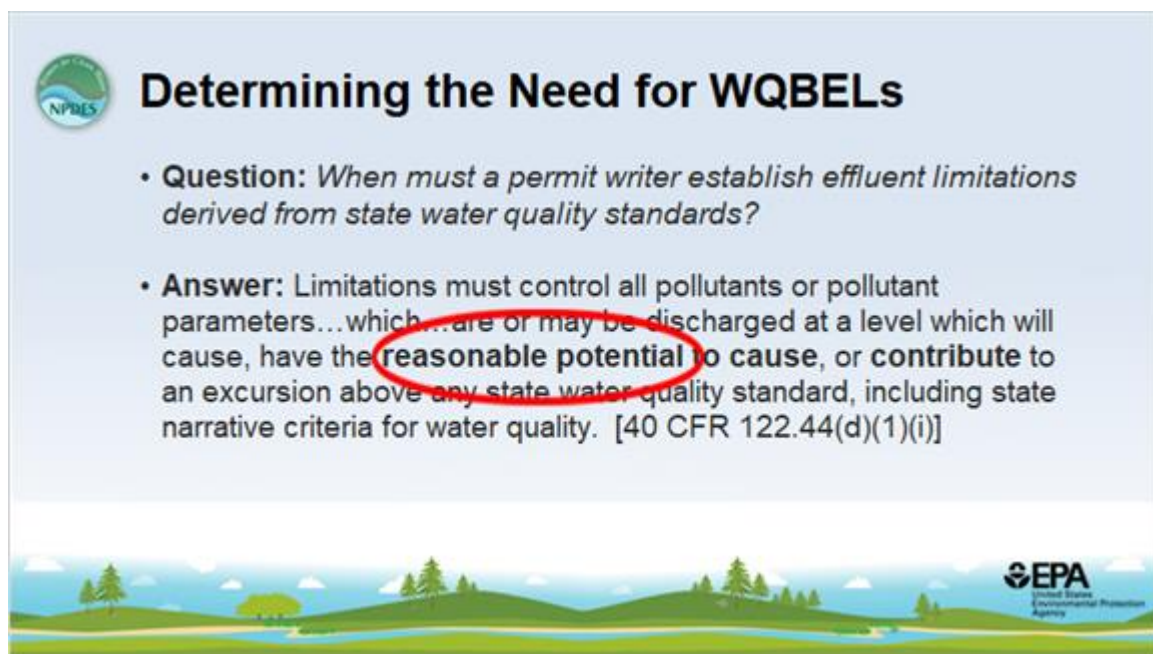
Next we determined whether the water quality standards allow us to consider mixing and dilution of the effluent and receiving water. If mixing is allowed, the permit writer, or water quality modeler, needs to select an approach to model the interaction between the effluent and the receiving water. We said that most of the time permitting authorities use a steady-state water quality model.

We use that steady-state model to look at how the effluent and receiving water interact under critical conditions, so the fourth step in the process discussed how to establish the critical conditions. We'll revisit the selection of critical conditions later in this module.

The final step in characterizing the effluent and receiving water, established the dilution allowance or mixing zone based on the type of mixing that occurs under critical conditions and the requirements of the water quality standards and their implementation procedures.

So having identified the applicable water quality standards, and compiling all the information we can about the effluent and receiving water, what comes next?

1.5 Determining the Need for WQBELs



The slide features a light blue background with a white text box. In the top left corner is the NPBES logo. The title 'Determining the Need for WQBELs' is in bold black font. Below the title are two bullet points. The second bullet point has the phrase 'reasonable potential to cause' circled in red. At the bottom of the slide is a decorative graphic of a landscape with green hills, trees, and a blue sky, with the EPA logo in the bottom right corner.

Determining the Need for WQBELs

- **Question:** *When must a permit writer establish effluent limitations derived from state water quality standards?*
- **Answer:** Limitations must control all pollutants or pollutant parameters... which... are or may be discharged at a level which will cause, have the **reasonable potential to cause**, or contribute to an excursion above any state water quality standard, including state narrative criteria for water quality. [40 CFR 122.44(d)(1)(i)]

Notes:

Well, that brings us to Part III in the water quality-based effluent limitation development series, "Determining the Need for Water Quality-based Effluent Limits"

In this presentation, we'll examine how we take the information we've gathered in Parts I and II, and use the

information to answer the question, “When must the permit writer establish effluent limitations derived from state water quality standards?” And it turns out that the answer is provided very specifically in the NPDES permitting regulations

The regulations at 40 CFR 122.44(d)(1)(i) state, “Limitations must control all pollutants or pollutant parameters (either conventional, non-conventional, or toxic) which the Director determines are or may be discharged at a level which will *cause*, have the *reasonable potential to cause*, or *contribute* to an excursion above any state water quality standard, including state narrative criteria for water quality.”

Because of the wording of this regulation, EPA, and many authorized NPDES states, refer to the process that a permit writer uses to determine the need for water quality-based effluent limitations as the “reasonable potential test” or “reasonable potential analysis.”

1.6 Reasonable Potential Analysis (RPA)

The slide features the NPDES logo in the top left corner. The main title is "Reasonable Potential Analysis (RPA)". To the right of the text is a graphic of the number "726A" in a blue, stylized font. A small white box with the text "Free from..." is positioned above the "A". The slide background is light blue with a green landscape illustration at the bottom, including a river, trees, and hills. The EPA logo is in the bottom right corner.

- We can conduct a “reasonable potential analysis” based on
 - numeric criteria
 - narrative criteria
 - numeric interpretation
 - qualitative interpretation
- A reasonable potential analysis can be completed
 - with effluent data
 - without effluent data
 - data from other sources or from similar discharges
 - qualitative information

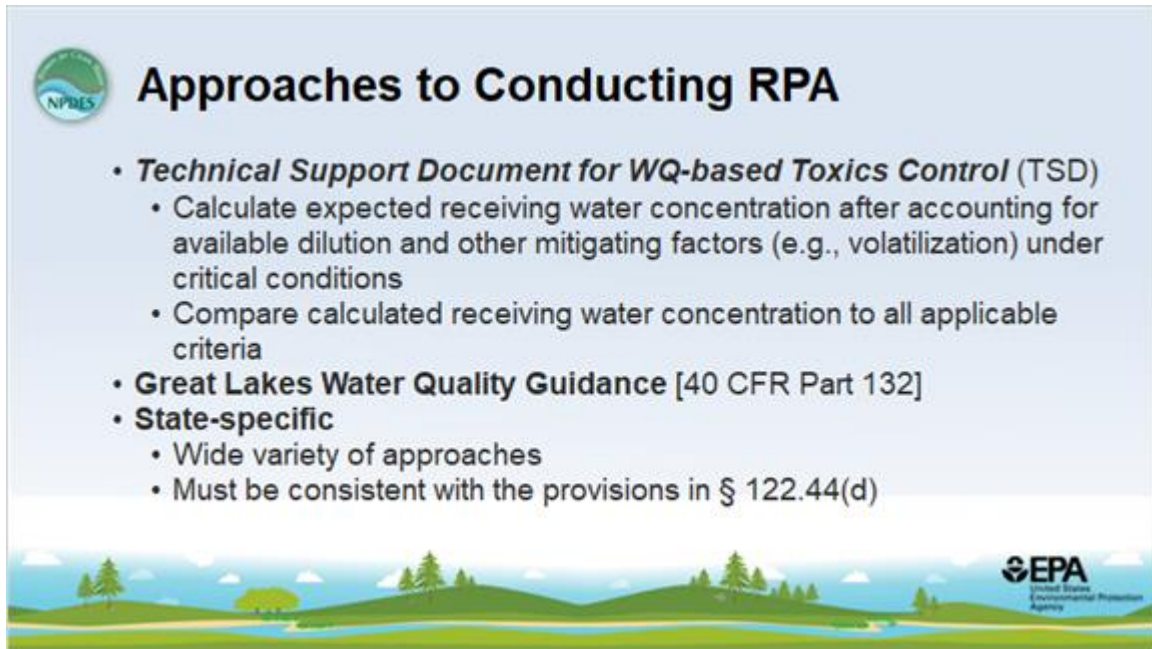
Notes:

It's important to remember that the regulations at 40 CFR 122.44(d)(1) specifically require effluent limits where there is a reasonable potential for an excursion above either numeric or narrative criteria. Therefore, permitting authorities should establish procedures to guide permit writers through the reasonable potential analysis for all applicable types of water quality criteria.

In most cases, the reasonable potential analysis will be based on a quantitative assessment of the potential impact of a discharge using site-specific data characterizing the effluent and receiving water; however, there may instances where data are unavailable.


For example, a new discharger will have to apply for and receive its first NPDES permit before it commences its discharge. In this scenario, the permitting authority can still perform a reasonable potential analysis, but will likely use estimates of the levels of pollutants in the effluent based on engineering evaluations provided by the applicant and/or discharge data from similar types of facilities.

1.7 Approaches to Conducting RPA



Approaches to Conducting RPA

- **Technical Support Document for WQ-based Toxics Control (TSD)**
 - Calculate expected receiving water concentration after accounting for available dilution and other mitigating factors (e.g., volatilization) under critical conditions
 - Compare calculated receiving water concentration to all applicable criteria
- **Great Lakes Water Quality Guidance [40 CFR Part 132]**
- **State-specific**
 - Wide variety of approaches
 - Must be consistent with the provisions in § 122.44(d)

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Notes:

As we just noted, the most common scenario for conducting a reasonable potential analysis is where we have both numeric water quality criteria and site-specific effluent and receiving water data for a pollutant of concern. The remainder of this presentation addresses this situation.

Permitting authorities employ a variety of approaches for conducting reasonable potential analyses where they have numeric criteria and quantitative effluent and receiving water data.

The approach that we'll present is from USEPA's 1991 Technical Support Document for Water Quality-based Toxics Control (commonly referred to as the TSD). The TSD describes a procedure that assesses the impact of a point source discharge on a receiving water by calculating the expected receiving water concentration after accounting for available dilution and other mitigating factors (e.g., volatilization). The analysis is conducted under one or more sets of "critical conditions" and compares the predicted receiving water concentration to all applicable criteria from the state water quality standards.

EPA has developed other approaches as well. In 1995, EPA and the Great Lakes states agreed to a comprehensive plan for the Great Lakes system promulgated in 40 CFR Part 132. This regulation describes a procedure for conducting a reasonable potential analysis and calculating water quality-based effluent limits very similar to the TSD

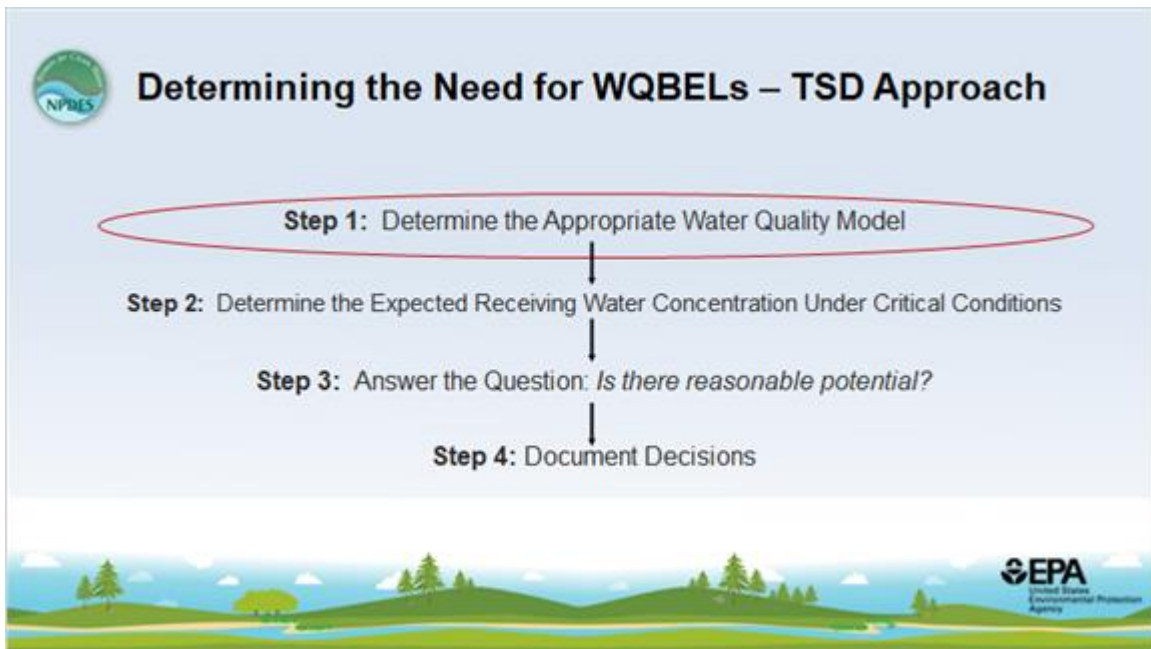
approach, but with a few additional requirements.

State permitting authorities have also developed unique state-specific reasonable potential procedures, although most derive in some fashion from the TSD approach.

Fundamentally, the specifics of the approach aren't locked into the regulations, but all evaluation must be consistent with the provisions in § 122.44(d).

Greg, why don't you start laying out the steps for the reasonable potential analysis as described in the TSD?

1.8 Determining the Need for WQBELs – TSD Approach



Notes:

OK, Dave.

Here are the steps that we'll follow in the TSD-based reasonable potential analysis:

- First, we'll determine the appropriate water quality model
- Second, we'll determine the expected receiving water concentration under critical conditions
- Third, we'll determine whether there is a "reasonable potential" and,
- Finally, we'll document the analysis and decisions.
-

So, the first step is to determine the specific water quality model we need to use. Hopefully we looked at some of the basic modeling considerations when we characterized the effluent and receiving water, but now we need to be a bit more specific with respect to each pollutant of concern.

Let's review and expand on some of the concepts we discussed earlier.

1.9 Step 1: Determine the Appropriate Water Quality Model

Step 1: Determine the Appropriate Water Quality Model

Where dilution or mixing is not considered, no water quality model is needed.

Outfall

Where Criteria Must Be Met at the "End of Pipe" No Water Quality Model is Needed

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Notes:

Remember, for any pollutant of concern for which we cannot consider any dilution or mixing zone, we don't need a water quality model.

We simply determine whether the effluent alone might exceed the applicable water quality criteria at the point of discharge, or "end of pipe."

1.10 Step 1: Determine the Appropriate Water Quality Model

The slide is titled "Step 1: Determine the Appropriate Water Quality Model" and features the NPDES logo in the top left corner. In the center, there is an illustration of a person with red hair sitting at a desk with a computer monitor displaying a bar chart. Surrounding this illustration are the names of water quality models: "CORMIX" in green, "QUAL2K" in gold, "Streeter-Phelps" in blue, and "Mass-balance equation" in red. Below the illustration is a quote: "Essentially, all models are wrong, but some are useful." – George E.P. Box. At the bottom right, the EPA logo is visible, and the background shows a landscape with green hills, trees, and a blue sky.

Notes:

Where dilution or mixing can be considered for a pollutant of concern, we'll take what we know about critical conditions and the available dilution or mixing zone and use that information in a water quality model to determine what effect the discharge will have on the receiving water, either by itself or in combination with other sources of pollutants.

By conducting this analysis, we can answer the question, "Will the discharge cause, have the reasonable potential to cause, or contribute to an excursion above an applicable water quality standard?"

Or, in short, "Is there reasonable potential?"

Remember, in the vast majority of permitting scenarios, we will use some type of steady-state water quality model. Steady-state simply means that the model will predict the impact of the effluent on the receiving water under a single set of critical conditions.

The type of steady-state model that we use to simulate the impact of the effluent on the receiving water depends on the type of mixing that occurs in the receiving water and, in some cases, the type of pollutant or parameter we're modeling.

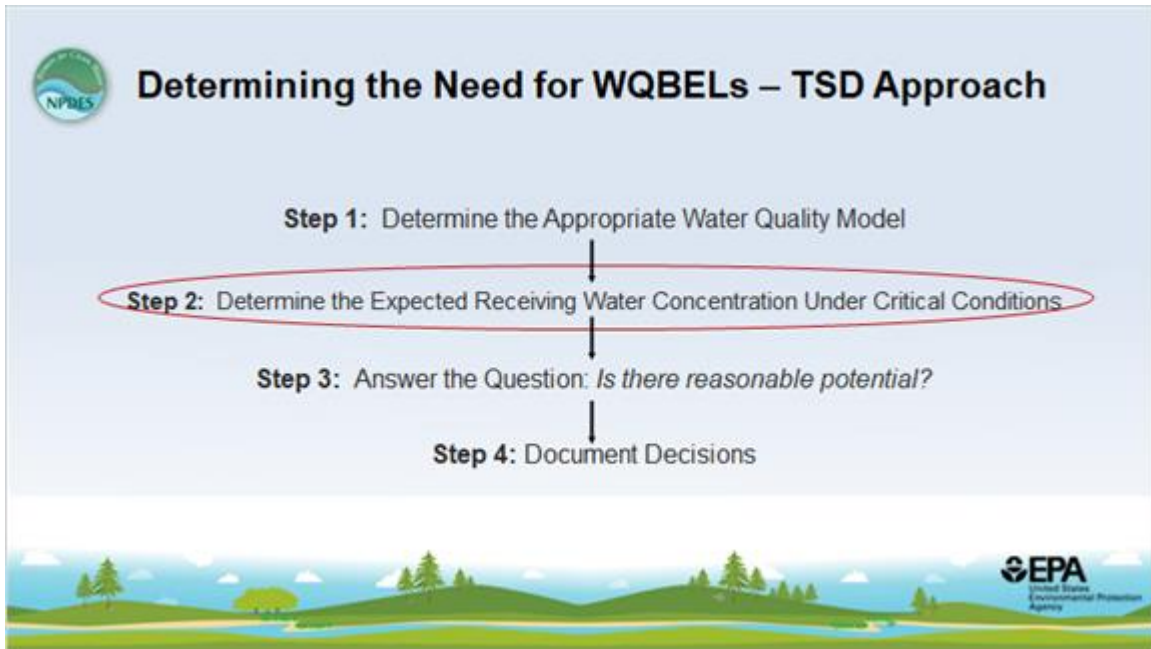
For example, to model dissolved oxygen in a river, we might choose the Streeter-Phelps equation.

For modeling heavy metals in an incomplete mix situation, we might choose to run CORMIX as a steady-state model.

We could use QUAL2K to model nutrients.

For many pollutants, such as most priority or toxic pollutants, we can use a simple mass-balance equation. This is the model that we will use in some examples later on.

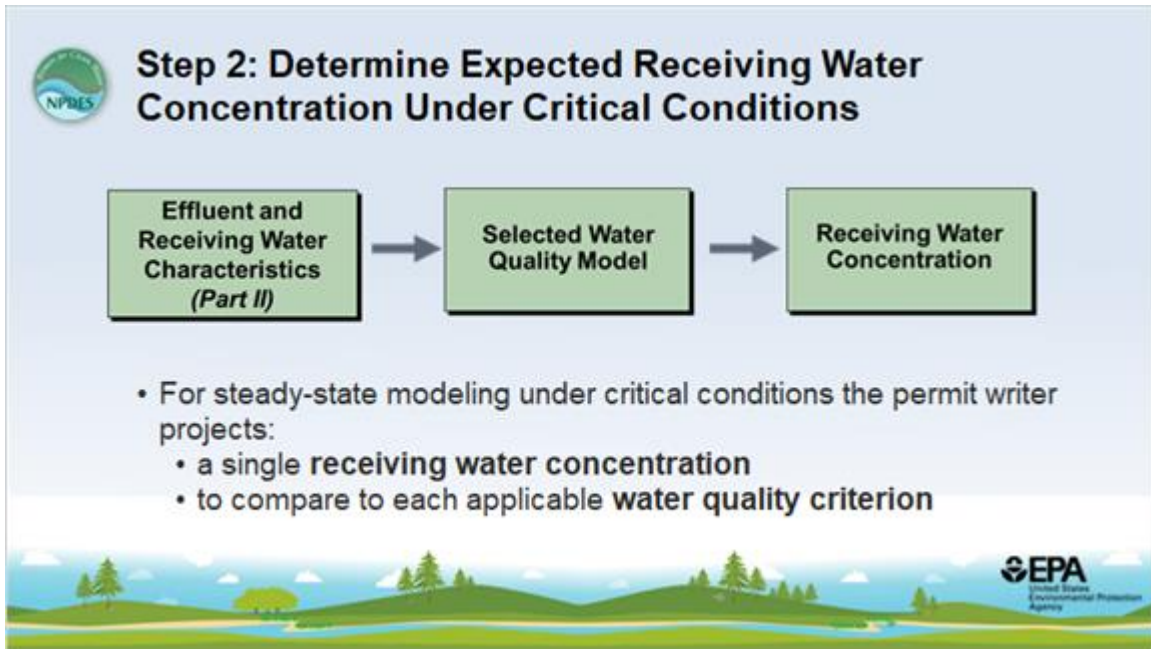
1.11 Determining the Need for WQBELs – TSD Approach



Notes:

Once we have selected an appropriate water quality model, we're ready to use that model to determine the expected receiving water concentration of the pollutant of concern under critical conditions.

1.12 Step 2: Determine Expected Receiving Water Concentration Under Critical Conditions

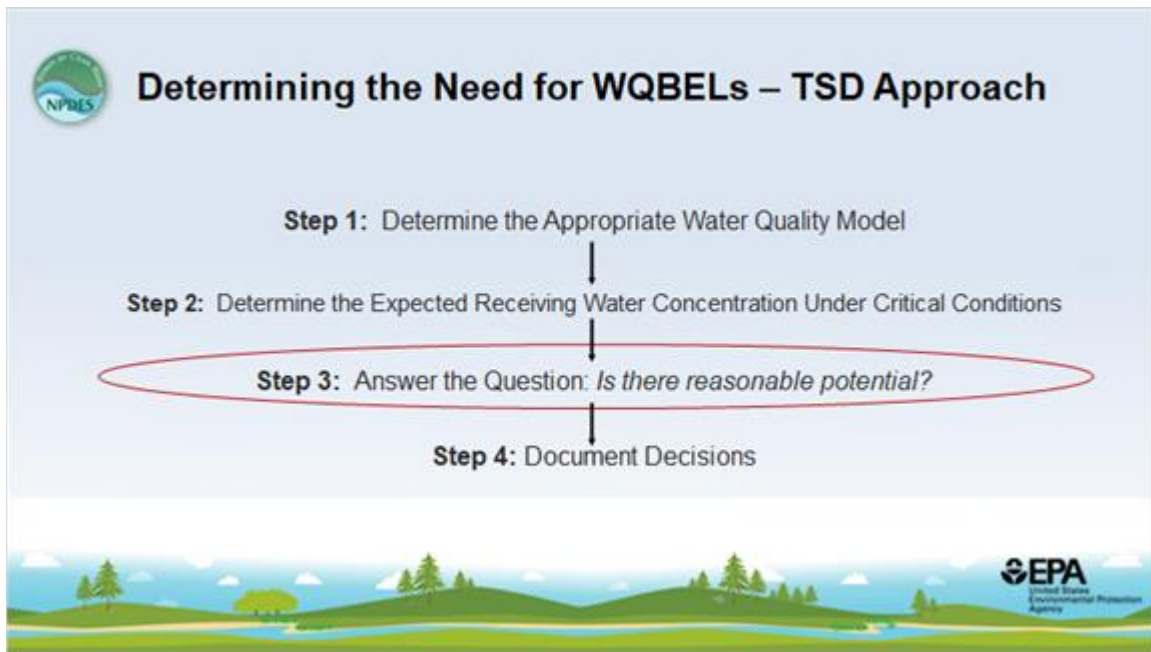


Notes:

The modeling effort requires that we take the effluent and receiving water characterization data (which we discussed in Part II of this series), input the data into our selected model, and calculate the resultant receiving water concentration.

A steady-state model allows us to predict a single receiving water concentration that we would expect under critical conditions. In the next step, we'll compare that predicted receiving water concentration to the applicable water quality criteria to determine "reasonable potential."

1.13 Determining the Need for WQBELs – TSD Approach




Notes:

Now we get to the heart of the matter.


After applying the appropriate model and determining the expected receiving water concentration, we're ready to answer the question, "Is there reasonable potential?"

1.14 Step 3: Answer the Question: Is There Reasonable Potential?

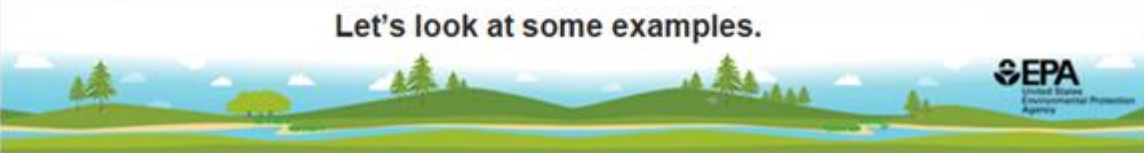


Step 3: Answer the Question: Is There Reasonable Potential?

- If the projected receiving water concentration exceeds the applicable water quality criterion, then there is reasonable potential and the permit writer must establish WQBELs
- If the projected receiving water concentration is equal to or less than the applicable water quality criterion, then there is no reasonable potential and we have not demonstrated a need to establish WQBELs



Let's look at some examples.



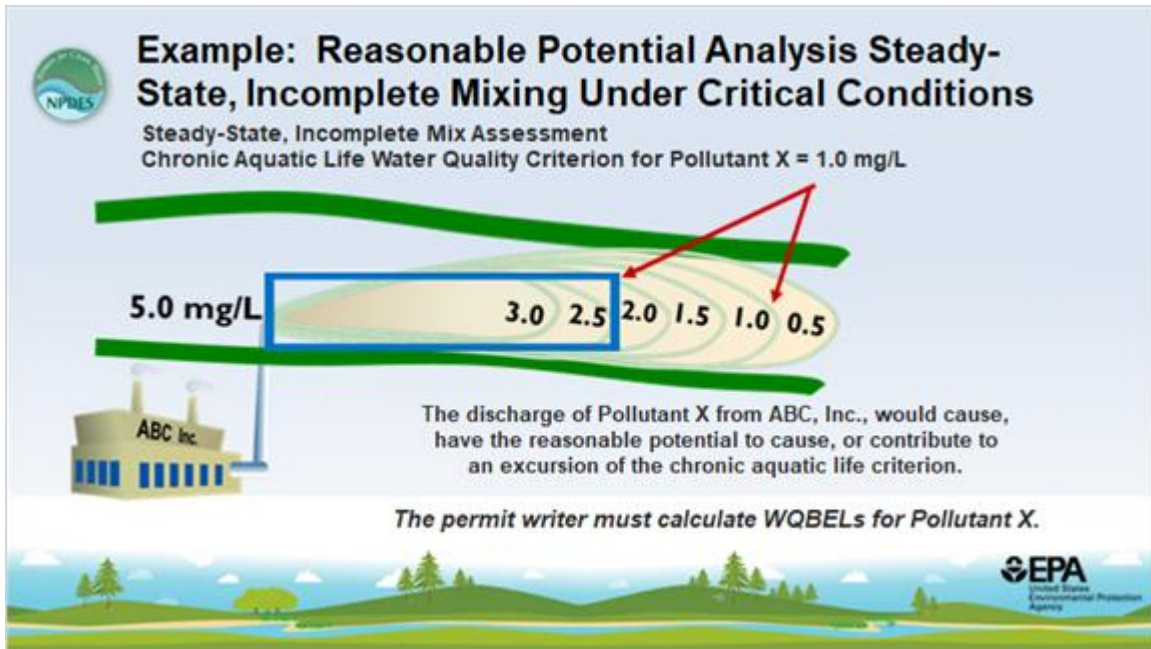
Notes:

If the receiving water concentration that we project using our selected water quality model exceeds the applicable water quality criterion, then there is “reasonable potential” and we must establish water quality-based effluent limits in the NPDES permit.

If, on the other hand, the receiving water concentration we project is equal to or less than the applicable water quality criterion, then there is no “reasonable potential” and we have not demonstrated a need to establish water quality-based effluent limits.

Let's look at some examples of how we determine reasonable potential under different types of effluent and receiving water mixing.

1.15 Example: Reasonable Potential Analysis Steady-State, Incomplete Mixing Under Critical Conditions



Notes:

In this incomplete mix situation, the pollutant “X” is discharged from the facility (“ABC Incorporated”) and it forms a plume in the receiving water rather than mixing rapidly and completely with the entire stream flow very near the point of discharge.

We might choose to model the mixing of the effluent and receiving water under critical conditions using a steady-state incomplete mixing model, such as CORMIX. We would use our water quality model to assess the potential impact of the discharge on the receiving water in relation to a specific water quality criterion.

Assume we’re evaluating a chronic aquatic life water quality criterion of 1.0 mg/L for Pollutant X.

We first perform a statistical analysis of the effluent data and determine that the maximum projected discharge concentration for ABC Inc., is 5.0 mg/L.

We then apply our water quality model to estimate pollutant concentrations in the receiving water downstream of the discharge under critical conditions.

To determine whether the aquatic life criterion is achieved downstream, we also would have to look at the regulatory mixing zone that applies in this water body for this pollutant.

Remember, the regulatory mixing zone is a limited area in the receiving water where some initial mixing of the effluent and receiving water takes place and where the water quality standards would allow the water quality criterion to be exceeded.

How would we determine the size of the regulatory mixing zone? Again, remember that the applicable water quality standards or an implementation policy, such as a mixing zone policy, would specify the allowable size of the regulatory mixing zone.

We'll assume that we've reviewed the water quality standards and our mixing zone policy and determined the size of the mixing zone, which we'll represent using this light blue box.

To answer the question "Is there reasonable potential?" we need to determine whether the pollutant concentration at the edge of the mixing zone exceeds the applicable water quality criterion.

If we look at the illustration, we can see that, in fact, it does.

Take a look at the downstream end of the mixing zone, for example. There, the pollutant concentration is about 2.5 mg/L. To attain water quality standards, the pollutant concentration would need to be at or below the water quality criterion of 1.0 mg/L.

You can see that we have to go well beyond the mixing zone at the downstream end before the concentration is below 1.0 mg/L.

So, what does that tell us? It tells that, based upon our predictive model, the discharge of Pollutant X from ABC Incorporated may cause, have the reasonable potential to cause, or contribute to an excursion of the chronic aquatic life criterion.

And what does that mean? It means that the permit writer must include effluent limits for Pollutant X in the permit sufficient to protect water quality.

Of course, this is a very simplistic incomplete modeling example, but it does serve to illustrate the basic concepts.

For the remainder of today's presentation, we're going to simplify things a bit more. In the following example, we'll determine "reasonable potential," for a conservative pollutant discharged into a free-flowing river where there is rapid and complete mixing of the discharge with the receiving water and where the water quality standards allow a certain percentage of the critical stream flow for dilution. As we will see, these assumptions greatly simplify our water quality modeling to the point where our model can be reduced to a single, simple equation.

For a discussion of that equation, I'll turn it back over to Dave.

1.16 Mass Balance Equation

The diagram illustrates the mass balance equation for a river. It shows a cross-section of a river with a discharge point. The river is divided into three sections: Upstream (Qs, Cs), Discharge (Qd, Cd), and Downstream (Qr, Cr). A factory labeled 'ABC Inc.' is shown discharging into the river. The flow is indicated by arrows pointing downstream. The NPDES logo is in the top left, and the EPA logo is in the bottom right.

Mass-Balance Equation: $Q_s C_s + Q_d C_d = Q_r C_r$

- Q = Flow (mgd or cfs)
- C = Pollutant concentration (mg/l)
- Mass = [Concentration] [Flow]

Notes:

Thanks Greg.

Here is the example that Greg just described where ABC Incorporated discharges a conservative pollutant mitigated only by dilution and we have rapid and complete mixing under critical conditions.

The model that we can use in this situation is the mass-balance equation.

The principle behind the mass balance equation is that, where mass is conserved, $2 + 2 = 4$. In other words, the amount (or mass) of the pollutant downstream of our outfall is equal to the mass of the pollutant upstream plus the mass of the pollutant in the discharge. This assumption of conservation of mass works well for most pollutants, especially close to the discharge point (or near-field), as long as the pollutant of concern is not highly reactive or highly volatile.

Mathematically, we can calculate the mass of a pollutant by multiplying the flow, represented by the variable "Q", times the concentration of the pollutant, represented by the variable "C" along with any conversion factors needed to keep our units of measure straight.

Remember, a mass-balance equation can be more complex than shown here. For example, there could be other pollutant sources in the same area or a pollutant could be non-conservative and require consideration of a reaction rate or decay rate.

To simplify our discussion, however, we're going to look at a single source, ABC Incorporated, discharging a

pollutant that does not decay quickly, which we will call Pollutant X, to a stream where the effluent mixes rapidly and completely with the receiving water. For this situation, we are able to model these conditions using a simple mass-balance equation.

1.17 Steady-State Complete Mix Assessment

$$Q_s C_s + Q_d C_d = Q_r C_r$$

Steady-State Complete Mix Assessment
 $Q_s C_s + Q_d C_d = Q_r C_r$

Upstream (Q_s, C_s) Discharge (Q_d, C_d) ABC Inc. Downstream (Q_r, C_r)

Determine the concentration of **Pollutant X** (the pollutant of concern) in the water body downstream of the discharge:

$$C_r = \frac{Q_s C_s + Q_d C_d}{Q_r}$$

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Notes:

Keep in mind that our objective at this point is to assess reasonable potential. In other words, do we believe that the discharge of Pollutant X from ABC Incorporated will cause, have a reasonable potential to cause, or contribute to an excursion above applicable water quality criteria in the receiving water?

To make this assessment, we need to rearrange the mass balance equation to calculate the concentration of the pollutant of concern downstream of the point where the effluent from ABC

Incorporated is discharged into the receiving water. This downstream pollutant concentration is represented by the variable C_r in our equation.

To calculate C_r , we will need to determine values for each of the variables on the right hand side of the equation and plug them in to solve for C_r .

Remember, we're using a steady-state, mass-balance equation, so we'll input a single value for each of these

variables, and since we're only going to use a single value, we want to be sure that the value we select reflects the critical condition for the discharge and the receiving water.

1.18 Calculating Receiving Water Concentration Under Critical Conditions

Calculating Receiving Water Concentration Under Critical Conditions

Upstream (Q_s, C_s) Discharge (Q_d, C_d) ABC Inc. Downstream (Q_r, C_r)

Criterion for protection of aquatic life from acute effects from Pollutant X: $\leq 1.0 \text{ mg/L}$

Q_s = Critical stream flow (1Q10) for acute criterion = ???????
 Q_d = Critical effluent flow from discharge flow data = ???????
 Q_r = Sum of critical stream flow and critical effluent flow = ???????
 C_s = Critical upstream pollutant concentration = ???????
 C_d = Critical effluent pollutant concentration = ???????

$$C_r = \frac{Q_s C_s + Q_d C_d}{Q_r}$$

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Notes:

So now let's look at our example of ABC Incorporated and figure out how we might define our set of critical conditions and begin plugging values into our rearranged mass balance equation.

The first thing we need to know as we start this reasonable potential analysis is what is our target downstream of the outfall. In other words what is it that we will compare to our calculated C_r ?

Well, the target is the applicable water quality criterion.

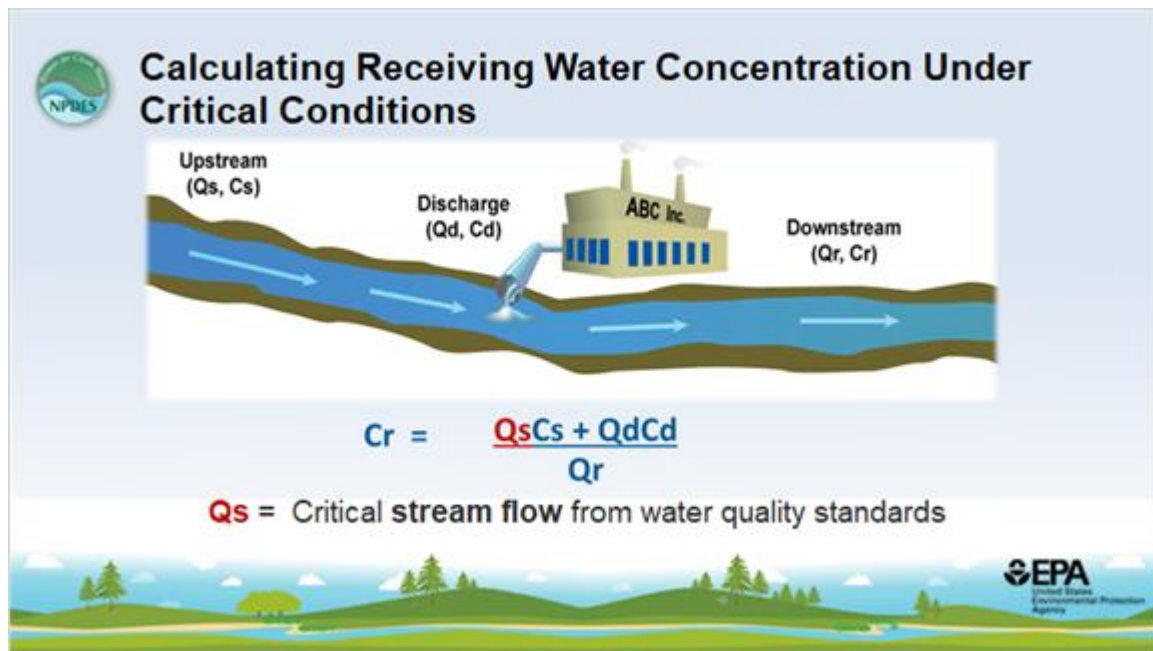
In our example, let's assume that we're going to assess the reasonable potential to exceed the acute aquatic life criterion for Pollutant X. We reviewed the state's water quality standards and found that the applicable acute aquatic life criterion in this segment of the receiving water is 1.0 mg/L of X.

Therefore, we now need to determine whether the discharge from ABC Incorporated will cause, have the reasonable potential to cause, or contribute to an excursion above 1.0 mg/L of Pollutant X after mixing with the receiving water.

With that goal in mind, let's now define the critical conditions for each of the variables on the right-hand side of our

equation and solve for Cr.

1.19 Calculating Receiving Water Concentration Under Critical Conditions



Notes:

Taking a look at the rearranged mass balance equation, we'll start by determining the critical flow values, represented in our equation by the variable "Q"

The first flow value in our equation is Qs, the critical condition for the stream flow upstream of the discharge.

Usually, the critical stream flow values will be defined by the state in its water quality standards regulations or implementation policy. For toxic pollutants, aquatic organisms are usually most stressed under low-flow conditions. Assuming rapid and complete mixing, low stream flow is also the condition where the effluent will have the least amount of dilution, and therefore the most significant impact on the receiving water.

For example, the state water quality standards may specify that the critical flow condition for the acute aquatic life criterion for Pollutant X is the 1Q10 low flow. This is a statistical estimate of the lowest one day average flow that would be expected to recur once every 10 years.

Fortunately, the USGS, or United States Geological Survey, maintains an extensive network of stream flow gage stations throughout the United States and publishes low flow estimates that we can use.

In our example, then, we'll need to examine USGS or state stream flow data to determine the 1Q10 low flow at a

point upstream of the discharge from ABC. We also might need to account for any additional sources of flow or withdrawal of water between the point where a 1Q10 low flow has been calculated and the point of discharge from ABC.

1.20 Calculating Receiving Water Concentration Under Critical Conditions

Calculating Receiving Water Concentration Under Critical Conditions

Upstream (Q_s, C_s) Discharge (Q_d, C_d) ABC Inc. Downstream (Q_r, C_r)

Criterion for protection of aquatic life from acute effects from Pollutant X: = 1.0 mg/L
 Q_s = Critical stream flow (1Q10) for acute criterion = 1.2 cfs
 Q_d = Critical effluent flow from discharge flow data = ???????
 Q_r = Sum of critical stream flow and critical effluent flow = ???????
 C_s = Critical upstream pollutant concentration = ???????
 C_d = Critical effluent pollutant concentration = ???????

$$C_r = \frac{Q_s C_s + Q_d C_d}{Q_r}$$

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Notes:

Well, it turns out we were fortunate enough to have a USGS stream gage just upstream of our outfall, and we determined that the 1Q10 flow (the critical stream flow required for our example) is 1.2 cubic feet per second.

Now Greg, why don't you help us figure out how we can find our next flow value, Q_d .

1.21 Calculating Receiving Water Concentration Under Critical Conditions

Calculating Receiving Water Concentration Under Critical Conditions

Upstream (Qs, Cs) Discharge (Qd, Cd) ABC Inc. Downstream (Qr, Cr)

$$C_r = \frac{Q_s C_s + Q_d C_d}{Q_r}$$

Qd = Critical *effluent flow* from discharge flow data

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Notes:

In our mass balance equation, Qd, represents the critical flow of the discharge, or effluent.

Determining a value for Qd could be straightforward if our permitting authority has a policy or procedures for determining this value.

First, we should be able to obtain effluent flow data from discharge monitoring reports or from an application from ABC Incorporated or perhaps from a flow or dilution study the facility has completed.

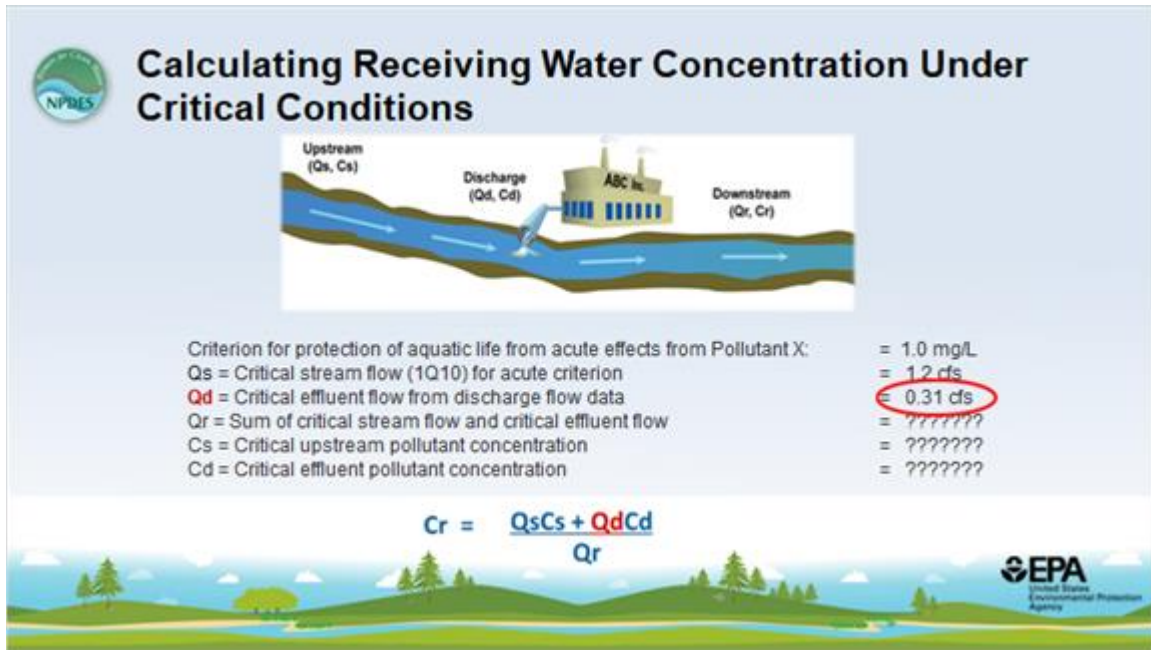
Then, we could look to our policies or permitting procedures to see which flow measurement we need to use as the critical effluent flow for our calculations.

For example, our procedures could specify that the critical effluent flow is maximum daily flow reported on the permit application, or perhaps the maximum of the monthly average flows from

ABC Incorporated's discharge monitoring reports for the past three years.

Those are just examples. The important thing to remember is to follow our permitting authority's policy or procedures for determining this value or, if our permitting authority does not specify how to determine this value, we should look at past practices and strive for consistency.

1.22 Calculating Receiving Water Concentration Under Critical Conditions



Calculating Receiving Water Concentration Under Critical Conditions

Upstream (Q_s, C_s) Discharge (Q_d, C_d) ABC Inc. Downstream (Q_r, C_r)

Criterion for protection of aquatic life from acute effects from Pollutant X: = 1.0 mg/L
 Q_s = Critical stream flow (1Q10) for acute criterion = 1.2 cfs
 Q_d = Critical effluent flow from discharge flow data = 0.31 cfs
 Q_r = Sum of critical stream flow and critical effluent flow = ???????
 C_s = Critical upstream pollutant concentration = ???????
 C_d = Critical effluent pollutant concentration = ???????

$$C_r = \frac{Q_s C_s + Q_d C_d}{Q_r}$$

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Notes:

In our example, we'll assume that using our permitting authority's policies and procedures and the available effluent flow data, we've determined that the critical effluent flow is 0.31 cubic feet per second.

So, Dave, that leaves one last critical flow value that we need for our equation, Q_r .

Do you think you can help us with that one?

1.23 Calculating Receiving Water Concentration Under Critical Conditions

Calculating Receiving Water Concentration Under Critical Conditions

Upstream (Qs, Cs) Discharge (Qd, Cd) ABC Inc. Downstream (Qr, Cr)

$$C_r = \frac{Q_s C_s + Q_d C_d}{Q_r}$$

Qr = Sum of upstream flow (Qs) and discharge flow (Qd)

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Notes:

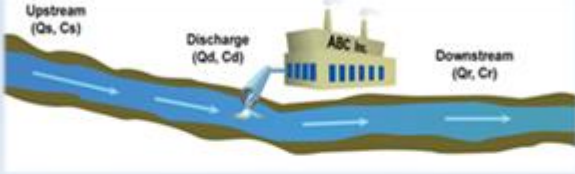
Thanks, Greg, I think I can handle it.

Qr represents the stream flow just below our outfall and is simply calculated by adding the upstream flow Qs to the effluent flow Qd.

We've already determined Qs and Qd in the previous slides, so all we have to do is add them together.

1.24 Calculating Receiving Water Concentration Under Critical Conditions


 **Calculating Receiving Water Concentration Under Critical Conditions**



Upstream (Q_s, C_s) Discharge (Q_d, C_d) ABC Inc. Downstream (Q_r, C_r)

Criterion for protection of aquatic life from acute effects from Pollutant X: = 1.0 mg/L
 Q_s = Critical stream flow (1Q10) for acute criterion = 1.2 cfs
 Q_d = Critical effluent flow from discharge flow data = 0.31 cfs
 Q_r = Sum of critical stream flow and critical effluent flow = **1.51 cfs**
 C_s = Critical upstream pollutant concentration = ???????
 C_d = Critical effluent pollutant concentration = ???????

$$C_r = \frac{Q_s C_s + Q_d C_d}{Q_r}$$

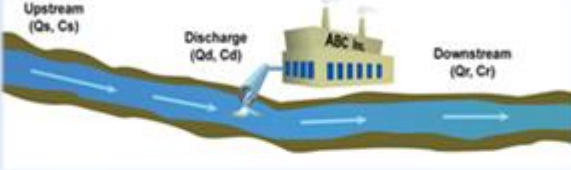
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Notes:

In our ABC Incorporated example, we simply add 1.2 cubic feet per second (that's our Q_s) and 0.31 cubic feet per second (that's our Q_d) and we get 1.51 cubic feet per second, Q_r .

Now we can move on to the critical condition values in our equation, represented by the variable "C"


1.25 Calculating Receiving Water Concentration Under Critical Conditions



Calculating Receiving Water Concentration Under Critical Conditions

$$C_r = \frac{Q_s C_s + Q_d C_d}{Q_r}$$

C_s = Critical *background* (upstream) pollutant concentration from ambient monitoring data



Notes:

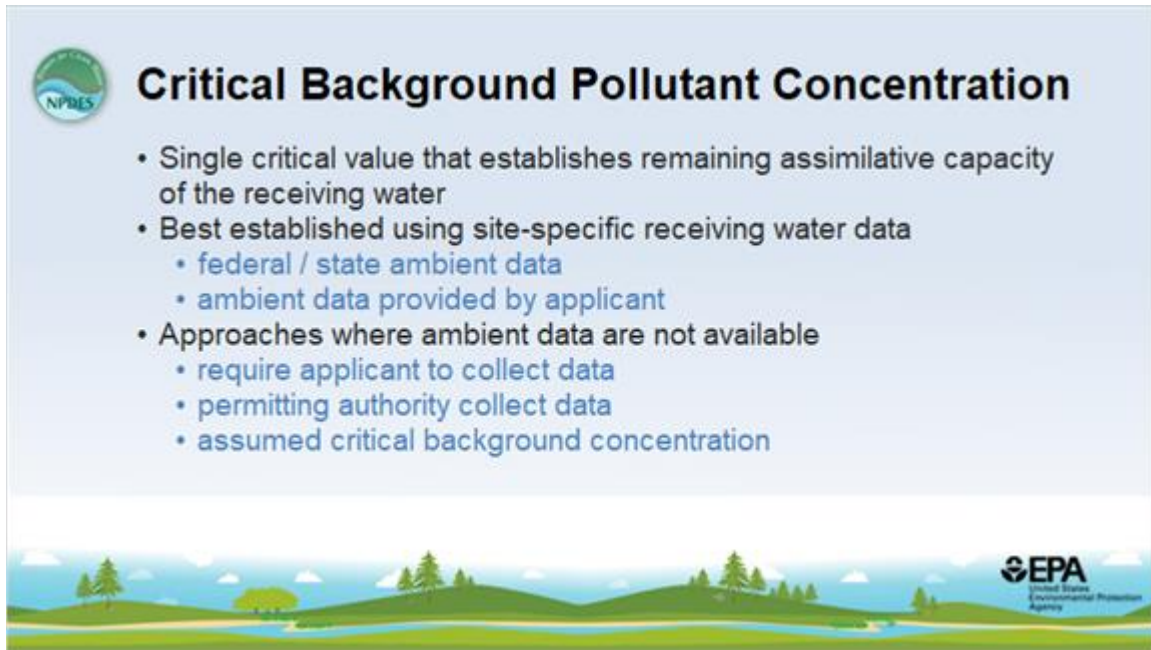
OK. Glad you tackled the tough one for us there, Dave.

At any rate, you're right-it is time to start looking at the concentration values that we need to plug into the mass balance equation.

The first concentration we must determine is the background concentration of the pollutant of concern upstream of the discharge.

That value is represented in the mass-balance equation by C_s.

1.26 Critical Background Pollutant Concentration



Critical Background Pollutant Concentration

- Single critical value that establishes remaining assimilative capacity of the receiving water
- Best established using site-specific receiving water data
 - federal / state ambient data
 - ambient data provided by applicant
- Approaches where ambient data are not available
 - require applicant to collect data
 - permitting authority collect data
 - assumed critical background concentration

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Notes:

The critical background pollutant concentration is a single critical value that establishes the remaining assimilative capacity of the receiving water.

The critical background concentration is best established using site-specific receiving water data, which can be obtained from federal or state ambient databases or from data provided by the applicant.

Here again, our permitting authority policies or procedures might address how to determine this value.

For example, where ambient data are available, we could be directed to use the maximum measured pollutant concentration upstream of the discharge or perhaps an upper bound or average of the measured concentrations.

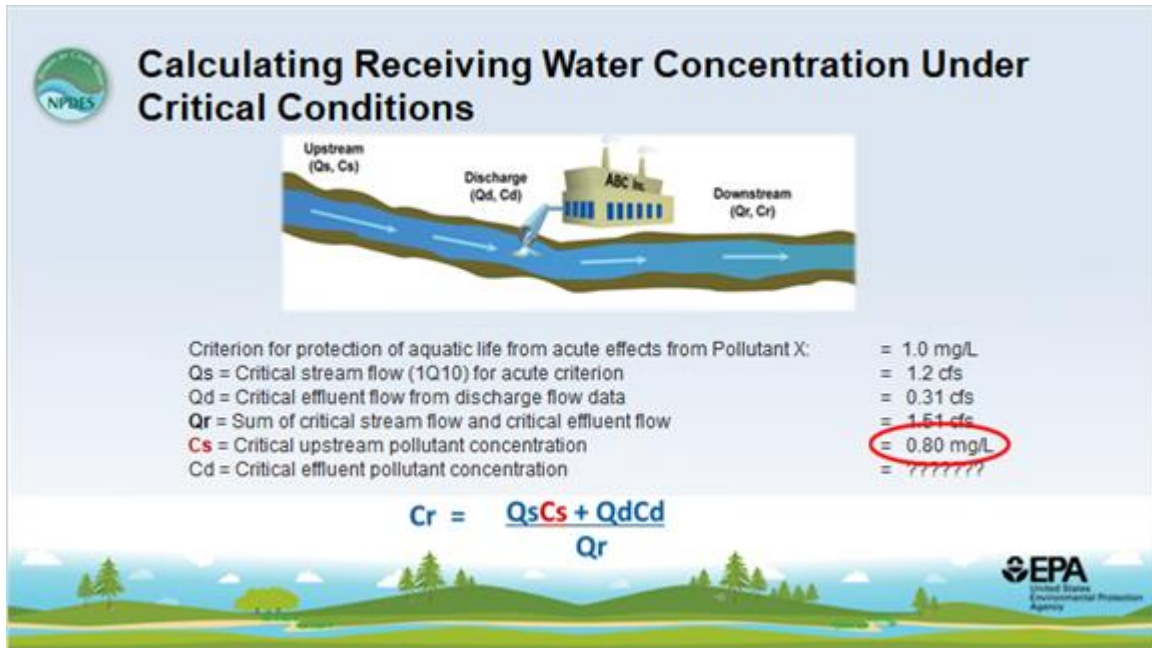
If data are not available, our permitting authority might have other procedures to follow. For example, we might be directed to require the applicant to collect data, collect data as the permitting authority, look at similar streams to determine an estimate of the background pollution concentration, or use a default value, such as a percentage of the applicable water quality criterion for the pollutant of concern.

We should note that assuming that the critical receiving water concentration of the pollutant of concern is “zero” is the least conservative option, and could significantly overestimate the receiving water’s assimilative capacity. The use of a “zero” background assumption should be evidence driven, pollutant and site-specific, and documented in the permit record.

If there are no policies or procedures available for determining background pollutant concentrations, we would

want to look at other permits to understand past practices and maintain consistency with those practices.

1.27 Calculating Receiving Water Concentration Under Critical Conditions



Calculating Receiving Water Concentration Under Critical Conditions

Upstream (Q_s, C_s) Discharge (Q_d, C_d) ABC Inc. Downstream (Q_r, C_r)

Criterion for protection of aquatic life from acute effects from Pollutant X: = 1.0 mg/L
 Q_s = Critical stream flow (1Q10) for acute criterion = 1.2 cfs
 Q_d = Critical effluent flow from discharge flow data = 0.31 cfs
 Q_r = Sum of critical stream flow and critical effluent flow = 1.51 cfs
 C_s = Critical upstream pollutant concentration = 0.80 mg/L
 C_d = Critical effluent pollutant concentration = ?????

$$C_r = \frac{Q_s C_s + Q_d C_d}{Q_r}$$

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Notes:

In our example problem, using the data we have and our permitting authority's policies and procedures, we determined that the critical upstream pollutant concentration is 0.80 mg/L.

Well, those question marks are starting to disappear as we find a value for each of these variables.

But there is still one missing.

We need to determine the critical effluent concentration of the pollutant of concern, C_d . Dave, where are we going to get this value?

1.28 Calculating Receiving Water Concentration Under Critical Conditions

Calculating Receiving Water Concentration Under Critical Conditions

Upstream (Qs, Cs) Discharge (Qd, Cd) ABC Inc. Downstream (Qr, Cr)

$$C_r = \frac{Q_s C_s + Q_d C_d}{Q_r}$$

Cd = Critical effluent pollutant concentration

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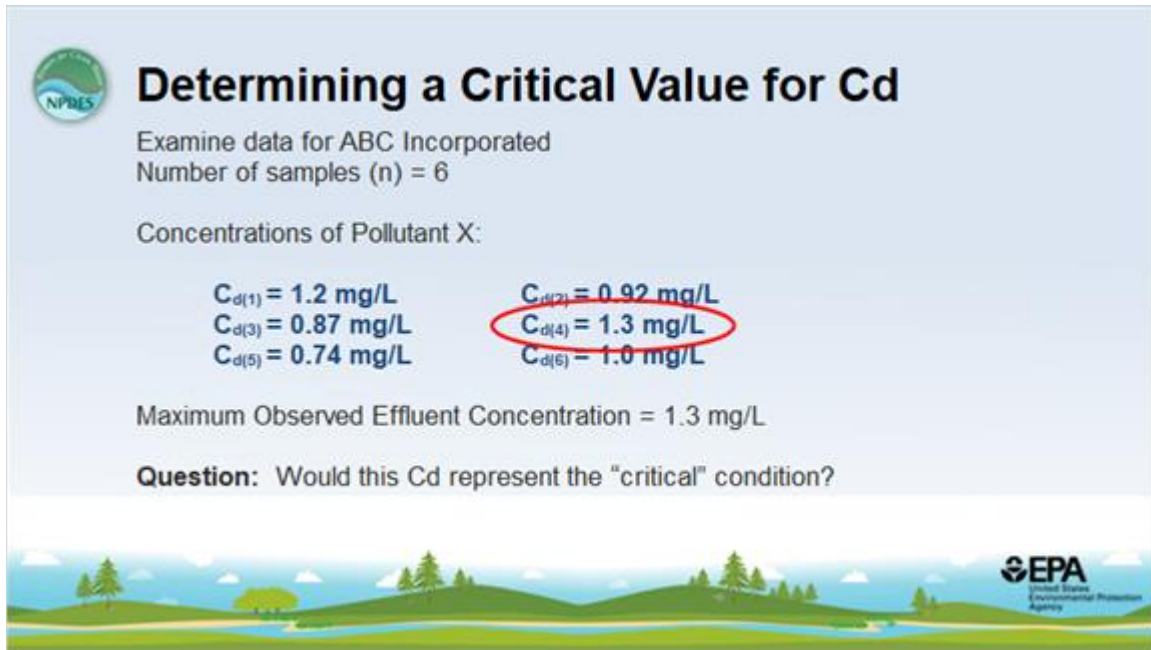
Notes:

Well, if you think back to why we're going through this process in the first place (to determine the possible impact of the discharge on the receiving stream) this is really the "critical" critical condition.

We need to gather up all of the actual effluent measurements of Pollutant X from ABC Incorporated and determine what the facility is putting into the receiving water.

Since we're looking for the critical effluent pollutant concentration, we want to find a concentration for Cd that represents something close to the maximum concentration of Pollutant X that we would ever expect to find in the discharge.

1.29 Determining a Critical Value for Cd



Determining a Critical Value for Cd

Examine data for ABC Incorporated
Number of samples (n) = 6

Concentrations of Pollutant X:

$C_{d(1)} = 1.2 \text{ mg/L}$	$C_{d(2)} = 0.92 \text{ mg/L}$
$C_{d(3)} = 0.87 \text{ mg/L}$	$C_{d(4)} = 1.3 \text{ mg/L}$
$C_{d(5)} = 0.74 \text{ mg/L}$	$C_{d(6)} = 1.0 \text{ mg/L}$

Maximum Observed Effluent Concentration = 1.3 mg/L

Question: Would this Cd represent the "critical" condition?


Notes:

While our objective is to find this critical effluent concentration, the reality is that we'll likely have a pretty small data set of actual effluent measurements.

Here in our example for ABC Incorporated, it turns out the facility measured the concentration of Pollutant X six times over the past three years. Based on our knowledge of the facility, these values appear to be representative of current treatment plant performance.



As you can see, the maximum concentration of these six samples is 1.3 mg/L. So, do we think that this maximum measured value of 1.3 mg/L is the highest concentration of "X" that ABC will ever discharge?

1.30 Determining a Critical Value for Cd



Determining a Critical Value for Cd

- Answer: *Not likely*
 - Our limited data set does not account for day-to-day **variability** in effluent quality (i.e., the facility probably did not self-monitor on its worst possible day)
 - When determining reasonable potential, "...the permitting authority shall use procedures which account for...the **variability** of the pollutant or pollutant parameter in the effluent..."
[§ 122.44(d)(1)(ii)]



Notes:

Well, it's not very likely.

For nearly any wastewater treatment system, there will be "good days" and "bad days."


The chances that ABC Incorporated got "lucky" enough to conduct its self-monitoring on its very worst discharge day of the year is very small.

In a mathematical sense, we can say that our limited data set doesn't really account for day-to-day variability of the concentration of Pollutant X in the effluent for ABC Incorporated. Statistically, six samples is just not large enough to ensure that we've captured the potential variations in effluent concentration that we would expect to occur.

It also turns out that the NPDES regulations at 40 CFR 122.44(d)(1)(ii) require that we consider how an effluent varies over time as we conduct a reasonable potential analysis.


This means that we need a methodology to establish the critical effluent pollutant concentration in a way that accounts for a small data set and the variability of the effluent.

1.31 Determining a Critical Value for Cd



Determining a Critical Value for Cd

- Follow permitting authority procedures to determine the critical value for Cd
 - permitting authority regulation, policy, or guidance
- EPA's *Technical Support Document for Water Quality-based Toxics Control* (TSD)
 - uses a statistical analysis
 - assumes effluent data follow a lognormal distribution



Notes:

Most states that administer the NPDES permit program will have some detailed procedures for analyzing effluent data and conducting the reasonable potential analysis. If you're a state permit writer, you should of course, use your state's procedures.

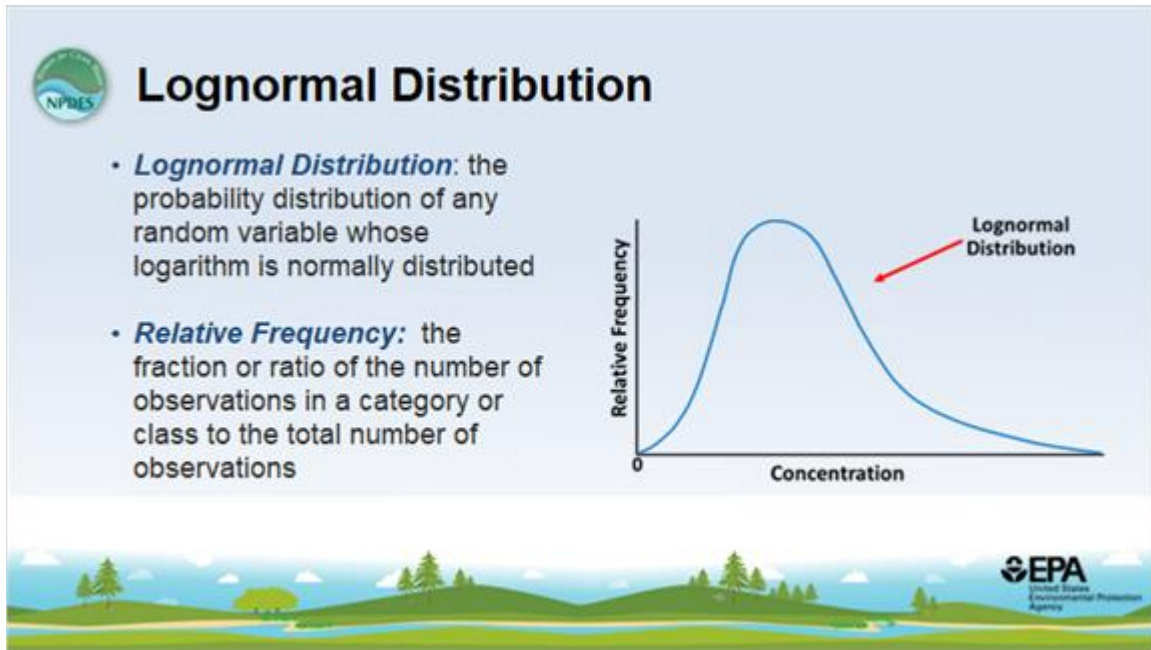
As we mentioned earlier, however, EPA has established it's recommendations for water quality-based permitting for toxics in the TSD.

Specifically, the TSD provides a detailed statistical procedure for characterizing pollutant concentrations in the effluent based on a limited data set and accounting for the variability of that effluent.

The procedures use a statistical analysis that assumes that most effluent data follow what's called a lognormal distribution . Using that distribution, the TSD procedures allow a permit writer to project a critical effluent concentration from a limited data set.

In the examples that follow, we'll be presenting the statistical methodology established in EPA's TSD.

1.32 Lognormal Distribution



Notes:

In order to understand these procedures, we need to define some key terms.

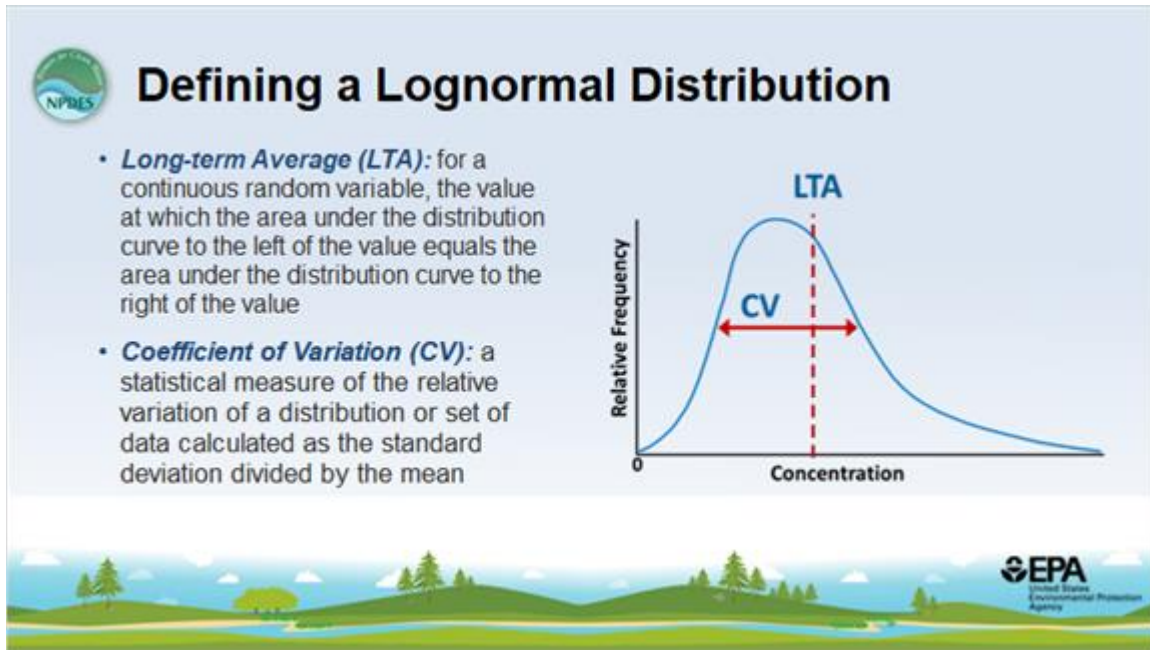
A lognormal distribution is a probability distribution of any random variable whose logarithm is normally distributed.

Two features of the lognormal distribution that you might notice right away are:

First, the concentration values are at or above zero. In other words, there is no such thing as a negative concentration.

And, second, the right hand tail of the curve is asymptotic to the x-axis. In other words, statistically, there is no upper limit to the potential concentration of the pollutant in the effluent. However, as we move farther to the right on the x-axis, the chances of these higher values occurring becomes negligible.

1.33 Defining a Lognormal Distribution



Notes:

The curve itself can be described using a couple of terms of art:

- The first is the long term average or LTA. The LTA is the point on the x-axis that bisects the area under the curve. Because the curve is skewed to the upper end values, the LTA is nearly always to the right of the peak of the curve.
- The second term of art, is the coefficient of variation or CV. The CV is calculated as the standard deviation of the data divided by the mean and represents a measure of the relative distribution or variation of the data around that long-term average. Note that if the CV were to increase, the curve would spread out away from the long-term average. And, on the other hand, if the CV were to decrease, the curve would pull in toward the long-term average so that the concentrations would be clustered more tightly around that average.

OK Greg, let's regroup now and recall why we're going through all this statistical "mumbo-jumbo" in the first place.

1.34 Calculating Receiving Water Concentration Under Critical Conditions

Calculating Receiving Water Concentration Under Critical Conditions

Upstream (Qs, Cs) Discharge (Qd, Cd) ABC Inc. Downstream (Qr, Cr)

$$C_r = \frac{Q_s C_s + Q_d C_d}{Q_r}$$

Recall... we want to determine:
Cd = Critical effluent pollutant concentration

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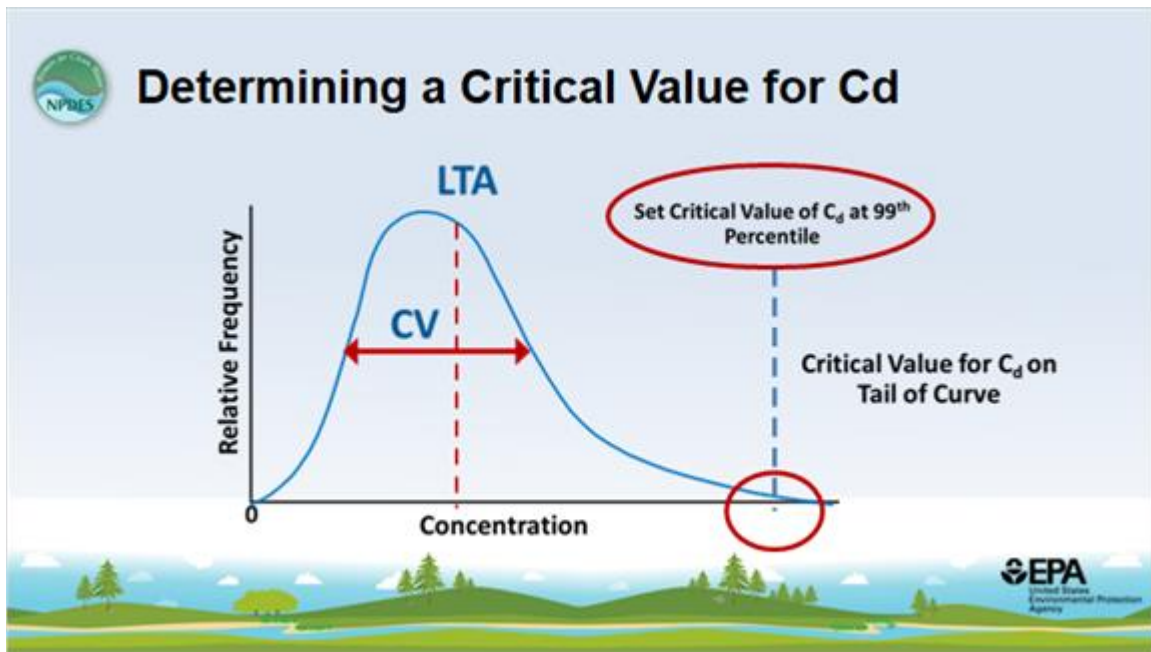
Notes:

Alright Dave, but, by the way, I imagine that those distribution curves are really starting to bring up some bad memories of statistics courses for some of the folks viewing this presentation.

Let's try to make some sense of it all.

Now, remember, that our goal was to find the critical effluent concentration of Pollutant X that we can plug into the mass balance equation for Cd.

1.35 Determining a Critical Value for C_d



Notes:

We can assume that a frequency distribution for the concentration of Pollutant X in ABC Incorporated's effluent follows the lognormal curve that we can estimate even from our limited data set.

So, where on that curve is the critical value of the pollutant concentration in the effluent?

For the concentration of a pollutant in an effluent a critical value would be a value somewhere out on the tail end of that lognormal distribution curve—at some point representing a concentration rarely exceeded in the effluent.

We pick a specific point by deciding what percentage of measured concentrations of the pollutant in the effluent should be below that critical value. In other words, we are going to set that point at a specific percentile value on the curve.

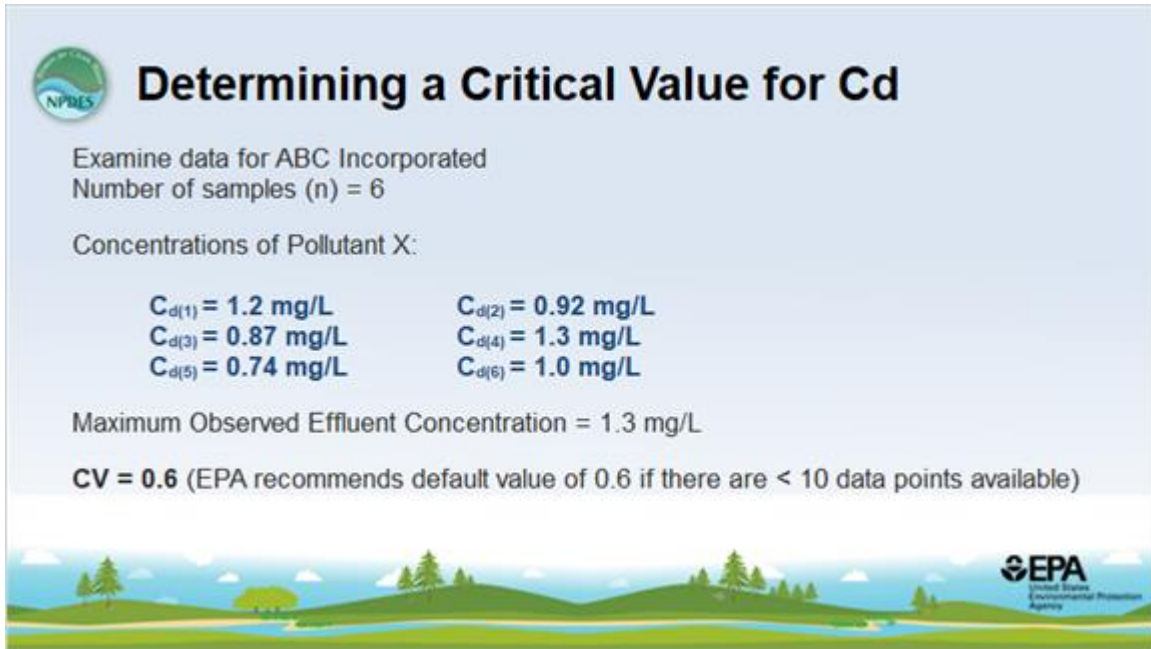
Remember taking standardized tests? If you found out that your score on the test was at the 90th percentile, that meant that your score was better than approximately 90 percent of the other people who took the test. If you didn't do quite that well, your score might have been at the 70th percentile. If you had a score in the middle of the pack, it would have been at the 50th percentile.

So, what percentile should we select as the critical value for C_d ?

EPA recommends that the critical value for the pollutant concentration in the effluent be at the 90th percentile or above.

For our example in this presentation, we are going to use the 99th percentile, which EPA also uses in its TSD.

1.36 Determining a Critical Value for Cd



Determining a Critical Value for Cd

Examine data for ABC Incorporated
Number of samples (n) = 6

Concentrations of Pollutant X:

$C_{d(1)} = 1.2 \text{ mg/L}$	$C_{d(2)} = 0.92 \text{ mg/L}$
$C_{d(3)} = 0.87 \text{ mg/L}$	$C_{d(4)} = 1.3 \text{ mg/L}$
$C_{d(5)} = 0.74 \text{ mg/L}$	$C_{d(6)} = 1.0 \text{ mg/L}$

Maximum Observed Effluent Concentration = 1.3 mg/L

CV = 0.6 (EPA recommends default value of 0.6 if there are < 10 data points available)

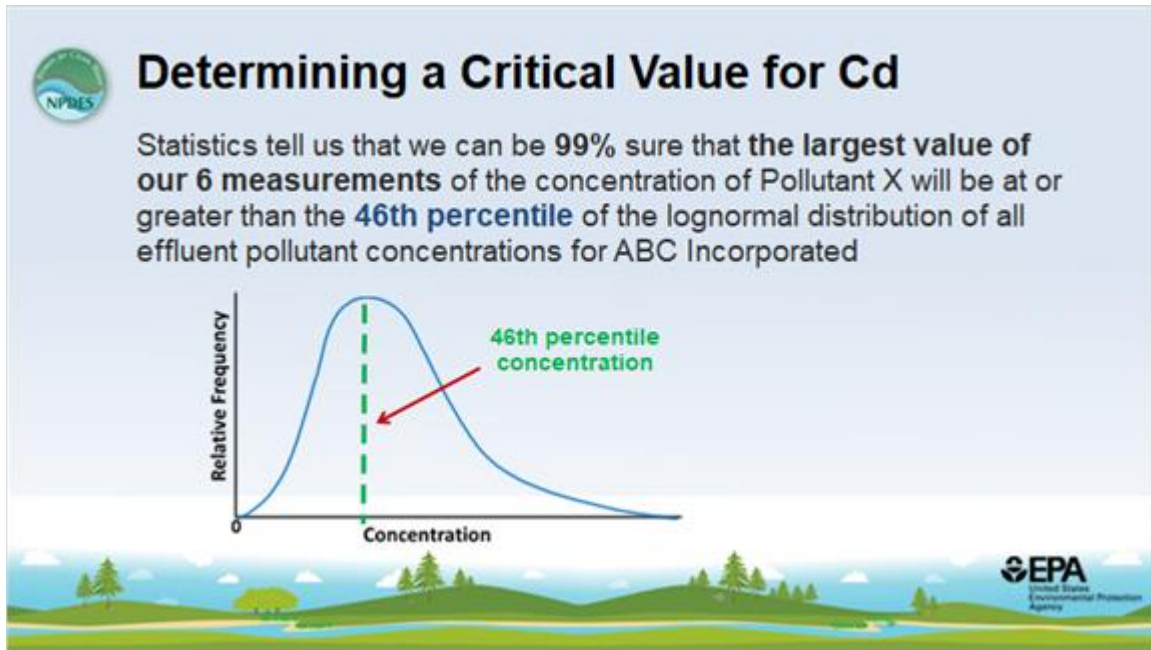
Notes:

Let's look again at our effluent data for the discharge of Pollutant X from ABC Incorporated and see how we would find the 99th percentile of the pollutant concentration.

Remember, we had six samples, and we said that the maximum concentration we observed likely would not be considered the critical value because six samples simply do not tell us enough about the variability of pollutant concentrations over time.

But, knowing what we know about the lognormal distribution, is there anything we can we say about these six samples?

1.37 Determining a Critical Value for Cd



Notes:

Well, in fact, there is something we can say about our six samples.

Statistically, we can say that if we have six measurements of the concentration of Pollutant X in ABC Incorporated's effluent, we can be 99 percent sure that the highest of those six samples is at or greater than the 46th percentile on the lognormal distribution of effluent pollutant concentrations for ABC Incorporated.

In other words, we are very certain that at least 46 percent of the time, the concentration of Pollutant X in ABC Incorporated's effluent will be below our highest measured concentration, which was 1.3 mg/L.

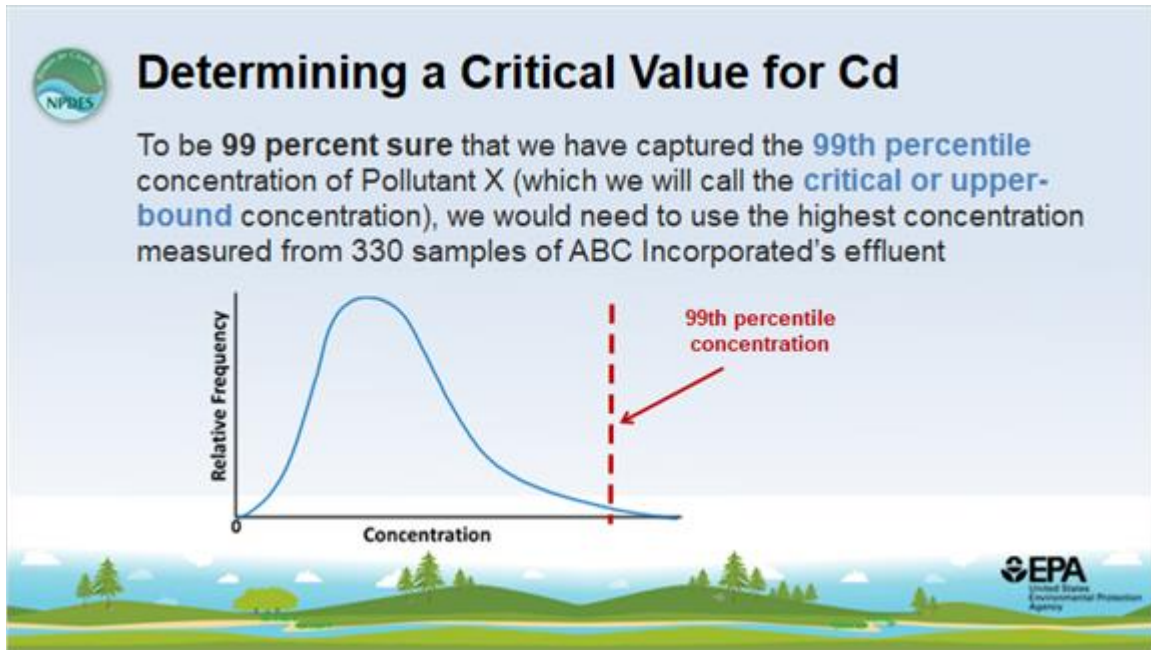
Now, is the 46th percentile value a good representative of the critical condition?

Well, no it is not. We just said that what we wanted to look for as the critical condition was the 99th percentile concentration of the pollutant in the effluent.

The 46th percentile is well below that and, in fact, is even below the average value.

So our intuition was correct. Six samples are simply not sufficient to determine a critical value for the effluent concentration of Pollutant X.

1.38 Determining a Critical Value for Cd

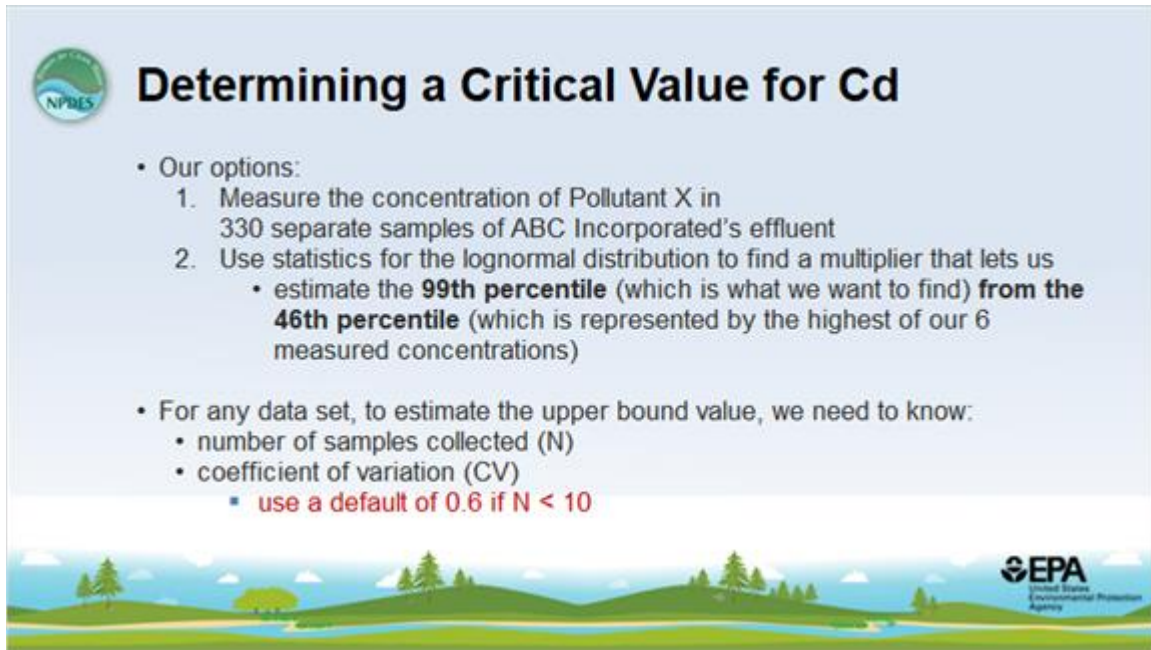


Notes:

If we apply some statistical “magic” related to the lognormal distribution, it tells us is that it would actually take at least 330 measured values of the concentration of Pollutant X in the effluent for us to be 99 percent sure that our highest measured value is at the 99th percentile on the lognormal distribution.

So, we would need 330 samples to get our critical value, but we only have six.

1.39 Determining a Critical Value for Cd



Determining a Critical Value for Cd

- Our options:
 1. Measure the concentration of Pollutant X in 330 separate samples of ABC Incorporated's effluent
 2. Use statistics for the lognormal distribution to find a multiplier that lets us
 - estimate the **99th percentile** (which is what we want to find) **from the 46th percentile** (which is represented by the highest of our 6 measured concentrations)
- For any data set, to estimate the upper bound value, we need to know:
 - number of samples collected (N)
 - coefficient of variation (CV)
 - use a default of 0.6 if $N < 10$

Notes:

What options do we have for getting a critical value for Cd?

Our first option is to get back out there, or have the permitted facility get back out there, and take another 324 random samples of the effluent over time so that we can be sure we have found the 99th percentile value of the concentration of Pollutant X.

Although in some cases that kind of data set may be available, most of the time it probably will not be, which is why I think I'll let the summer intern inform the facility of that option.


Our second option, and the one we are more likely to apply, is to use EPA's TSD method to estimate the 99th percentile value based on the relationship on the lognormal distribution between the 46th percentile (which, if you remember, is what we know from our 6 samples) and the 99th percentile (which is what we're trying to find).

In fact, we can use the TSD method to estimate the 99th percentile from any size data set. We simply need to know the number of samples that we have in the data set and the coefficient of variation for that data set.

You should note that EPA recommends a default coefficient of variation of 0.6 if your data set is less than 10 samples.

Let's look at a table from the TSD that provides us with the relationship we need.


1.40 Reasonable Potential Multiplying Factors



Reasonable Potential Multiplying Factors
(99% Confidence Level and 99% Probability Basis)

Sample Number	Coefficient of Variation									
	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
1	2.5	6.0	13.2	26.5	48.3	81.4	128.0	190.3	269.9	368.3
2	2.0	4.0	7.4	12.7	20.2	30.3	43.0	58.4	76.6	97.5
3	1.9	3.3	5.6	8.9	13.4	19.0	25.7	33.5	42.3	52.0
4	1.7	2.9	4.7	7.2	10.3	14.2	18.6	23.6	29.1	35.1
5	1.7	2.7	4.2	6.2	8.6	11.5	14.8	18.4	22.4	26.5
6	1.6	2.5	3.8	5.5	7.5	9.8	12.4	15.3	18.3	21.5
7	1.6	2.4	3.5	5.0	6.7	8.7	10.8	13.1	15.6	18.2
8	1.5	2.3	3.3	4.6	6.1	7.8	9.6	11.6	13.6	15.8
9	1.5	2.2	3.2	4.3	5.7	7.1	8.7	10.4	12.2	14.0
10	1.5	2.2	3.0	4.1	5.3	6.6	8.0	9.5	11.0	12.6
11	1.4	2.1	2.9	3.9	5.0	6.2	7.4	8.8	10.1	11.5
12	1.4	2.0	2.8	3.7	4.7	5.8	7.0	8.1	9.4	10.6
13	1.4	2.0	2.7	3.6	4.5	5.5	6.5	7.6	8.7	9.9
14	1.4	2.0	2.6	3.4	4.3	5.2	6.2	7.2	8.2	9.2
15	1.4	1.9	2.6	3.3	4.1	5.0	5.9	6.8	7.7	8.7
16	1.4	1.9	2.5	3.2	4.0	4.8	5.6	6.5	7.3	8.2
17	1.4	1.9	2.5	3.1	3.8	4.6	5.4	6.2	7.0	7.8
18	1.4	1.9	2.4	3.0	3.7	4.4	5.2	5.9	6.7	7.4
19	1.4	1.8	2.4	3.0	3.6	4.3	5.0	5.7	6.4	7.1
20	1.3	1.8	2.3	2.9	3.5	4.2	4.8	5.5	6.1	6.8

Annotations: A red circle highlights '6' in the Sample Number column. A red arrow points to the '0.6' column header. A red circle highlights the value '3.8' in the row for Sample Number 6 and Coefficient of Variation 0.6.



Notes:


EPA has supplied a table of multiplying factors in the TSD that relate the percentile represented by the maximum of a specific number of samples (N) to the 99th percentile.

Remember, in our case, we had 6 samples, and the highest value from those 6 samples represents the 46th percentile on the lognormal distribution curve.

We are going to take EPA's advice and we will assume, because we have less than 10 samples, that we have a coefficient of variation of 0.6.

We see that the multiplier we use to find the 99th percentile value when we have 6 samples and a coefficient of variation of 0.6, would be 3.8.

1.41 Determining a Critical Value for Cd





Determining a Critical Value for Cd

Examine data for ABC Incorporated using the TSD statistical approach
Number of samples (n) = 6

Concentrations of Pollutant X:

$C_{d(1)} = 1.2 \text{ mg/L}$	$C_{d(2)} = 0.92 \text{ mg/L}$
$C_{d(3)} = 0.87 \text{ mg/L}$	$C_{d(4)} = 1.3 \text{ mg/L}$
$C_{d(5)} = 0.74 \text{ mg/L}$	$C_{d(6)} = 1.0 \text{ mg/L}$

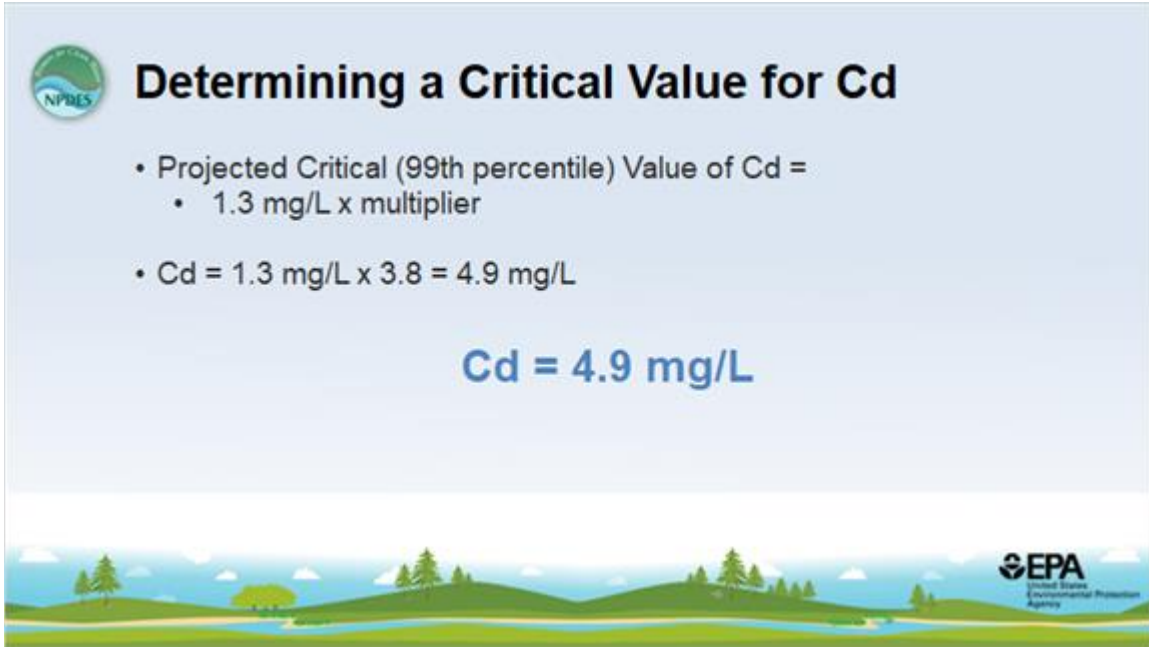
Maximum Observed Effluent Concentration = 1.3 mg/L



Notes:

Once again, remember that our maximum observed effluent concentration from our six samples was 1.3 mg/L.

1.42 Determining a Critical Value for Cd



Determining a Critical Value for Cd

- Projected Critical (99th percentile) Value of Cd =
 - 1.3 mg/L x multiplier
- Cd = 1.3 mg/L x 3.8 = 4.9 mg/L

Cd = 4.9 mg/L

The slide features a light blue background with a decorative footer showing a landscape with green hills, trees, and a blue sky. The NPDES logo is in the top left, and the EPA logo is in the bottom right.

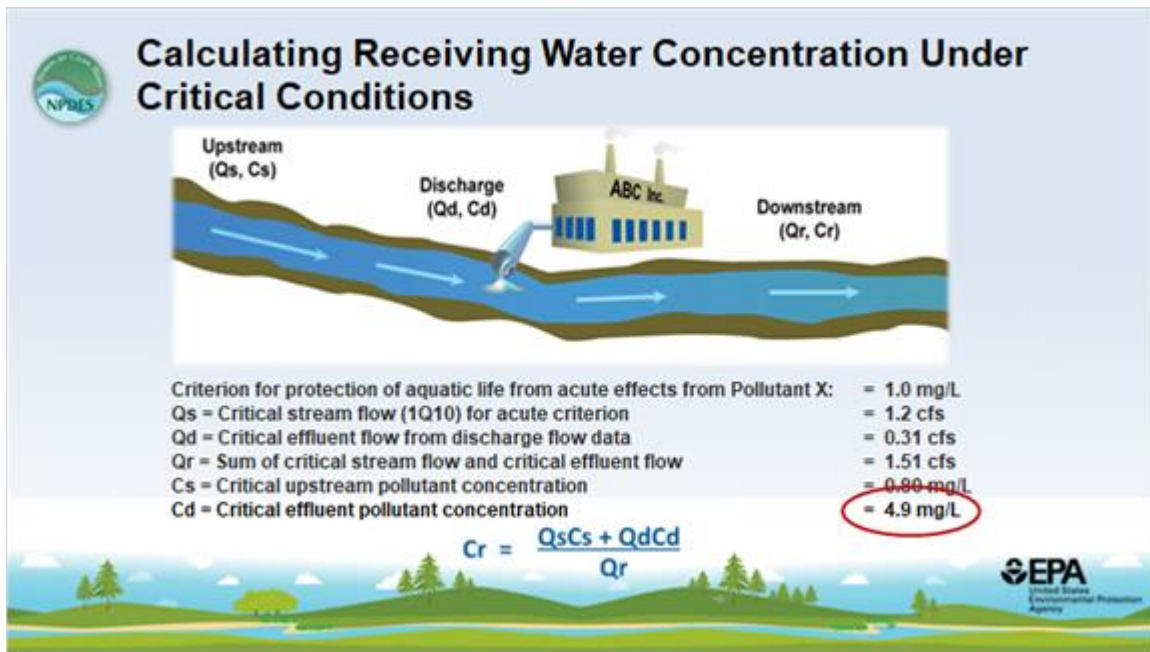
Notes:

So, we simply have to multiply our maximum measured concentration (1.3 mg/L) by the multiplier from the table, which we determined was 3.8.

And that gives us a critical value of 4.9 mg/L for Cd, the pollutant concentration in the effluent.

Well, now that I've done the hard part, I am going to give this value to Dave to finish out our calculations.

1.43 Calculating Receiving Water Concentration Under Critical Conditions



Notes:

Thanks Greg.

That was a lot of work to find our value of Cd, but now we can demonstrate that we met the regulatory requirement to account for the variability of the effluent concentration.

Now, with all of our input variables defined, we're ready to apply our mass balance model and see what we get.

So here is our depiction of ABC Incorporated again, and recall that we are looking at a conservative pollutant under rapid and complete mixing conditions and our goal is to determine whether the discharge from ABC Incorporated will cause, have the reasonable potential to cause, or contribute to an excursion above the acute criterion for Pollutant X.

We apply our water quality model to determine the expected concentration of Pollutant X in the receiving water.

So, let's review where we are so far.

The water quality standards tell us that the acute criterion for Pollutant X, that we can't exceed in the receiving water, is 1.0 mg/L.

We also have examined the water quality standards and available effluent and ambient data to determine critical values for the upstream flow, Qs, the effluent flow, Qd, and the upstream concentration of Pollutant X, Cs.

In addition, we just used effluent concentration data for Pollutant X to determine the expected 99th percentile concentration of Pollutant X in the discharge from ABC Incorporated. In this case we projected the 99th percentile concentration as 4.9 mg/L.

1.44 Expected Receiving Water Concentration

Expected Receiving Water Concentration

$$C_r = \frac{Q_s C_s + Q_d C_d}{Q_r}$$
$$C_r = \frac{(1.2 \text{ cfs})(0.80 \text{ mg/L}) + (0.31 \text{ cfs})(4.9 \text{ mg/L})}{(1.2 \text{ cfs}) + (0.31 \text{ cfs})}$$
$$C_r = 1.6 \text{ mg/L}$$

EPA
United States
Environmental Protection
Agency

Notes:

When we plug in all of the values that we've collected and calculate C_r , we find that the concentration of Pollutant X downstream from the discharge from ABC Incorporated could reach 1.6 mg/L under these critical conditions.

1.45 Is There Reasonable Potential?

Is There Reasonable Potential?

Upstream (Qs, Cs) Discharge (Qd, Cd) ABC Inc. Downstream (Qr, Cr)

- For ABC Incorporated:
 - Projected $Cr = 1.6 \text{ mg/L} > 1.0 \text{ mg/L}$ (acute criterion)
 - The discharge of Pollutant X from ABC Incorporated would **cause, have the reasonable potential to cause, or contribute** to an excursion of the acute aquatic life criterion.
- **The permit writer must calculate WQBELs for Pollutant X.**

EPA
United States Environmental Protection Agency

Notes:


If we compare our calculated concentration of Pollutant X of 1.6 mg/L to the acute aquatic life criterion of 1.0 mg/L, we can see that our projected downstream concentration would exceed the criterion under these critical conditions.

Thus, we've determined that the discharge of Pollutant X from ABC Incorporated would cause, have the reasonable potential to cause, or contribute to an excursion of that criterion for Pollutant X

There is reasonable potential and we are required by the NPDES regulations calculate water quality-based effluent limits for Pollutant X for ABC Incorporated.




Whew! That was a lot of work to answer a simple question, but now we're finished, right Greg?

1.46 What Next?



What Next?

- We have considered only one aquatic life criterion. We still would need to consider, if available:
 - additional aquatic life criteria
 - human health criteria
 - wildlife criteria, etc.
- Repeat the entire analysis for additional pollutants of concern and additional outfalls
- For each pollutant for which we determine there is reasonable potential to exceed any of the criteria for that pollutant, **calculate chemical-specific WQBELs (Module 6D)**
- When there is no reasonable potential
 - determine whether any existing limitations should be retained
 - consider appropriate monitoring requirements



Notes:

Not quite, Dave.

Its important to remember that we need to repeat this process for all applicable criteria for Pollutant X.

In addition, we need to remember that the critical conditions might change in our calculations.

For example, the critical stream flow we just used when considering an acute aquatic life criterion was the 1Q10 low flow. The water quality standards could specify that the critical low flow when considering the chronic aquatic life criterion is the 7Q10 flow. We need to carefully check the water quality standards to see if the critical conditions are different for different criteria. So, we might have several more calculations we need to work through.

If our calculations demonstrate that the discharge of Pollutant X would cause, have the reasonable potential to cause, or contribute to an excursion of any of the applicable criteria for Pollutant X, then we must develop water quality-based effluent limitations for Pollutant X.

And now we really are finished, right Dave?

Well, again Greg, not quite.

After we've finished assessing reasonable potential for Pollutant X, we'll need to repeat the same process for each

pollutant of concern that we've identified for the facility that we are permitting. In fact, we might have to do this full reasonable potential analysis for multiple outfalls. Then, where we find that there is reasonable potential, we'll have to go through the steps needed to calculate chemical specific water quality-based effluent limitations.

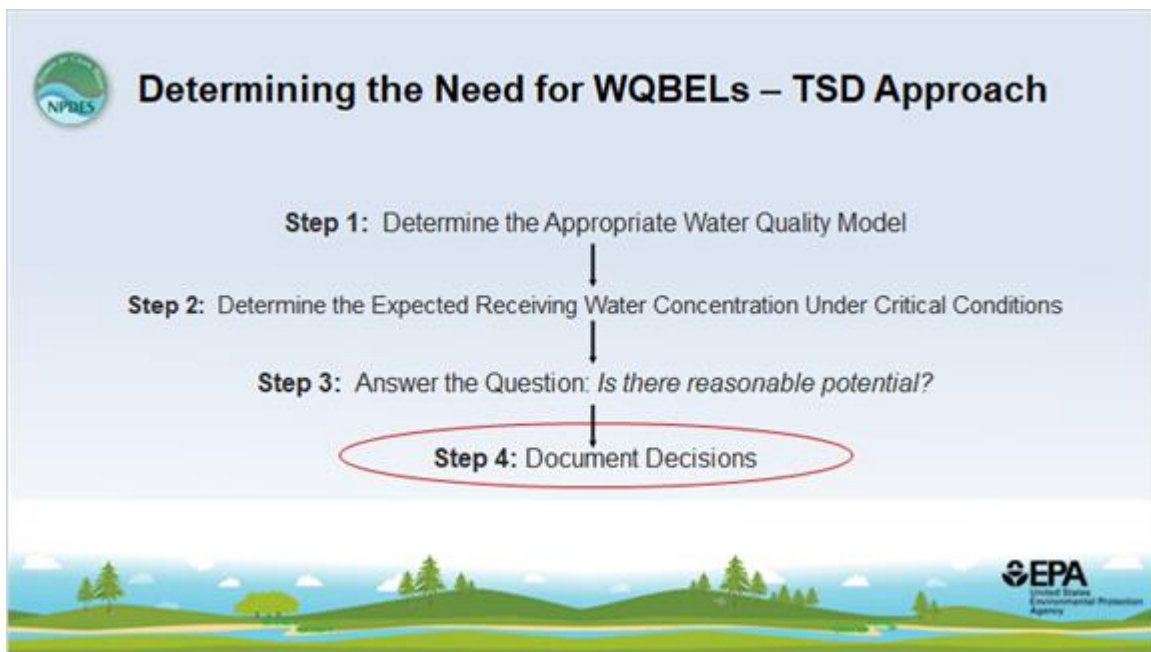
Thank goodness for spreadsheets!

For those pollutants for which there is no reasonable potential, we should look at whether there are any existing water quality-based effluent limits in the previous permit and whether the previous limits should be retained. Remember, even if we decide that it is technically appropriate to remove the limit, we still need to complete an anti-backsliding analysis in order to justify removing the existing water quality-based effluent limits from the reissued permit.

Also, for pollutants for which we have determined that there is no reasonable potential, we should consider whether or not to include monitoring requirements in the reissued permit. We might want to require some monitoring of these pollutants so that we have sufficient data to reassess reasonable potential the next time the permit is reissued.

Now we really are finished. Well, almost.


1.47 Determining the Need for WQBELs – TSD Approach



Notes:


Our final step, as usual, is to document all of our decisions.

1.48 Step 4: Document Decisions



Step 4: Document Decisions

- Document in the fact sheet or statement of basis:
 - statutory and regulatory citations
 - the applicable water quality standards
 - the process used to determine:
 - appropriate water quality model
 - critical conditions
 - dilution allowance or mixing zone
 - the process used to conduct the reasonable potential determination for each pollutant of concern (including showing calculations)



Notes:

It's very important that in the fact sheet or statement of basis for the permit, we include the appropriate statutory and regulatory citations, and citations of the applicable water quality standards and clearly explain the process we used to conduct the reasonable potential analysis, including showing calculations so that someone reviewing the fact sheet could repeat our analysis.