Adopting Water Quality Criteria for Secondary Contact Recreation: A User Guide

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The following EPA staff provided valuable contributions to the development and review of this document (in alphabetical order):

- Shari Barash, Chief, National Branch, Standards and Health Protection Division, Office of Science and Technology, Office of Water (Director, New Chemicals Division, Office of Pollution Prevention and Toxics, Office of Chemical Safety and Pollution Prevention).
- Lars Wilcut, National Branch, Standards and Health Protection Division, Office of Science and Technology, Office of Water.

The EPA gratefully acknowledges the valuable contributions of the following EPA internal reviewers of this document (in alphabetical order):

- Ed Dunne, Ph.D., Chief, National Branch, Standards and Health Protection Division, Office of Science and Technology, Office of Water.
- Susan Euling, Ph.D., Chief, Human Health Risk Assessment Branch, Health and Ecological Division, Office of Science and Technology, Office of Water.
- Colleen Flaherty, Director, Health and Ecological Division, Office of Science and Technology, Office of Water.
- Thomas Glazer, Water Law Office, Office of General Counsel.
- Sara Hisel-McCoy, Director, Standards and Health Protection Division, Office of Science and Technology, Office of Water.
- John Ravenscroft, Human Health Risk Assessment Branch, Health and Ecological Division, Office of Science and Technology, Office of Water.
- Manjali Vlcan, National Branch, Standards and Health Protection Division, Office of Science and Technology, Office of Water
- All 10 EPA regional offices.

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1. Background and Introduction

Under Section 303(c)(2)(A) of the Clean Water Act (CWA), states and authorized Tribes are responsible for adopting WQS that "…consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based upon such uses" (also see the EPA's implementing regulation at 40 CFR § 131.10 and 131.11). 40 CFR § 131.3(b) defines criteria as "…elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use. Section 304(a) of the CWA authorizes the EPA to provide scientific guidance to states and authorized Tribes by publishing and from time to time revising recommended water quality criteria that accurately reflect the latest scientific knowledge (sometimes referred to as "304(a) recommended criteria"). These CWA section 304(a) recommended criteria generally provide for the protection and propagation of fish, shellfish, and wildlife as well as recreation in and on the water (i.e., the uses specified in CWA section 101(a)(2)). Among other things, the EPA's water quality standards regulations at 40 CFR §131.11(a) require states and authorized Tribes to adopt criteria that protect the designated use and that such criteria be based on sound scientific rationale and contain sufficient parameters or constituents to protect the designated use. See Chapter 3 of the EPA's WQS Handbook for more information.

States and authorized Tribes may adopt EPA-recommended 304(a) water quality criteria or other scientifically defensible criteria. The EPA's most recent 304(a) recreational water quality criteria (RWQC) recommendations (USEPA, 2012) are intended to protect primary contact recreation (PCR). The EPA's 304(a) RWQC recommendations document describes PCR as "activities where immersion and ingestion are likely and there is a high degree of bodily contact with the water, such as swimming, bathing, surfing, water skiing, tubing, skin diving, water play by children, or similar water-contact activities."

Some states and authorized Tribes adopt recreational designated uses to reflect activities other than PCR that may be protected with criteria that are less stringent than the EPA's 304(a) RWQC recommendations for PCR. States and authorized Tribes have historically characterized these other types of recreational designated uses as secondary contact, limited water contact, limited body contact, partial body contact, incidental contact, or limited contact recreation (henceforth all referred to as secondary contact recreation or SCR). An SCR designated use consists of activities associated with less contact with ambient water or where immersion and ingestion of ambient water is less likely to occur compared to a PCR designated use. To protect SCR designated uses, some states and authorized Tribes have adopted criteria that are less stringent than the EPA's 304(a) RWQC recommendations for PCR. These less stringent criteria are based on the concept that SCR activities involve less exposure to ambient water compared to PCR activities, and the reduced exposure associated with SCR activities would compensate for a higher concentration of pathogens in the water resulting in the same risk of illness as provided by the EPA's 304(a) RWQC recommendations for PCR.

The EPA's 304(a) RWQC recommendations and two earlier EPA recommendations (USEPA, 1976, 1986) did not address the development and adoption of criteria to protect SCR. In the absence of EPA guidance, some states and authorized Tribes developed criteria values for SCR by multiplying the EPA's 304(a) RWQC recommendations by various values. A multiplier value that states and authorized Tribes commonly used to derive criteria for SCR is five. The multiplier value of five was derived from an interpretation of a 1968 National Technical Advisory Committee report (Federal Water Pollution Control Administration, 1968) that recommended criterion to protect SCR as a concentration of fecal coliforms five times higher than the report's recommended fecal coliforms criterion to protect PCR.

There are several concerns with the practice of deriving criteria for SCR by multiplying EPA's 304(a) RWQC recommendations by five:

1. The PCR fecal coliforms criterion value recommended in the 1968 National Technical Advisory Committee report was derived from now outdated epidemiological evidence.
2. The SCR fecal coliforms criterion value from that same report was based only on the opinion of the authors rather than on epidemiological evidence (the 1968 National Technical Advisory Committee report states: "In the absence of local epidemiological experience, the Subcommittee recommends…").
3. The EPA has moved away from recommending fecal coliforms as fecal indicator bacteria (FIB) because more recent epidemiological studies suggest *Escherichia coli* (*E. coli)* for fresh recreational waters and *Enterococci* for fresh and marine recreational waters are better predictors of risk of gastrointestinal illness than fecal coliforms (USEPA, 1986; Wade, Pai, Eisenberg, & Colford, 2003). Thus, multiplying the fecal coliforms criterion may not provide the expected illness risk level when applied to *E. coli* or *Enterococci*.

States and authorized Tribes need a method to develop and evaluate criteria to protect SCR in a scientifically defensible manner.

In 2022 the EPA published a white paper describing a risk-based method states and authorized Tribes could use to derive criteria that protect SCR (USEPA, 2022). Neither the white paper nor the method it describes are CWA section 304(a) recommended criteria. Rather, together the white paper and the method it describes are one scientifically defensible approach states and authorized Tribes could use to adjust the EPA's 304(a) RWQC recommendations for PCR that would provide a similar risk of gastrointestinal illness in exposure scenarios associated with SCR activities. The purpose of this user guide described herein is to help states and authorized Tribes implement the method described in the EPA's 2022 white paper. The EPA may update this user guide in the future. States and authorized Tribes may use other scientifically defensible methods for developing criteria to protect SCR.

2. Secondary Contact Recreational Designated Uses

The EPA describes PCR as "activities where immersion and ingestion are likely and there is a high degree of bodily contact with the water, such as swimming, bathing, surfing, water skiing, tubing, skin diving, water play by children, or similar water-contact activities" (USEPA, 2012). However, the EPA has not described SCR. Nevertheless, some states and authorized Tribes have adopted recreational designated uses that differ from the EPA's description of PCR where the state or authorized Tribe has determined through a use attainability analysis (UAA) that water quality cannot support all activities associated with PCR. Although states and authorized Tribes have used a variety of different names for such SCR designated uses, their common characteristic is that they are associated with recreational activities with a lower probability of bodily contact with ambient water, where immersion is less likely, or the probability or magnitude of incidental ingestion of water is lower compared to PCR. For example, some states and authorized Tribes adopt a specific activity as the SCR designated use such as “boating” or “fishing,” whereas other states and authorized Tribes adopt a designated use explicitly called SCR that includes any SCR activity. For purposes of this document, the EPA refers to all such designated uses as SCR.

The EPA recommends states and authorized Tribes clearly define SCR designated uses in the context of specific recreational activities and adopt those definitions into their WQS or other appropriate publicly available guidance. The method in the white paper the EPA published in 2022 to derive SCR criteria depends on knowledge of the specific recreational activity or activities the state or authorized Tribe intends to protect. If the state or authorized Tribe defines an SCR designated use using more than one recreational activity, the SCR criteria must protect the activity associated with the greatest exposure and thus the greatest illness risk to meet the requirements at 40 CFR §131.11(a)(1). States and authorized Tribes may also adopt different SCR designated uses for different waters with different corresponding SCR criteria based on the recreational activities characterizing each SCR designated use. States and authorized Tribes can help ensure that SCR in such waters is protected by clearly articulating the specific recreational activities that define the SCR designated use.

3. Calculating Criteria Values to Protect Secondary Contact Recreation

3.1. **Rationale**

Gastrointestinal (GI) illness associated with water recreation occurs when an individual incidentally ingests ambient water that contains pathogenic microorganisms. In terms of microbial risk assessment, the exposure is incidental ingestion, and the dose is the specific number of pathogenic microorganisms ingested during the exposure. The probability of illness is related to the dose of pathogenic microorganisms. Lower doses result in a lower probability of illness and higher doses result in a higher probability of illness. When the EPA was developing its 304(a) RWQC recommendations for PCR, the EPA determined that FIB concentration had the strongest association with GI illness and concluded that FIB criteria based on protecting the public from GI illness would prevent most types of recreational waterborne illnesses.

The EPA’s 304(a) RWQC recommendations are based on the risk of illness from PCR activities. The EPA evaluated FIB concentrations and illness rates of beachgoers engaging in PCR activities and chose concentrations of FIB associated with two target illness rates (one at 32 illnesses per 1,000 recreators and the other at 36 illnesses per 1,000 recreators). However, the probability of illness is determined by the dose of pathogenic microorganisms, and the dose of pathogenic microorganisms is determined by both the concentration of pathogenic microorganisms in the water and the amount of water incidentally ingested. Therefore, the same illness rate as the target illness rate for PCR can be achieved when ambient water has a higher concentration of pathogenic microorganisms if less water is incidentally ingested during recreation.

Figure 1 shows three simplified hypothetical scenarios demonstrating the interaction between the amount of incidental ingestion of ambient water associated with different types of recreational activities, the concentration of pathogenic microorganisms, and illness risk.[1] The left side of Figure 1 shows one simplified hypothetical scenario where the concentration of FIB in a waterbody exactly meets the EPA's 304(a) RWQC recommendations. In this simplified hypothetical scenario, there are 3 pathogenic microorganisms in every 3 milliliters (ml) of water equating to a concentration of 1 microorganism per milliliter. If PCR activities result in ingestion of 3 ml of water, then recreators will ingest a dose of 3 pathogenic microorganisms resulting in the target illness rate specified in the EPA's 304(a) RWQC recommendations. The right side of Figure 1 shows two simplified hypothetical scenarios where the concentration of FIB in the waterbody is above the level specified in the EPA's 304(a) RWQC recommendations. In the first hypothetical scenario on the right side of Figure 1, the concentration of pathogenic microorganisms is 3 microorganisms per milliliter – three times higher than the hypothetical scenario on the left of Figure 1. If PCR activity in the poorer water quality results in ingestion of 3 ml of water, then primary contact recreators will ingest a dose of 9 pathogenic microorganisms resulting in an illness rate greater than the target illness rate specified in the EPA's 304(a) RWQC recommendations. In the second hypothetical scenario on the far-right side of Figure 1, the concentration of pathogenic microorganisms is the same except SCR activity results in ingestion of 1 ml of water resulting in a dose of 3 pathogenic microorganisms resulting in a target illness rate that is the same as the first hypothetical scenario on left side of Figure 1 that exactly meets the EPA's 304(a) RWQC recommendations.

[1] The purpose of this simplified hypothetical scenario is to demonstrate a single concept. It does not address all factors that may affect risk of illness.

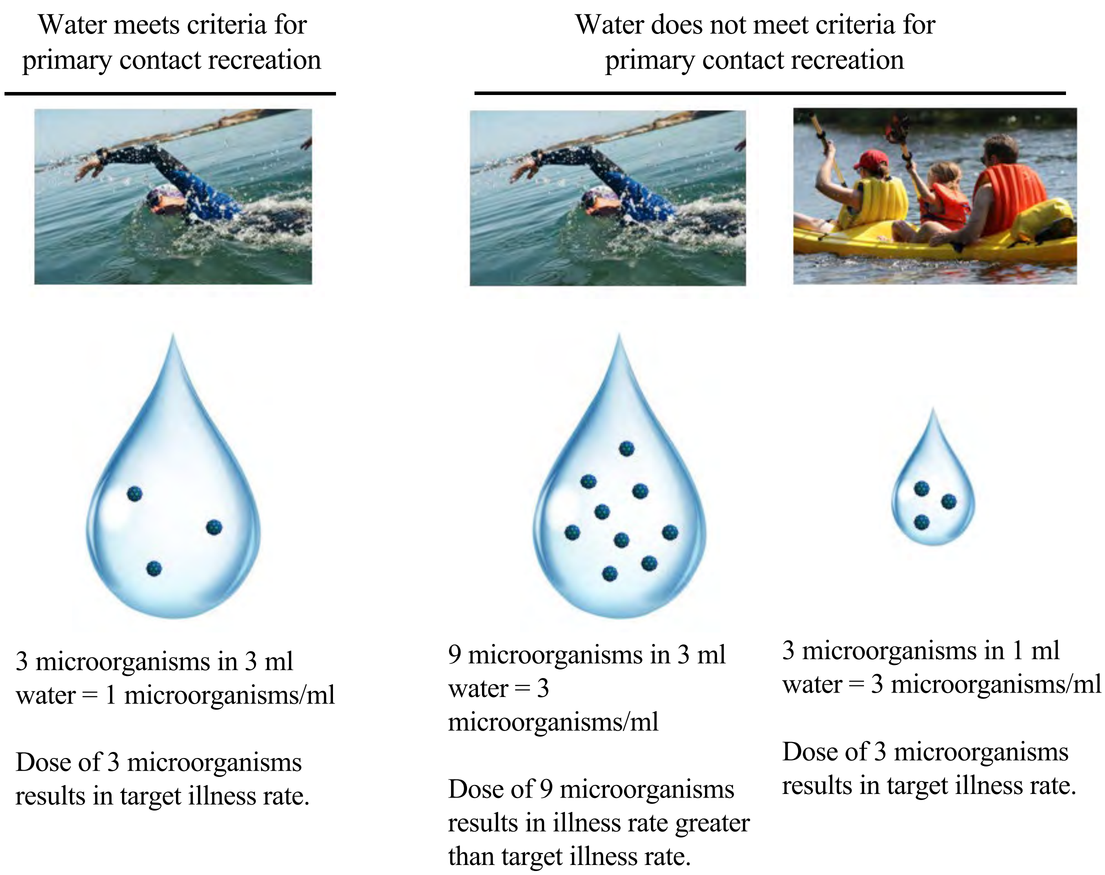

Figure 1. Simplified hypothetical scenarios demonstrating the interaction between the amount of incidental ingestion of ambient water associated with different types of recreational activities, the concentration of pathogenic microorganisms, and illness risk.

Equation 1 below provides a mechanism for states and authorized Tribes to calculate protective criteria for SCR that results in the same target illness rate as would occur during PCR in waters meeting the EPA's 304(a) RWQC recommendations. Appropriate application of Equation 1 should result in criteria that protect the designated use of SCR.

3.1. **Equation for calculating protective criteria for SCR**

States and authorized Tribes could calculate scientifically defensible SCR water quality criteria using the equation[2]:

$$C_{secondary} = C_{primary} \times \frac{I_{primary}}{I_{secondary}} \qquad \text{(Equation 1)}$$

where:

[2] Adapted from Equation 6 in USEPA (2022)

$C_{primary}$ = an EPA 304(a) RWQC recommended magnitude value for PCR (or in appropriate cases an adopted and EPA-approved site-specific criterion value – see section 3.2.7).

$C_{secondary}$ = the analogous criteria magnitude value for SCR with a risk of illness comparable to the risk associated with $C_{primary}$.

$I_{primary}$ = the amount of ambient water incidentally ingested during PCR.

$I_{secondary}$ = the amount of ambient water incidentally ingested during SCR.

This method essentially calculates a multiplier value as the ratio of incidental ingestion associated with PCR to incidental ingestion associated with SCR and applies that multiplier to the criteria values for PCR to derive criteria for SCR.

3.2. **Equation inputs**

Equation 1 requires the input values for variables $C_{primary}$, $I_{primary}$, and $I_{secondary}$. Appropriate input values ensure the calculation provides protective SCR criteria. Below are recommendations for how to choose appropriate values for $C_{primary}$, $I_{primary}$, and $I_{secondary}$.

3.2.1. *Considerations when selecting the value of $C_{primary}$*

Recreational water quality criteria are usually expressed as a magnitude, duration, and frequency that should not be exceeded. The EPA developed its method for deriving criteria for SCR by adjusting the magnitude components of the EPA's 304(a) RWQC recommendation for PCR. Thus, in most cases, the value $C_{primary}$ in Equation 1 should be the magnitude values for PCR from the EPA's 304(a) RWQC recommendations (or in appropriate cases the adopted and EPA-approved site-specific criterion values – see section 3.2.7) the state or authorized Tribe are adjusting to derive criteria magnitude values for SCR with the same target illness rate.

The EPA's 304(a) RWQC recommends *Escherichia coli* (*E. coli*) for fresh recreational waters and *Enterococci* for fresh and marine recreational waters as FIB. The EPA's 304(a) RWQC recommends states and authorized Tribes adopt two related but distinct criteria magnitude values of FIB to protect PCR. One magnitude value is a geometric mean (GM), and the other magnitude value is a statistical threshold value (STV). The GM magnitude value is the calculated GM of the number of colony-forming units (CFU) of FIB in 100 ml water samples that the waterbody should not exceed in any 30-day interval, and the STV is the number of CFU of FIB that should not be exceeded in more than 10 percent of the same 100 ml water samples that were used to calculate the GM. Table 1 shows the EPA's 304(a) RWQC recommendations for PCR.

Table 1. The EPA's 304(a) RWQC recommendations for PCR.

Indicator	Estimated Illness Rate 36 per 1,000		OR	Estimated Illness Rate 32 per 1,000	
	Magnitude			Magnitude	
	GM	STV		GM	STV
Enterococci – marine and fresh	35	130		30	110
E. coli – fresh	126	410		100	320
Duration and Frequency: The waterbody GM should not be greater than the selected GM magnitude in any 30-day interval. There should not be greater than a ten percent excursion frequency of the selected STV magnitude in the same 30-day interval. All values are CFU per 100 ml of water.					

The EPA's 304(a) RWQC recommends using both GM and STV magnitude values together (rather than a GM alone or STV alone) because both are needed to protect PCR designated uses. The level of protection associated with the EPA's 304(a) RWQC recommendations are described by the distribution of water quality measurements taken over an averaging period. The STV corresponds to the 90th percentile of the same distribution of water quality measurements described by the GM value, and thus should not be exceeded more than 10 percent of the time. Exceedances of the STV identifies an unusually high number of spikes in FIB measurements while considering the expected variability in water quality measurements. Specification of a level of protection is incomplete with a GM alone because it does not limit exposure to waters with an unusually high number of such events. Used together, the GM and STV indicate whether water quality is protective of the PCR designated use. Because the EPA's method for deriving SCR criteria assumes all the same factors the EPA used to derive its 304(a) RWQC recommendations for PCR, the EPA recommends using both GM and STV magnitude values together (rather than a GM alone or STV alone) to indicate water quality that is protective of an SCR designated use.

The EPA's 304(a) RWQC recommendation for PCR provides magnitude values for two levels of protection, one for 32 additional illnesses per 1,000 recreators, and the other for 36 additional illnesses per 1,000 recreators. In the EPA's 304(a) RWQC recommendation for PCR, the EPA recommends states and authorized Tribes make a risk management decision regarding their target illness rate which will subsequently determine the set of criteria values that are most appropriate for their waters. The EPA's 304(a) RWQC recommendations for PCR recommends states and authorized Tribes apply this risk management decision throughout the state or authorized Tribe to protect PCR. The EPA recommends not selecting a GM and STV associated with different target illness rates because the illness rate of the resulting criteria would be unknown.

The estimated illness rate of SCR criteria resulting from Equation 1 is the same illness rate associated with the values of $C_{primary}$. States and authorized Tribes interested in adopting criteria to protect SCR should consider the risk levels described in the EPA's 304(a) RWQC recommendations for PCR. For states and authorized Tribes that have already adopted the EPA's 304(a) RWQC recommendations for PCR, the EPA recommends applying those same adopted PCR criteria values as $C_{primary}$. States and authorized Tribes should apply Equation 1 both for the GM and the STV, and adopt those paired values into their WQS to protect SCR. For example, if a state or authorized Tribe adopted a GM and STV for PCR based on an estimated illness rate of 32 per 1,000 recreators, the state or authorized Tribe should use those same GM and STV values for $C_{primary}$ in Equation 1 to derive corresponding GM and STV values for SCR criteria with an estimated illness rate of 32 per 1,000 recreators.

> Example: A state or authorized Tribe intends to establish an SCR designated use for an inland freshwater stream with a target illness rate of 36 per 1,000 recreators. The state or authorized Tribe should select the GM and STV for *E. coli* from EPA's 304(a) RWQC recommendations for PCR with a target illness rate of 36 per 1,000 recreators and perform two separate calculations of $C_{secondary}$ using Equation 1, one with $C_{primary}$ equal to the GM of 126 CFU and the other with $C_{primary}$ equal to the STV of 410 CFU. The state or authorized Tribe could then adopt the resulting $C_{secondary}$ values as the GM and STV to protect the SCR designated use at the same illness rate of 36 per 1000 recreators. The designated use of SCR would be protected by criteria that includes both the GM and STV once they are adopted into state WQS and approved by EPA.

3.2.2. *Data sources for $I_{primary}$ and $I_{secondary}$*

Several studies provide quantitative estimates of incidental ingestion of ambient water associated with water-related activities (DeFlorio-Barker et al., 2018; Dorevitch et al., 2011; Dufour, Evans, Behymer, & Cantu, 2006; Schets, Schijven, & de Roda Husman, 2011; Schijven & de Roda Husman, 2006; Stone, Harding, Hope, & Slaughter-Mason, 2008; Suppes, Abrell, Dufour, & Reynolds, 2014; USEPA, 2019a). These studies provide quantitative estimates of incidental ingestion associated with the following activities:

- Boating
- Canoeing in calm water (i.e., no capsizing)
- Canoeing in turbulent water (i.e., with capsizing)
- Exercise swimming
- Fishing
- Kayaking in calm water (i.e., no capsizing)
- Kayaking in turbulent water (i.e., with capsizing)
- Rowing in calm water (i.e., no capsizing)
- Rowing in turbulent water (i.e., with capsizing)
- Leisure swimming
- Occupational diving
- Sports diving with full face mask
- Sports diving with ordinary face mask

- Surfing
- Swimming
- Wading/splashing
- Walking

Chapter 3 of the EPA's Exposure Factors Handbook (USEPA, 2019b) summarizes many of these studies and compiles quantitative estimates of ingestion volume provided by those studies in a collection of tables. States and authorized Tribes may use appropriate values from those sources for $I_{primary}$ and $I_{secondary}$, or they may use other appropriate values based on scientifically defensible data on incidental ingestion of ambient water associated with recreation. The EPA anticipates future research on incidental ingestion of ambient water associated with recreation to generate additional data states and authorized Tribes could potentially use to derive scientifically defensible SCR criteria.

3.2.3. *Considerations when selecting values for $I_{primary}$*

The value $I_{primary}$ represents the amount of incidental ingestion of ambient water associated with the PCR activities used to derive $C_{primary}$. The EPA developed Equation 1 by assuming all factors related to the development of the EPA's 304(a) RWQC recommendations for PCR (hazard of concern, indicators of fecal contamination, enumeration methods, human health endpoints, scope of analysis, pathogens, and pathogen dose-response relationships) are also applicable to SCR activities except for level of exposure (USEPA, 2022). Because Equation 1 adjusts the EPA's 304(a) RWQC recommendations for PCR using an adjustment factor that is the ratio of incidental ingestion associated with the EPA's 304(a) RWQC recommendations for PCR to the incidental ingestion associated with SCR activities, the variable $I_{primary}$ should represent the level of exposure in the epidemiological studies the EPA used to develop the 304(a) RWQC recommendations for PCR.

Although the EPA's 304(a) RWQC recommendations describes PCR as "swimming, bathing, surfing, or similar water contact activities," the epidemiological studies the EPA used to develop its 304(a) RWQC recommendations evaluated illness rates of "swimmers" at public beaches in comparison to beachgoers with no water contact. However, the magnitude of exposure to ambient surface water associated with "swimming" in a recreational setting can be difficult to characterize. The EPA's epidemiological studies generally characterized "swimming" as recreation in ambient water where recreators immerse their body up to the waist or higher (USEPA, 2009; Wade et al., 2008; Wade et al., 2006). Thus, the value of $I_{primary}$ should reflect at minimum the amount of incidental ingestion of ambient water associated with recreation when recreators immerse their body up to their waist or higher.

3.2.4. *Considerations when selecting values for $I_{secondary}$*

The value $I_{secondary}$ represents the amount of incidental ingestion of ambient water associated with SCR activities. An SCR designated use can encompass a wide array of different recreational activities. The distinction between SCR and PCR is that SCR is associated with recreational activities with less incidental ingestion of ambient water compared to PCR.

Because SCR can encompass a wide array of different recreational activities, deriving protective criteria using Equation 1 requires knowledge of the specific recreational activities the state or authorized Tribe intends to protect with the SCR designated use. As recommended above, states and authorized Tribes should clearly define SCR designated uses in the context of specific recreational activities and adopt those definitions into their WQS regulations or include them in other publicly available guidance. Defining SCR designated uses by describing the specific recreational activities to be protected will help the state or authorized Tribe select an appropriate value for $I_{secondary}$, provide clarity and transparency to the EPA and the public about how the state or authorized Tribe derived the criteria values, and will help the state or authorized Tribe articulate risks associated with recreating in SCR waters so that individuals can make their own risk management decisions.

When an SCR designated use includes more than one recreational activity that may have different incidental ingestion rates, the state or authorized Tribe should select the largest value of $I_{secondary}$ associated with the SCR activities that define the SCR designated use (i.e., the recreational activity associated with the greatest exposure). If an SCR designated use includes more than one recreational activity but quantitative data on incidental ingestion is not available for all of them, states and authorized Tribes should select the largest value from the available values for $I_{secondary}$ if there is a reasonable expectation that the largest available value represents the activity with the largest incidental ingestion. Alternatively, states and authorized Tribes may perform or fund studies to derive a value for $I_{secondary}$ representing the activity associated with the greatest exposure.

3.2.5. *Other considerations when selecting values for $I_{primary}$ and $I_{secondary}$*

To derive criteria protective of SCR, Equation 1 adjusts a RWQC for PCR using an adjustment factor calculated as the ratio of $I_{primary}$ to $I_{secondary}$. This method is based on the assumption that all factors the EPA used to develop its 304(a) RWQC recommendations for PCR (hazard of concern, indicators of fecal contamination, enumeration methods, human health endpoints, scope of analysis, pathogens, and pathogen dose-response relationships) are also applicable to SCR except for the level of exposure (USEPA, 2022). Thus, when using a value of $C_{primary}$ that is based on the EPA's 304(a) RWQC recommendations, it is critically important to accurately characterize both the exposure associated with the EPA's 304(a) RWQC recommendations and the exposure associated with the SCR activities the state or authorized Tribe wishes to protect.

Chapter 3 of the EPA's Exposure Factors Handbook lists estimates of incidental ingestion associated with a wide range of water-based activities. The EPA has also derived other estimates of incidental ingestion for water quality criteria recommendations (e.g., USEPA, 2019a). In many cases, several different estimates from the same or different studies are available for the same or similar recreational activities. For example, the EPA's Exposure Factors Handbook (USEPA, 2019b) lists 27 different estimates of incidental ingestion associated with swimming that range between 3.5 ml/hour and 60.0 ml/hour. When a variety of estimates of incidental ingestion for a particular recreational activity are available, it is important to select the value that will result in scientifically defensible criteria protective of the designated use.

There are a variety of factors that can lead to different measurements of incidental water ingestion associated with recreation. One factor is measurement error. Measurement error (the difference between the measured value and its true value) can be divided into two categories: random error and systematic error.

Random error in a measurement is caused by inherently unpredictable fluctuations in the readings of a measurement apparatus or in the experimenter's interpretation of the instrumental reading. Random error shows up as different results for repeated measurements of the same quantity. Random error typically has a normal distribution with a mean of zero. Thus, the overall effect of random error decreases as the number of individual measurements increases. When selecting values for $I_{primary}$ and $I_{secondary}$, states and authorized Tribes should scrutinize the source of those values for reliable measurement methods and sufficient sample sizes to ensure statistical confidence in the results.

Systematic error, also called statistical bias, is error that is introduced by an inaccuracy involving either the observation or measurement process. Statistical bias is predictable and always affects the results of an experiment in a predictable direction. A variety of factors can result in statistical bias when measuring incidental ingestion associated with recreation. Some potential factors that could result in statistical bias include but are not limited to:

- Sex (e.g., female versus male)
- Age (e.g., children versus adults)
- Salinity (e.g., fresh waters versus marine waters)
- Study venue (e.g., natural surface waters versus pools)
- Measurement method (e.g., cyanuric acid in urine versus categorical self-reported ingestion volume)
- Activity characteristics (e.g., wading, bathing, splashing, playing, swimming)
- Exposure characteristics (e.g., any contact with water versus requiring head-immersion)
- Descriptive statistics reported (e.g., arithmetic mean, geometric mean, median, 95th percentile)
- Unit of measurement (e.g., ml/hour, ml/day, or ml/event)
- Other study-specific uncontrolled confounding variables (either known, forgotten, or unknown)

When selecting values for $I_{primary}$ and $I_{secondary}$, states and authorized Tribes should carefully evaluate the studies from which those values were derived to ensure that statistical bias will not adversely affect the results of Equation 1. One way to reduce adverse effects of statistical bias is to select a matched pair of values for $I_{primary}$ and $I_{secondary}$ that contain the same statistical bias so that they cancel through division. This approach can be described mathematically by extending Equation 1 to include all factors related to statistical bias such that:

$$C_{secondary} = C_{primary} \times \frac{I_{primary} \times \sum_{i=1}^{n} bias_i^{primary}}{I_{secondary} \times \sum_{i=1}^{n} bias_i^{secondary}} \qquad \text{(Equation 2)}$$

where:

$\sum_{i=1}^{n} bias_i^{primary}$ = the sum of *n* bias factors (signed percentage) inherent in the estimate of incidental ingestion associated with PCR.

$\sum_{i=1}^{n} bias_i^{secondary}$ = the sum of *n* bias factors (signed percentage) inherent in the estimate of incidental ingestion associated with SCR.

n = the number of bias factors.

and then rearrange Equation 2 such that:

$$C_{secondary} = C_{primary} \times \frac{I_{primary}}{I_{secondary}} \times \frac{\sum_{i=1}^{n} bias_i^{primary}}{\sum_{i=1}^{n} bias_i^{secondary}} \qquad \text{(Equation 3)}$$

Equation 3 extends Equation 1 to include statistical bias in measurements of $I_{primary}$ and $I_{secondary}$. When $\sum_{i=1}^{n} bias_i^{primary}$ equals $\sum_{i=1}^{n} bias_i^{secondary}$ (that is, the sum of all statistical bias for $I_{primary}$ and $I_{secondary}$ are the same), $\frac{\sum_{i=1}^{n} bias_i^{primary}}{\sum_{i=1}^{n} bias_i^{secondary}}$ equals 1 and Equation 3 becomes Equation 1 and there are no adverse effects of statistical bias. Although quantifying statistical bias for the purpose of deriving SCR criteria may not be feasible, this examination demonstrates that selecting values of $I_{primary}$ and $I_{secondary}$ with the same statistical bias results in unbiased output from Equation 1.

To reduce the effect of statistical bias, states and authorized Tribes should select a matched pair of values for $I_{primary}$ and $I_{secondary}$. A matched pair of values are values of $I_{primary}$ and $I_{secondary}$ with intrinsic statistical biases that are as close as possible to each other. In some cases, it may be more appropriate to select values for $I_{primary}$ or $I_{secondary}$ that have less precision if using those values reduces the difference in statistical bias between the two. In other cases, careful evaluation of the methods used to derive the chosen values may be necessary. States and authorized Tribes should include the rationale for selecting values for $I_{primary}$ and $I_{secondary}$ when submitting SCR criteria to the EPA for review under CWA section 303(c). Failure to account for differences in statistical bias when selecting values for $I_{primary}$ and $I_{secondary}$ could result in SCR criteria values that are not scientifically defensible or adequately protective of the designated use. See text box below and Section 4 for examples that demonstrate how a state or authorized Tribe might consider potential statistical bias when selecting values for $I_{primary}$ and $I_{secondary}$. In addition, the values of $I_{primary}$ and $I_{secondary}$ should be descriptive statistics that are appropriate and consistent with the distribution of the underlying data from which they were derived.

Example: A state developed criteria to protect a designated use of fishing, which is generally considered an SCR activity. The state used ingestion rates reported in a scientific journal that measured the amount of water incidentally ingested during different recreational activities (Dorevitch et al., 2011). The study measured incidental ingestion associated with fishing using two different methods - one study using self-reported ingestion (none, a drop, a teaspoon, or a mouthful) while subjects fished in ambient surface waters, and the other study by measuring cyanuric acid in urine as a tracer of ingested water while subjects engaged in simulated fishing at a swimming pool. Selecting the ingestion estimate associated with fishing in ambient surface water for $I_{secondary}$ may at first appear a better choice because it would seem to more closely represent the recreational activity the state is trying to protect. However, the journal article did not report incidental ingestion during the PCR activity of swimming in ambient surface water that the state could use as $I_{primary}$. Instead, the journal article only reported incidental ingestion during the PCR activity of swimming using the tracer method in a swimming pool. To avoid the potential for statistical bias by using different measurement methods (i.e., the measurement for fishing from self-reported ingestion in ambient surface waters versus the measurement for swimming in a swimming pool from cyanuric acid in urine as a tracer of ingested water), the state selected the ingestion value associated with fishing from the swimming pool study for $I_{secondary}$. By using ingestion estimates that were both measured using the same methodology, the state minimized statistical bias and calculated the most scientifically defensible criteria to protect a designated use of fishing. See Section 4 for complete examples including calculations.

One potential source of statistical bias in estimates of incidental ingestion is age. Children immerse their head and body more than adults (USEPA, 2009; Wade et al., 2008; Wade et al., 2006), display more hand-to-mouth contact (Xue et al., 2007), stay in the water longer (Dufour, Behymer, Cantu, Magnuson, & Wymer, 2017; Wade et al., 2008; Wade et al., 2006), and ingest more water (DeFlorio-Barker et al., 2018; Dufour et al., 2017; Suppes et al., 2014) when recreating.

The EPA's method for deriving criteria to protect SCR designated uses is based on the assumption that all factors the EPA used to develop its 304(a) RWQC recommendations for PCR are also applicable to SCR except for the level of exposure (USEPA, 2022). The age range of the population EPA studied to derive its 304(a) RWQC recommendations for PCR was the general population including children. Therefore, when using EPA's 304(a) RWQC recommendations for PCR as values for $C_{primary}$, states and authorized Tribes should select matched pairs of values for $I_{primary}$ and $I_{secondary}$ that represent incidental ingestion during recreation by the general population including children. If available values for $I_{primary}$ and/or $I_{secondary}$ are derived from populations with distributions of ages that substantially deviates from the general population, states and authorized Tribes should try to recalculate age matched values from the underlying data or derive and apply appropriate correction factors (however, see section 3.2.6 for information about how to consider potentially greater exposure of children during recreation).

3.2.6. *Consideration for protection of children*

As discussed in section 3.2.5, children may have greater exposure to ambient water during PCR activities compared to adults. If a state or authorized Tribe seeks to develop criteria that accounts for potentially greater exposure to children, the state or authorized Tribe could select a value for $I_{secondary}$ that represents the amount of ambient water incidentally ingested during a particular recreational activity only by children. If using EPA's 304(a) RWQC recommendations for PCR as values for $C_{primary}$, the value of $I_{primary}$ should continue to represent the amount of ambient water incidentally ingested during PCR by the general population including children because that was the population the EPA studied to develop its 304(a) RWQC recommendations for PCR. The incidental ingestion of ambient water by children would presumably be greater than the incidental ingestion of ambient water by the general population including children if children overall ingest more ambient water when they recreate. The resulting higher value of $I_{secondary}$ would then account for the greater exposure by children when recreating. In this special case, the difference in age distributions underlying the values of $I_{primary}$ and $I_{secondary}$ would not be statistical bias, but instead reflect an actual difference in exposure between these two groups of recreators. States and authorized Tribes should continue to minimize other potential sources of statistical bias when selecting values for $I_{primary}$ and $I_{secondary}$.

3.2.7. *Site-specific criteria*

States and authorized Tribes may also use the methodology described in the EPA's 2022 white paper (USEPA, 2022) to calculate site-specific SCR criteria that reflect site-specific conditions of a particular waterbody. To do so, the state or authorized Tribe would enter into Equation 1 the EPA-approved site-specific PCR criteria applicable to that waterbody as the values of $C_{primary}$, values for $I_{primary}$ that characterize exposure associated with the derivation of the site-specific PCR criteria, and values for $I_{secondary}$ that characterizes exposure associated with the SCR designated use.

Site-specific SCR criteria, like all criteria, must be scientifically defensible and protective of the designated use as required by the EPA's water quality standards regulations at 40 CFR §131.11(a). As with SCR criteria based on EPA's 304(a) RWQC recommendation, states and authorized Tribes should include the data, information, and rationale used to select the values used in Equation 1 ($C_{primary}$, $I_{primary}$, and $I_{secondary}$) and an explanation of how the state or authorized Tribe derived the site-specific SCR criteria values when submitting them to the EPA for review. This information enables the EPA to determine if the SCR criteria are scientifically defensible and protective of the SCR designated use.

4. Example Calculations

The selection of appropriate values to enter in Equation 1 and subsequent calculation of SCR criteria are demonstrated in the following hypothetical examples.

Example 1

A state decided to adopt a designated use of fishing (an SCR activity) in a stream that did not support PCR[3]. The state adopted into their WQS the designated use of fishing for that stream and

[3] If a state wishes to remove a PCR designated use for a particular water body, it must follow the WQS revision process set out in 40 CFR 131.10 including providing an appropriate justification (i.e., a use attainability analysis),

E. coli criteria specified as a GM of 378 CFU and an STV of 1,230 CFU. The state used the following rationale in its documentation when submitting the WQS to the EPA for review and action.

Deriving SCR criteria for fishing using Equation 1 requires the appropriate selection of $C_{primary}$ (criteria magnitude values for PCR from the EPA's 304(a) RWQC recommendations, or in appropriate cases, adopted and EPA-approved site-specific criterion values), $I_{primary}$ (amount of incidental ingestion associated with the activities used to derive $C_{primary}$) and $I_{secondary}$ (amount of incidental ingestion associated with the SCR activity of fishing). The state currently has WQS for PCR for other fresh surface waters based on the EPA's 304(a) RWQC recommendations. The state's current PCR criteria are associated with an illness rate of 36 per 1,000 recreators. Because the state is currently using *E. coli* as indicator bacteria for waters that support PCR and has policies and procedures to monitor water quality using *E. coli* as an indicator, the state chooses to continue using *E. coli* as the water quality indicator and use its EPA 304(a) RWQC recommendation for PCR (GM of 126 CFU and an STV of 410 CFU) as the values of $C_{primary}$.

To use Equation 1, the state needs to identify values for $I_{primary}$ and $I_{secondary}$. Chapter 3 of the EPA's 2019 Exposure Factors Handbook lists incidental ingestion estimates for several different recreational activities. Table 3-96 in the EPA's 2019 Exposure Factors Handbook lists ingestion estimates reported in a scientific paper (Dorevitch et al., 2011) for recreational activities that include fishing (shown in Figure 2).

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and must adopt the highest attainable use, consistent with 40 CFR 131.10(g). The State must also adopt criteria to protect the newly designated highest attainable use consistent with 40 CFR 131.11. See the Designated Uses chapter in the WQS Handbook for more information.

Table 3-96. Estimated Water Ingestion during Water Recreation Activities (mL/hr)								
		Surface Water Study				Swimming Pool Study		
Activity	*N*	Median	Mean	UCL	*N*	Median	Mean	UCL
Limited Contact Scenarios								
Boating	316	2.1	3.7	11.2	0	-	-	-
Canoeing	766				76			
No capsize		2.2	3.8	11.4		2.1	3.6	11.0
With capsize		3.6	6.0	19.9		3.9	6.6	22.4
All activities		2.3	3.9	11.8		2.6	4.4	14.1
Fishing	600	2.0	3.6	10.8	121	2.0	3.5	10.6
Kayaking	801				104			
No capsize		2.2	3.8	11.4		2.1	3.6	10.9
With capsize		2.9	5.0	16.5		4.8	7.9	26.8
All activities		2.3	3.8	11.6		3.1	5.2	17.0
Rowing	222				0			
No capsize		2.3	3.9	11.8		-	-	-
With capsize		2.0	3.5	10.6		-	-	-
All activities		2.3	3.9	11.8		-	-	-
Wading/splashing	0	-	-	-	112	2.2	3.7	11.2
Walking	0	-	-	-	23	2.0	3.5	10.6
Full Contact Scenarios								
Immersion	0	-	-	-	112	3.2	5.1	15.3
Swimming	0	-	-	-	114	6.0	10.0	34.8
TOTAL	2,705				662			

N = Number of participants.
UCL = Upper confidence limit (i.e., mean + 1.96 × SD).
\- = No data.

Source: Dorevitch et al. (2011).

Figure 2. Table 3-96 from the EPA's 2019 Exposure Factors Handbook highlighting areas of the table with potentially relevant data for deriving criteria to protect fishing as an SCR designated use. Arrows point to the values selected in the example (see text for selection justification).

The table lists several estimates the state could potentially use for the values of $I_{primary}$ and $I_{secondary}$ (dashed boxes in Figure 2). One set of potential values for $I_{primary}$ are labeled "immersion" and the other set of potential values for $I_{primary}$ are labeled "swimming." To choose between the potential values for $I_{primary}$, the state evaluated the original scientific article that was the source of these data (Dorevitch et al., 2011). The paper described "immersion" as controlled trials involving standing in the water and immersing one's head three times over a 10-minute interval whereas the paper described "swimming" as lap swimming. Because the paper's description of "swimming" more closely resembles the level of exposure in the epidemiological studies the EPA used to develop its 304(a) RWQC recommendations for PCR compared to the description of "immersion", the state decided to select an estimate from the activity category "swimming" for the value $I_{primary}$.

The table lists two different ingestion estimates associated with fishing. One ingestion estimate is derived from measurements where study subjects self-reported the volume of water ingested while fishing in ambient surface water ("Surface Water Study"), and the other ingestion estimate is the ingestion rate derived from measurements of cyanuric acid (a chlorine stabilizer used in swimming pools) in urine as an indicator of incidental ingestion of water while study subjects engaged in simulated fishing in a swimming pool ("Swimming Pool Study"). Selecting the ingestion rate from the surface water study rather than the swimming pool study may initially appear to be the logical choice because fishing in ambient surface water is closer to the exposure scenario associated with the recreational activity the state is seeking to protect. However, the study provides ingestion rates for swimming derived from the swimming pool study but does not provide ingestion rates for swimming in ambient surface water. Although the EPA's 2019 Exposure Factors Handbook provides many other ingestion estimates associated with swimming in ambient surface water from several other studies, the state selected the ingestion rate associated with swimming in a swimming pool as the value for $I_{primary}$ and the ingestion rate associated with simulated fishing in a pool as the value for $I_{secondary}$ from Table 3-96 in the EPA's 2019 Exposure Factors Handbook because both estimates were from the same study and were derived using the same experimental methods, thus minimizing the chance that the two estimates are affected by unequal statistical bias. Furthermore, the original scientific article identified the distribution of the underlying data as most closely approximating a lognormal distribution. Therefore, the state selected the median values rather than the arithmetic mean values because the arithmetic mean assumes a normal distribution of the data whereas the median makes no assumptions about the underlying data distribution. Thus, the state selected the median value of 2.0 ml/hour[4] for the value of $I_{secondary}$ and the median value of 6.0 ml/hour for the value of $I_{primary}$ identified by the arrows in Figure 2.

Because the SCR criteria to protect fishing will include both a GM and STV, the state applies the equation twice - once for each value of $C_{primary}$ using the same values for $I_{primary}$ and $I_{secondary}$ each time. Applying Equation 1 to each value of $C_{primary}$ yields:

$$\textit{E. coli}\text{ GM (fishing)} = 126 \times \frac{6.0\frac{\text{ml}}{\text{hour}}}{2.0\frac{\text{ml}}{\text{hour}}} = 378\text{ CFU}$$

$$\textit{E. coli}\text{ STV (fishing)} = 410 \times \frac{6.0\frac{\text{ml}}{\text{hour}}}{2.0\frac{\text{ml}}{\text{hour}}} = 1{,}230\text{ CFU}$$

Example 2

A state decided to adopt a designated use of kayaking (which the state considered an SCR activity) at a marine beach that does not support PCR. In its WQS, the state defined the designated use as rough water kayaking and adopted *Enterococci* criteria specified as a GM of 44 CFU and an STV of 163 CFU to protect the kayaking designated use. The state used the following rationale in its documentation when submitting the WQS to the EPA for review and action.

The state's currently applicable recreational designated use at all their other marine beaches is PCR with criteria based on the EPA's 304(a) RWQC recommendations for *Enterococci* criteria associated with an illness rate of 36 per 1,000 recreators (GM of 35 CFU and an STV of 130

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[4] The median value for ingestion associated with fishing in ambient surface water and the median value for ingestion associated with simulated fishing in a swimming pool are coincidentally the same in this hypothetical example.

CFU). Thus, the state selected these values as $C_{primary}$ to develop SCR criteria to protect kayaking at this specific beach.

To use Equation 1, the state needed to identify values for $I_{primary}$ and $I_{secondary}$. Chapter 3 of the EPA's 2019 Exposure Factors Handbook lists incidental ingestion estimates for several different recreational activities. Table 3-96 in the EPA's 2019 Exposure Factors Handbook lists ingestion estimates reported in a scientific paper (Dorevitch et al., 2011) for recreational activities that include kayaking (shown in. Figure 3).

Table 3-96. Estimated Water Ingestion during Water Recreation Activities (mL/hr)

		Surface Water Study				Swimming Pool Study		
Activity	*N*	Median	Mean	UCL	*N*	Median	Mean	UCL
Limited Contact Scenarios								
Boating	316	2.1	3.7	11.2	0	-	-	-
Canoeing	766				76			
No capsize		2.2	3.8	11.4		2.1	3.6	11.0
With capsize		3.6	6.0	19.9		3.9	6.6	22.4
All activities		2.3	3.9	11.8		2.6	4.4	14.1
Fishing	600	2.0	3.6	10.8	121	2.0	3.5	10.6
Kayaking	801				104			
No capsize		2.2	3.8	11.4		2.1	3.6	10.9
With capsize		2.9	5.0	16.5		4.8	7.9	26.8
All activities		2.3	3.8	11.6		3.1	5.2	17.0
Rowing	222				0			
No capsize		2.3	3.9	11.8		-	-	-
With capsize		2.0	3.5	10.6		-	-	-
All activities		2.3	3.9	11.8		-	-	-
Wading/splashing	0	-	-	-	112	2.2	3.7	11.2
Walking	0	-	-	-	23	2.0	3.5	10.6
Full Contact Scenarios								
Immersion	0	-	-	-	112	3.2	5.1	15.3
Swimming	0	-	-	-	114	6.0	10.0	34.8
TOTAL	2,705				662			

N = Number of participants.
UCL = Upper confidence limit (i.e., mean + 1.96 × SD).
\- = No data.

Source: Dorevitch et al. (2011).

Figure 3. Table 3-96 from the EPA's 2019 Exposure Factors Handbook highlighting areas of the table with potentially relevant data for deriving criteria to protect rough water kayaking as an SCR designated use. Arrows point to the values selected in the example (see text for selection justification).

The table lists several estimates the state could potentially use for the values of $I_{primary}$ and $I_{secondary}$ (dashed boxes in Figure 3). One set of potential values for $I_{primary}$ are labeled "immersion" and the other set of potential values for $I_{primary}$ are labeled "swimming." Using the same rationale as described in Example 1, the state selected an estimate from the activity category "swimming" for $I_{primary}$ because the description of "swimming" in the original study more closely resembles the level of exposure in the epidemiological studies the EPA used to develop its 304(a) RWQC recommendations for PCR compared to the description of "immersion".

Because environmental conditions at this marine beach are challenging, this beach attracts experienced kayakers who often capsize and recover. The table lists several different ingestion estimates associated with kayaking. Ingestion estimates provided are derived from subjects who were kayaking without capsizing, kayaking with capsizing, and kayaking both with and without capsizing. Because the state is seeking to derive criteria that will protect rough water kayaking where capsizing is a common occurrence, the state selected an ingestion estimate from the category “kayaking with capsize.”

The table also provides estimates that were derived either from measurements where study subjects self-reported the volume of water ingested while kayaking in ambient surface water (“Surface Water Study”), or from measurements of cyanuric acid (a chlorine stabilizer used in swimming pools) in urine as an indicator of incidental ingestion of water while study subjects engaged in kayaking in a swimming pool (“Swimming Pool Study”). Using the same rationale discussed in Example 1, the state chose to use estimates for kayaking with capsize derived from the swimming pool study because the study provides ingestion rates for swimming derived only from the swimming pool study and does not provide ingestion rates for swimming in ambient surface water. Using ingestion estimates that were derived using the same experimental methods reduces the chance that the two estimates are affected by unequal statistical bias. Furthermore, the original scientific article identified the distribution of the underlying data as most closely approximating a lognormal distribution. Therefore, the state selected the median values rather than the arithmetic mean values because the arithmetic mean assumes a normal distribution whereas the median makes no assumptions about the underlying distribution. Thus, the state selected the median value of 4.8 ml/hour for the value of $I_{secondary}$ and the median value of 6.0 ml/hour for the value of $I_{primary}$ identified by the arrows in Figure 3.

Because the criteria to protect kayaking will include both a GM and STV, the state applied the equation twice - once for each value of $C_{primary}$ using the same values for $I_{primary}$ and $I_{secondary}$ each time. Applying Equation 1 to each value of $C_{primary}$ yields:

$$\textit{Enterococci}\text{ GM (kayaking with capsize)} = 35 \times \frac{6.0\frac{\text{ml}}{\text{hour}}}{4.8\frac{\text{ml}}{\text{hour}}} = 44 \text{ CFU}$$

$$\textit{Enterococci}\text{ STV (kayaking with capsize)} = 130 \times \frac{6.0\frac{\text{ml}}{\text{hour}}}{4.8\frac{\text{ml}}{\text{hour}}} = 163 \text{ CFU}$$

5. <u>Conclusion</u>

Some states and authorized Tribes adopt designated uses to protect recreational activities that are associated with less ambient water contact or where immersion and ingestion of ambient water is less likely compared to PCR. States and authorized Tribes have historically called these types of recreational activities SCR. States and authorized Tribes may use Equation 1 together with the conditions, limitations and assumptions described in USEPA (2022) and this document to derive scientifically defensible criteria to protect SCR designated uses. Any such criteria must be adopted pursuant to state or Tribal law and be approved by EPA as consistent with CWA section 303(c) and the EPA’s implementing regulation at 40 CFR part 131before it is effective for CWA purposes. EPA encourages states and authorized Tribes to work closely with their EPA counterparts when adopting designated uses intended to protect SCR and when deriving criteria to protect such uses.

6. References

DeFlorio-Barker, S., Arnold, B. F., Sams, E. A., Dufour, A. P., Colford, J. M., Jr., Weisberg, S. B., . . . Wade, T. J. (2018). Child environmental exposures to water and sand at the beach: Findings from studies of over 68,000 subjects at 12 beaches. *J Expo Sci Environ Epidemiol, 28*(2), 93-100. doi:10.1038/jes.2017.23

Dorevitch, S., Panthi, S., Huang, Y., Li, H., Michalek, A. M., Pratap, P., . . . Li, A. (2011). Water ingestion during water recreation. *Water Res, 45*(5), 2020-2028. doi:10.1016/j.watres.2010.12.006

Dufour, A. P., Behymer, T. D., Cantu, R., Magnuson, M., & Wymer, L. J. (2017). Ingestion of swimming pool water by recreational swimmers. *J Water Health, 15*(3), 429-437. doi:10.2166/wh.2017.255

Dufour, A. P., Evans, O., Behymer, T. D., & Cantu, R. (2006). Water ingestion during swimming activities in a pool: a pilot study. *J Water Health, 4*(4), 425-430. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/17176813

Federal Water Pollution Control Administration. (1968). *Water Quality Criteria. Report of the National Technical Advisory Committee to the Secretary of the Interior*. (800-R-68-900). Washington, DC: Author

Schets, F. M., Schijven, J. F., & de Roda Husman, A. M. (2011). Exposure assessment for swimmers in bathing waters and swimming pools. *Water Res, 45*(7), 2392-2400. doi:10.1016/j.watres.2011.01.025

Schijven, J., & de Roda Husman, A. M. (2006). A survey of diving behaviour and accidental water ingestion among Dutch occupational and sport divers to assess the risk of infection with waterborne pathogenic microorganisms. *Environ Health Perspect, 114*(5), 712-717. doi:10.1289/ehp.8523

Stone, D. L., Harding, A. K., Hope, B. K., & Slaughter-Mason, S. (2008). Exposure assessment and risk of gastrointestinal illness among surfers. *J Toxicol Environ Health A, 71*(24), 1603-1615. doi:10.1080/15287390802414406

Suppes, L. M., Abrell, L., Dufour, A. P., & Reynolds, K. A. (2014). Assessment of swimmer behaviors on pool water ingestion. *Journal of Water and Health, 12*(2), 269-279. doi:10.2166/wh.2013.123

USEPA. (1976). *Quality Criteria for Water*. (440-9-76-023). Washington DC: Author

USEPA. (1986). *Ambient Water Quality Criteria for Bacteria - 1986*. (440-5-84-002). Washington DC: Author

USEPA. (2009). *Report on 2009 National Epidemiologic and Environmental Assessment of Recreational Water Epidemiology Studies*. (600-R-10-168). Washington, DC: Author

Retrieved from https://www.epa.gov/sites/production/files/2019-03/documents/report-2009-national-epidemiologic-studies.pdf

USEPA. (2012). *Recreational Water Quality Criteria*. (820-F-12-058). Washington DC: Author Retrieved from https://www.epa.gov/sites/production/files/2015-10/documents/rwqc2012.pdf

USEPA. (2019a). *Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin*. (822-R-19-001). Washington DC: Author Retrieved from https://www.epa.gov/sites/production/files/2019-05/documents/hh-rec-criteria-habs-document-2019.pdf

USEPA. (2019b). *Update for Chapter 3 of the Exposure Factors Handbook. Ingestion of Water and Other Select Liquids.* (600-R-18-259F). Washington, DC: Author Retrieved from https://www.epa.gov/expobox/exposure-factors-handbook-chapter-3

USEPA. (2022). *An Approach for Applying EPA's 2012 Recreational Water Quality Criteria Recommendation to Non primary Contact Exposure Scenarios - White Paper*. (823-B-22-001). Washington DC: Author Retrieved from https://www.epa.gov/wqc/recreational-water-quality-criteria-and-methods#secondary

Wade, T. J., Calderon, R. L., Brenner, K. P., Sams, E., Beach, M., Haugland, R., . . . Dufour, A. P. (2008). High sensitivity of children to swimming-associated gastrointestinal illness: results using a rapid assay of recreational water quality. *Epidemiology, 19*(3), 375-383. doi:10.1097/EDE.0b013e318169cc87

Wade, T. J., Calderon, R. L., Sams, E., Beach, M., Brenner, K. P., Williams, A. H., & Dufour, A. P. (2006). Rapidly measured indicators of recreational water quality are predictive of swimming-associated gastrointestinal illness. *Environ Health Perspect, 114*(1), 24-28. doi:10.1289/ehp.8273

Wade, T. J., Pai, N., Eisenberg, J. N., & Colford, J. M., Jr. (2003). Do U.S. Environmental Protection Agency water quality guidelines for recreational waters prevent gastrointestinal illness? A systematic review and meta-analysis. *Environ Health Perspect, 111*(8), 1102-1109. doi:10.1289/ehp.6241

Xue, J., Zartarian, V., Moya, J., Freeman, N., Beamer, P., Black, K., . . . Shalat, S. (2007). A meta-analysis of children's hand-to-mouth frequency data for estimating nondietary ingestion exposure. *Risk Anal, 27*(2), 411-420. doi:10.1111/j.1539-6924.2007.00893.x