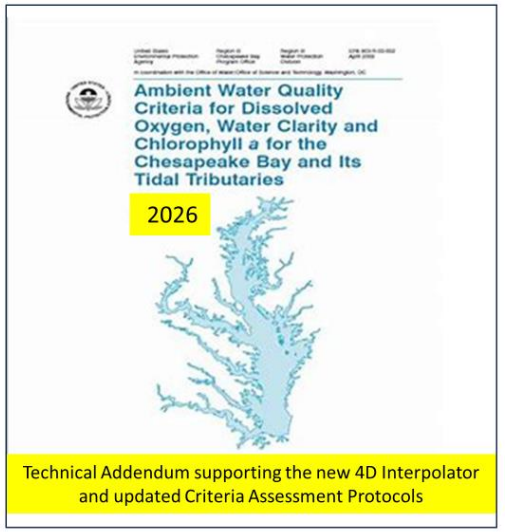
Peter Tango USGS@CBPO
Chair CAP WG
March 7, 2024

Developing a new Chesapeake Bay Technical Addendum

Coming soon!

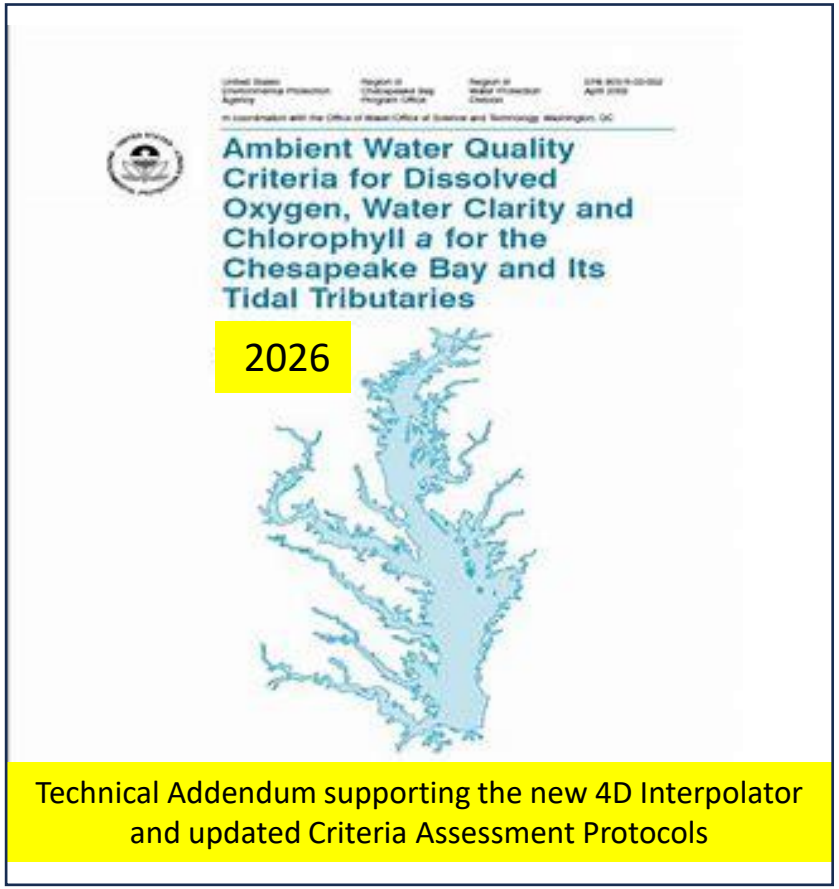
- It's time for the next technical addendum to be developed.
- Production through the Criteria Assessment Protocol Workgroup



Technical Addendum supporting the new 4D Interpolator and updated Criteria Assessment Protocols

Coming soon!

- It’s time for the next technical addendum to be developed.
- Production through the Criteria Assessment Protocol Workgroup



Technical Addendum supporting the new 4D Interpolator and updated Criteria Assessment Protocols

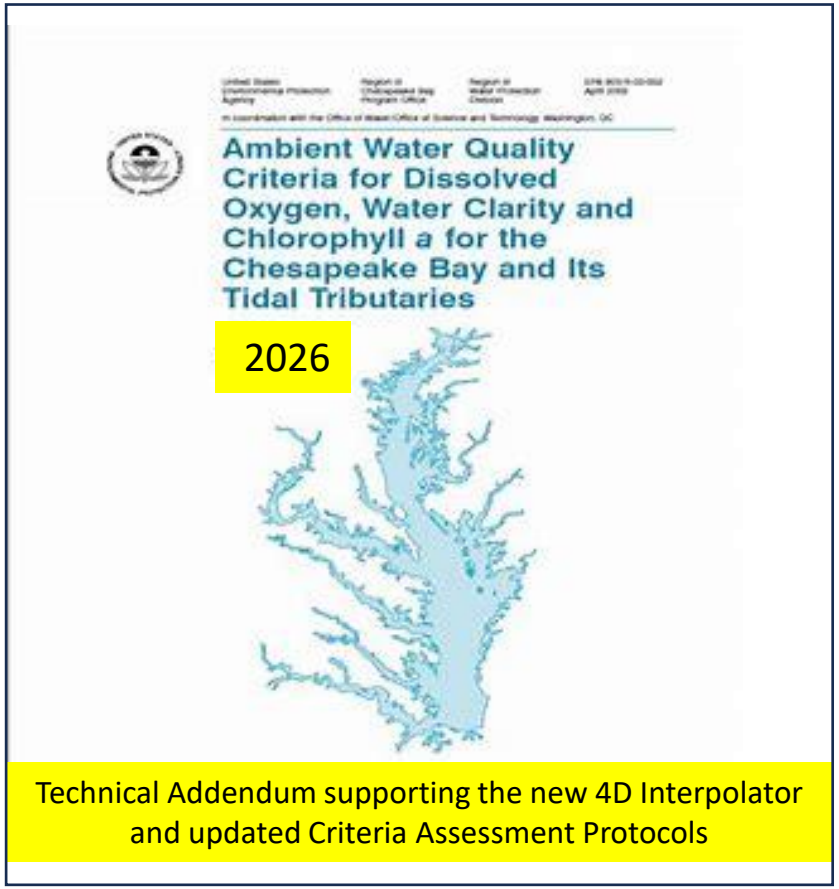
Coming soon!

New protocol documentation from CAP WG has gone through STAC scientific review for CBP

Planning to have documentation reviewed along with the CBP Phase 7 set of modeling tools, methods, and their documentation by STAC in 2026

This means we have work to do in 2024 and 2025.

Note: The document outline may be subdivided and delivered as multiple documents



4-D interpolator development timeline

Draft January 2024

Priority categories for 2024 are in red

Calendar Year	2022				2023				2024				2025				2026				2027			
Calendar Quarter	Q1 Jan-Mar	Q2 Apr-Jun	Q3 Jul-Sep	Q4 Oct-Dec	Q1 Jan-Mar	Q2 Apr-Jun	Q3 Jul-Sep	Q4 Oct-Dec	Q1 Jan-Mar	Q2 Apr-Jun	Q3 Jul-Sep	Q4 Oct-Dec	Q1 Jan-Mar	Q2 Apr-Jun	Q3 Jul-Sep	Q4 Oct-Dec	Q1 Jan-Mar	Q2 Apr-Jun	Q3 Jul-Sep	Q4 Oct-Dec	Q1 Jan-Mar	Q2 Apr-Jun	Q3 Jul-Sep	Q4 Oct-Dec
Project Year	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6			
1. Development-daily estimates	■	■	■	■	■	■	■	■	■	■	■													
2. Develoment-hourly estimates					■	■	■	■	■	■	■	■												
3. Development - shallow water							■	■	■	■	■	■	■	■	■									
4. Development - GIS tasks	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
5. Development -combined daily & hourly								■	■	■	■	■	■											
6. Development-criteria evaluation								■	■	■	■	■	■	■	■	■								
7. Software							■	■	■	■	■	■	■	■	■	■								
8. Documenting	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
9. Training													■	■	■	■								
10. Year of Review																	■	■	■	■				
11. Operational																					■	■	■	■

Chapter 1. Introduction

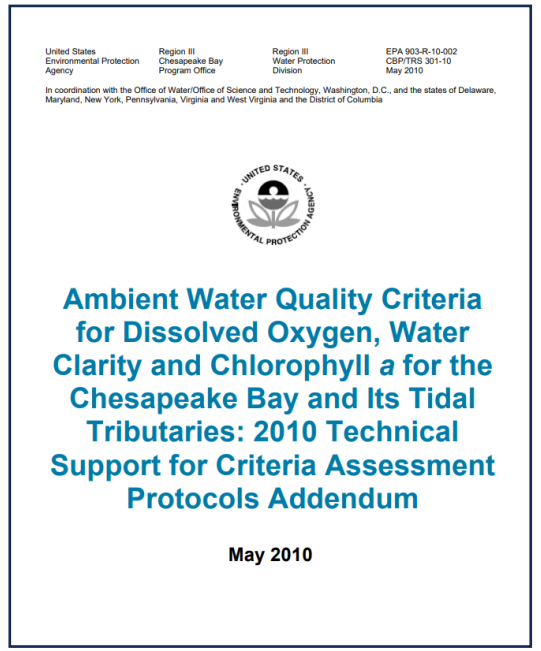
- **Brief review on where we have been:**
  - The Existing Bay Interpolator for Dissolved Oxygen Criteria Attainment Assessment
  - Aerial survey of SAV
  - Water clarity assessment via shallow water monitoring
  - CHLA assessments, James River synthesis
- **Review: Criteria, data gaps, technical issues**
  - Recognize that during our history of assessment thus far, there are questions regarding our criteria, their interpretation and assessing attainment results
- **Where are we going: Highlight new tools and protocols for assessment**
  - Potentially satellite based assessment of SAV
    - Data sources
    - AI Algorithms and interpretation
  - Any progress with quantitative interpretation of narrative criteria and satellite-based criteria assessment
  - Dissolved oxygen assessment for all criteria durations,
    - New data streams
    - 4D interpolator
    - Protocols to assess results from the 4D interpolator

Chapter 2. Technical Issues since USEPA (2017)

Recognize that in the past we have addressed technical issues with new technical documentation

E.g., Calculations of a dynamic pycnocline (rather than fixed vertical habitat boundaries for a subset of segments, “Episodic pycnocline application”)

E.g., What means are applied for CHLA assessment - Arithmetic or Geometric?



United States Environmental Protection Agency | Region III Chesapeake Bay Program Office | Region III Water Protection Division | EPA 903-R-10-002 CBP/TRS 301-10 May 2010

In coordination with the Office of Water/Office of Science and Technology, Washington, D.C., and the states of Delaware, Maryland, New York, Pennsylvania, Virginia and West Virginia and the District of Columbia

Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll *a* for the Chesapeake Bay and Its Tidal Tributaries: 2010 Technical Support for Criteria Assessment Protocols Addendum

May 2010

2024: Inconsistencies with handling significant figures in our criteria documentation with no scientific rationale when republishing sourced information

USEPA 1986 National Criteria Table 8

Table 8. Water quality criteria for ambient dissolved oxygen concentration.

	Coldwater Criteria		Warmwater Criteria	
	Early Life Stages[1,2]	Other Life Stages	Early Life Stages[2]	Other Life Stages
30 Day Mean	NA[3]	6.5	NA	5.5
7 Day Mean	9.5 (6.5)	NA	6.0	NA
7 Day Mean Minimum	NA	5.0	NA	4.0
1 Day Minimum[4,5]	8.0 (5.0)	4.0	5.0	3.0

[1] These are water column concentrations recommended to achieve the required intergravel dissolved oxygen concentrations shown in parentheses. The 3 mg/l differential is discussed in the criteria document. For species that have early life stages exposed directly to the water column, the figures in parentheses apply.

[2] Includes all embryonic and larval stages and all juvenile forms to 30-days following hatching.

[3] NA (not applicable).

[4] For highly manipulatable discharges, further restrictions apply (see page 37)

[5] All minima should be considered as instantaneous concentrations to be achieved at all times.

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republished in USEPA (2003) with 0's dropped.

26

Table III-4. U.S. EPA freshwater dissolved oxygen water quality criteria (mg liter^{-1}) for warm-water species.

Duration	Early Life Stages[1]	Other Life Stages
30-day mean	NA[2]	5.5
7-day mean	6	NA
7-day mean minimum	NA	4
1-day minimum[3]	5	3

[1]Includes all embryonic and larval stages and all juvenile forms to 30 days following hatching.
[2]Not applicable.
[3]All minima should be considered as instantaneous concentrations to be achieved at all times.
Source: U.S. EPA 1986.

ambient-wqc-dissolved-oxygen-1986.pdf (epa.gov)

AmbientWaterCover.qxd (d38c6ppuviqmfp.cloudfront.net)

Inconsistencies within USEPA (2003)

Larval and Juvenile Growth Criteria

The criterion value protecting against adverse effects on growth under continuous exposures, called the criterion continuous concentration (or CCC), when recalculated for only Chesapeake Bay species, increased 0.2 mg liter^{-1} to a Chesapeake Bay-specific value of 5.0 mg liter^{-1}. To maintain consistency with EPA Virginian Province criteria and the national EPA criteria derivation guidelines, no changes were made to the Virginian Province criteria value of 4.8 mg liter^{-1}.

Page 20, USEPA (2003)
2 significant figures

?

Table 1. Chesapeake Bay dissolved oxygen criteria.

Designated Use	Criteria Concentration/Duration	Protection Provided
Migratory fish spawning and nursery use	7-day mean ≥ 6 mg liter^{-1} (tidal habitats with 0-0.5 ppt salinity)	Survival/growth of larval/juvenile tidal-fresh resident fish; protective of threatened/endangered species.
	Instantaneous minimum ≥ 5 mg liter^{-1}	Survival and growth of larval/juvenile migratory fish; protective of threatened/endangered species.
	Open-water fish and shellfish designated use criteria apply	
Shallow-water bay grass use	Open-water fish and shellfish designated use criteria apply	
Open-water fish and shellfish use	30-day mean ≥ 5.5 mg liter^{-1} (tidal habitats with 0-0.5 ppt salinity)	Growth of tidal-fresh juvenile and adult fish; protective of threatened/endangered species.
	30-day mean ≥ 5 mg liter^{-1} (tidal habitats with >0.5 ppt salinity)	Growth of larval, juvenile and adult fish and shellfish; protective of threatened/endangered species.
	7-day mean ≥ 4 mg liter^{-1}	Survival of open-water fish larvae.
	Instantaneous minimum ≥ 3.2 mg liter^{-1}	Survival of threatened/endangered sturgeon species.[1]
Deep-water seasonal fish and shellfish use	30-day mean ≥ 3 mg liter^{-1}	Survival and recruitment of bay anchovy eggs and larvae.
	1-day mean ≥ 2.3 mg liter^{-1}	Survival of open-water juvenile and adult fish.
	Instantaneous minimum ≥ 1.7 mg liter^{-1}	Survival of bay anchovy eggs and larvae.
	Open-water fish and shellfish designated-use criteria apply	
Deep-channel seasonal refuge use	Instantaneous minimum ≥ 1 mg liter^{-1}	Survival of bottom-dwelling worms and clams.
	Open-water fish and shellfish designated use criteria apply	

Same table: Inconsistency between publications by the lead EPA author of USEPA (2003) and Batiuk et al. (2009)

Table 1. Chesapeake Bay dissolved oxygen criteria.

Designated Use	Criteria Concentration/Duration	Protection Provided
Migratory fish spawning and nursery use	7-day mean ≥ 6 mg liter^{-1} (tidal habitats with 0-0.5 ppt salinity)	Surviva protecti
	Instantaneous minimum ≥ 5 mg liter^{-1}	Surviva protecti
	Open-water fish and shellfish designated use criteria apply	

1 significant figure USEPA (2003)

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Journal of Experimental Marine Biology and Ecology 381 (2009) S204–S215

Table 1
Chesapeake Bay dissolved oxygen water quality criteria for the protection of tidal water designated us species and threatened/endangered species.

Designated use	Criteria concentration/duration	Protect
Migratory fish spawning and nursery use	7-day mean ≥ 6.0 mg L^{-1} (tidal habitats with 0–0.5 salinity)	Surviv fish; p
	Instantaneous minimum ≥ 5.0 mg L^{-1}	Surviv protec
	Open-water fish and shellfish designated use criteria apply	
Shallow-water bay grass use	teria apply	
Open-water fish ar shellfish use	–0.5 salinity)	Growth protec
	5 salinity)	Growth protec
	7-day mean ≥ 4 mg L^{-1}	Surviv
	Instantaneous minimum ≥ 3.2 mg L^{-1}	Surviv
Deep-water seasonal fish and shellfish use	30-day mean ≥ 3 mg L^{-1}	Surviv
	1-day mean ≥ 2.3 mg L^{-1}	Surviv
	Instantaneous minimum ≥ 1.7 mg L^{-1}	Surviv
	Open-water fish and shellfish designated-use criteria apply	
Deep-channel seasonal refuge use	Instantaneous minimum ≥ 1 mg L^{-1}	Surviv
	Open-water fish and shellfish designated use criteria apply	

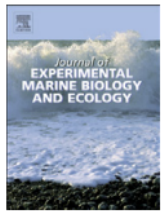
[a] At temperatures considered stressful to shortnose sturgeon (29 °C), DO concentrations above ar sturgeon species. Source: U.S. EPA, 2003a.

2 significant figures Batiuk et al. (2009)

Contents lists available at ScienceDirect

Journal of Experimental Marine Biology and Ecology

journal homepage: www.elsevier.com/locate/jembe



Derivation of habitat-specific dissolved oxygen criteria for Chesapeake Bay and its tidal tributaries

Richard A. Batiuk [a,*], Denise L. Breitburg [b], Robert J. Diaz [c], Thomas M. Cronin [d], David H. Secor [e], Glen Thursby [f]

[a] U.S. Environmental Protection Agency, Chesapeake Bay Program Office, 410 Severn Avenue, Annapolis, Maryland 21403, USA
[b] Smithsonian Environmental Research Center, P.O. Box 28, 647 Contees Wharf Road, Edgewater, Maryland 21037-0028, USA
[c] Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, 1208 Greate Road, Gloucester Point, Virginia 23062, USA
[d] U.S. Geological Survey, 926A USGS National Center, 12201 Sunrise Valley Drive, Reston, Virginia 20192, USA
[e] University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, P.O. Box 38, Solomons, Maryland 20688, USA
[f] U.S. Environmental Protection Agency, Office of Research and Development, Atlantic Ecology Division, 27 Tarzwell Drive, Narragansett, Rhode Island 02882, USA

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Designated Use	Criteria Concentration/Duration	Protection Provided
Migratory fish spawning and nursery use	7-day mean ≥ 6 mg liter^{-1} (tidal habitats with 0-0.5 ppt salinity)	Survival, protecti
	Instantaneous minimum ≥ 5 mg liter^{-1}	Survival, protecti
	Open-water fish and shellfish designated use criteria apply	

1 significant figure USEPA (2003)

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Designated use	Criteria concentration/duration	Protection pr
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	Instantaneous minimum ≥ 5.0 mg L^{-1}	Survival and protective of
	Open-water fish and shellfish designated use criteria apply	
Shallow-water bay grass use	apply	
Open-water fish ar shellfish use	salinity)	Growth of tic protective of
	30-day mean ≥ 5 mg L^{-1} (tidal habitats with >0.5 salinity)	Growth of la protective of
	7-day mean ≥ 4 mg L^{-1}	Survival of o
	Instantaneous minimum ≥ 3.2 mg L^{-1}	Survival of th
Deep-water seasonal fish and shellfish use	30-day mean ≥ 3 mg L^{-1}	Survival and
	1-day mean ≥ 2.3 mg L^{-1}	Survival of o
	Instantaneous minimum ≥ 1.7 mg L^{-1}	Survival of ba
	Open-water fish and shellfish designated-use criteria apply	
Deep-channel seasonal refuge use	Instantaneous minimum ≥ 1 mg L^{-1}	Survival of bo
	Open-water fish and shellfish designated use criteria apply	

[a] At temperatures considered stressful to shortnose sturgeon (29 °C), DO concentrations above an insta
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2 significant figures

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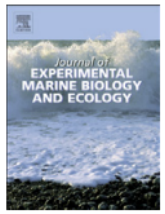

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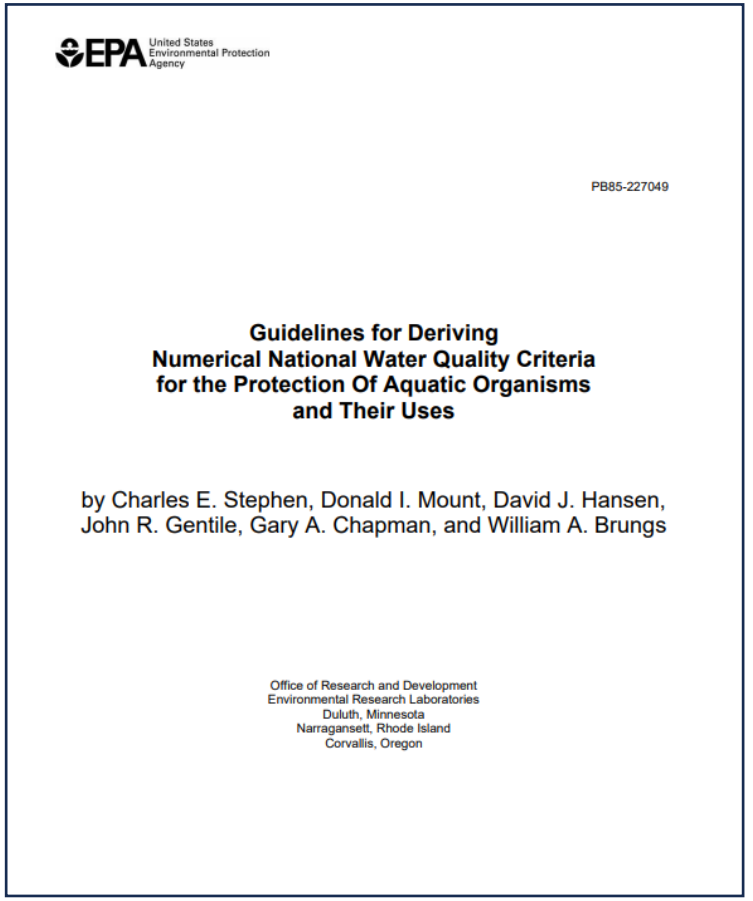
Guidance on criteria derivation: "Round both the CMC and the CCC to two significant digits"

USEPA (1985), pp 28-29.

"XI. Criterion
A criterion consists of two concentrations: the Criterion Maximum Concentration and the Criterion Continuous Concentration."

"Round both the CMC and the CCC to two significant digits."



EPA United States Environmental Protection Agency

PB85-227049

Guidelines for Deriving Numerical National Water Quality Criteria for the Protection Of Aquatic Organisms and Their Uses

by Charles E. Stephen, Donald I. Mount, David J. Hansen, John R. Gentile, Gary A. Chapman, and William A. Brungs

Office of Research and Development
Environmental Research Laboratories
Duluth, Minnesota
Narragansett, Rhode Island
Corvallis, Oregon

Chesapeake Bay water quality criteria and its addenda documentation does not have clear statements for:

Significant figures
Rounding rules

North Carolina Department of Environment and Natural Resources
Division of Water Resources
Water Permitting Section
Wastewater Branch

Precision in Discharge Monitoring Reports

August 3, 2015 (2nd revision)

1. INTRODUCTION

The results of monitoring required in wastewater permits must be reported as precisely as reasonably possible in order to enable the accurate determination of compliance with permit limits. Significant figures are an established means of expressing the precision of monitoring results.

This document provides guidance to promote the consistent use of significant figures in preparing Discharge Monitoring Reports (DMRs).

- Section 2 describes the use of significant figures, decimal places, and rounding to indicate precision in numbers. It also notes certain exceptions to the usual conventions for their use.
- Section 3 describes the proper use of significant figures in entering data on DMR forms.

Example of assessment guidance specifically addressing significant figures and rounding rules

North Carolina example on details with managing significant figures for monitoring reports

download (nc.gov)

2.2 Significant Figures

There is uncertainty in any measurement. Results must be recorded as precisely as reasonably possible; or, as Standard Methods states it, "All digits in a reported result are expected to be known definitely, except for the last digit, which may be in doubt. Such a number is said to contain only significant figures."[1] Thus, the precision of a measurement is indicated by the number of significant figures (SFs) in the recorded result. Table 1 summarizes the standard conventions for counting significant figures:

[1] APHA/AWWA/WEF, *Standard Methods for the Examination of Water and Wastewater*, 22nd Edition, 2012, Part 1050 B. http://www.mwa.co.th/download/file_upload/SMWW_1000-3000.pdf

Precision in Discharge Monitoring Reports
August 3, 2015 (2nd revision)

Table 1: Conventions for Determining Significant Figures

Conventions	Example Values	Significant Figures
1. Non-zero digits (1-9) are significant.	23	2
	231	3
2. Zeros between non-zero digits are significant.	4308	4
	40.05	4
3. Zeros to the left of the first non-zero digit are not significant.	0.00253	3
4. Trailing zeros (the right-most zeros) are significant in numbers that have a decimal point.	0.360	3
	4.00	3

Chapter 2. Technical Issues since USEPA (2017)

- D.O. Criteria
  - Inconsistency with significant figures
  - Any updates on significant figures of CB DO criteria
- D.O. Criteria Assessment
  - Rounding conventions with the data
  - Rounding conventions in a criterion assessment
- Continuous time series data for d.o., salinity, and temperature
  - Sensor precision for d.o., salinity and temperature data reporting
  - Data management: Addressing data gaps in time series for criterion assessment
- Designated Use Boundaries
- Any other identified issues

“Chapter 3”. New tools, new protocols for criteria assessment.

- **New tools and protocols for assessment**
  - **Potentially satellite-based assessment of SAV**
    - **Data sources**
    - **AI Algorithms and interpretation**
  - **Dissolved oxygen assessment for all criteria durations,**
    - **New data streams**
    - **4D interpolator**
    - **Protocols to assess results from the 4D interpolator**
  - **Any progress with quantitative interpretation of narrative criteria and satellite-based criteria assessment or water clarity assessment by new methods**

Suggested Actions from this Meeting

- **Form CAP WG working group to focus on updates for using new data streams and tools to assess all criteria** –
  - Meet monthly between CAP WG meetings
  - Seek support and assistance if needed (e.g., GIT funded project given cross outcome support needs with this effort on habitat assessment with new tools and data streams)
  - Document assessment methods for the new Tech doc
  - Develop documentation in preparation for review and publication

- **Maintain 3 meetings a year schedule for the full CAP WG**

- **Workgroup review and comment on draft technical addendum outline –**
  - **Comments due in 2 months, preparation for the next meeting.**
  - Review any comments and progress at the summer CAP WG meeting

- **Criteria review activity** – recommending a request to STAC for independent review regarding technical issues
  - Publish findings with EPA approval as part of the new technical documentation

Our next two presentations reflect upon criteria derivation and application

- 2:00 PM: **Virginia Province approach to setting water quality dissolved oxygen (DO) criteria** – Jerry Diamond (Tetra Tech)

- 2:30 PM: **Bay DO Assessment: DEQ's Near Term Plan and Looking Ahead to the 4-D Interpolator** – Tish Robertson (VA DEQ)


Thank you
69STATUS.SRKH.IN

Comparison of VP-wide and CB-specific larval recruitment effects curves informing CB D.O. criteria (USEPA 2003)

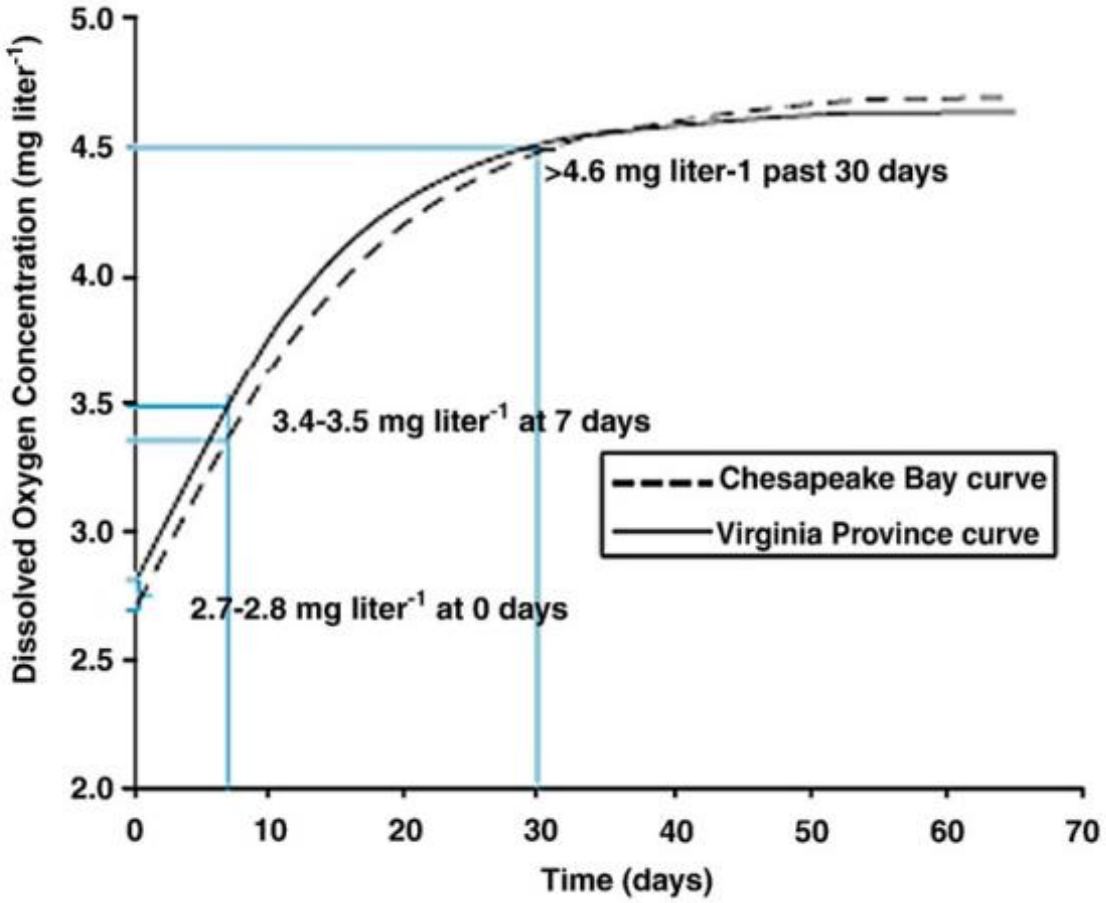


Fig. 3. Comparison of the Virginian Province-wide and Chesapeake Bay-specific larval recruitment effects curves (U.S. EPA, 2000, 2003a). Each line indicates concentrations reducing larval recruitment by 5% of the total population. Plots were generated using the larval recruitment model described in the Virginian Province document (U.S. EPA, 2000). The model is a discrete time, density-independent model that expresses the cumulative impact of low DO as a proportion of the potential annual recruitment of a species. The model accounts for both the magnitude and duration of a hypoxic event.