James River Chlorophyll Criteria Rulemaking: Preliminary Modeling Results and Additional Proposed Criteria Revisions

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James River RAP Meeting

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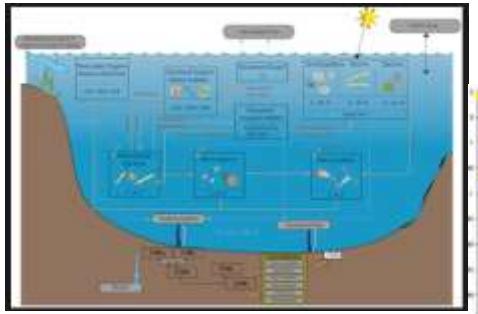
Outline

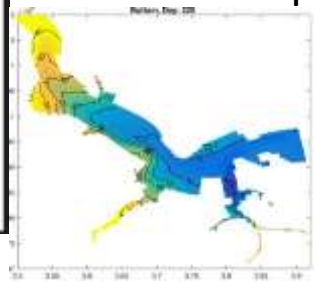
- Summary of work presented at last RAP meeting
- Presentation of new preliminary attainment results
- Dicussion of newly updated proposed criteria and assessment method rules
- Summary of new preliminary attainment results

At the February RAP meeting, DEQ presented preliminary attainability analysis using a variety of loading scenarios and predictions from the VIMS water quality model.

A specific loading condition is simulated via a watershed model using the average hydrology over some specified period. We call this a "scenario".

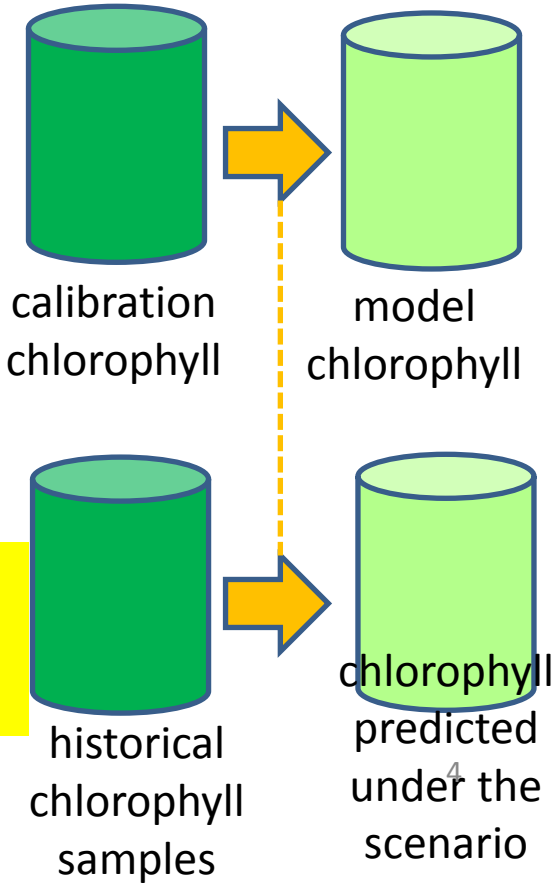
loads





VIMS water quality model

How does the modeled chlorophyll under the loading condition compare to the calibration chlorophyll?



The simulated change is then used to modify historical chlorophyll to "scenario" chlorophyll

Scenario Descriptions

- 2013 Progress Scenario: 2013 land uses, animal numbers, atmospheric deposition, point source loads, and pollution controls.
- 2017 Progress Scenario: 2017 land uses, animal numbers, atmospheric deposition, point source loads, and pollution controls.
- DO Attainment Scenario: Loads needed for attainment of DO criteria Bay-wide.
- WIP2 Scenario: estimated 2010 land uses, animal numbers, atmospheric deposition, point source loads, and 2025 pollution controls.
- E3 (Everyone, Everything, Everywhere) Scenario: Management actions applied to the fullest possible extent on 2010 land uses, animal numbers, atmospheric depo, and point sources.

The 1991-2000 period was the basis of the results from the simulations presented at the last RAP meeting.

- 1991-2000 loadings and hydrology
- 1991-2000 observations (fixed station) for “scenario-modification”

Segment-Season	Current criteria	Recommended
JMSTFU-spring	10	8
JMSTFU-summer	15	21
JMSTFL-spring	15	10
JMSTFL-summer	23	24
JMSOH-spring	15	13
JMSOH-summer	22	11
JMSMH-spring	12	7
JMSMH-summer	10	7
JMSPH-spring	12	8
JMSPH-summer	10	7

Summary of Results Presented at February RAP meeting

	2013 Progress	WIP2	E3
Current Criteria, Current Assessment Method			

Nonattainment predicted under scenario

Full attainment predicted under scenario

Summary of Results Presented at February RAP meeting

	2013 Progress	WIP2	E3
Current Criteria, Current Assessment Method			
Proposed Criteria, Proposed Assessment Method (1 exceedence in 3 years)			

Nonattainment predicted under scenario

Full attainment predicted under scenario

Summary of Results Presented at February RAP meeting

	2013 Progress	WIP2	E3
Current Criteria, Current Assessment Method			
Proposed Criteria, Proposed Assessment Method (1 exceedence in 3 years)			
Proposed Criteria, Proposed Assessment Method (2 exceedences in 6 years)			

Nonattainment predicted under scenario

Full attainment predicted under scenario

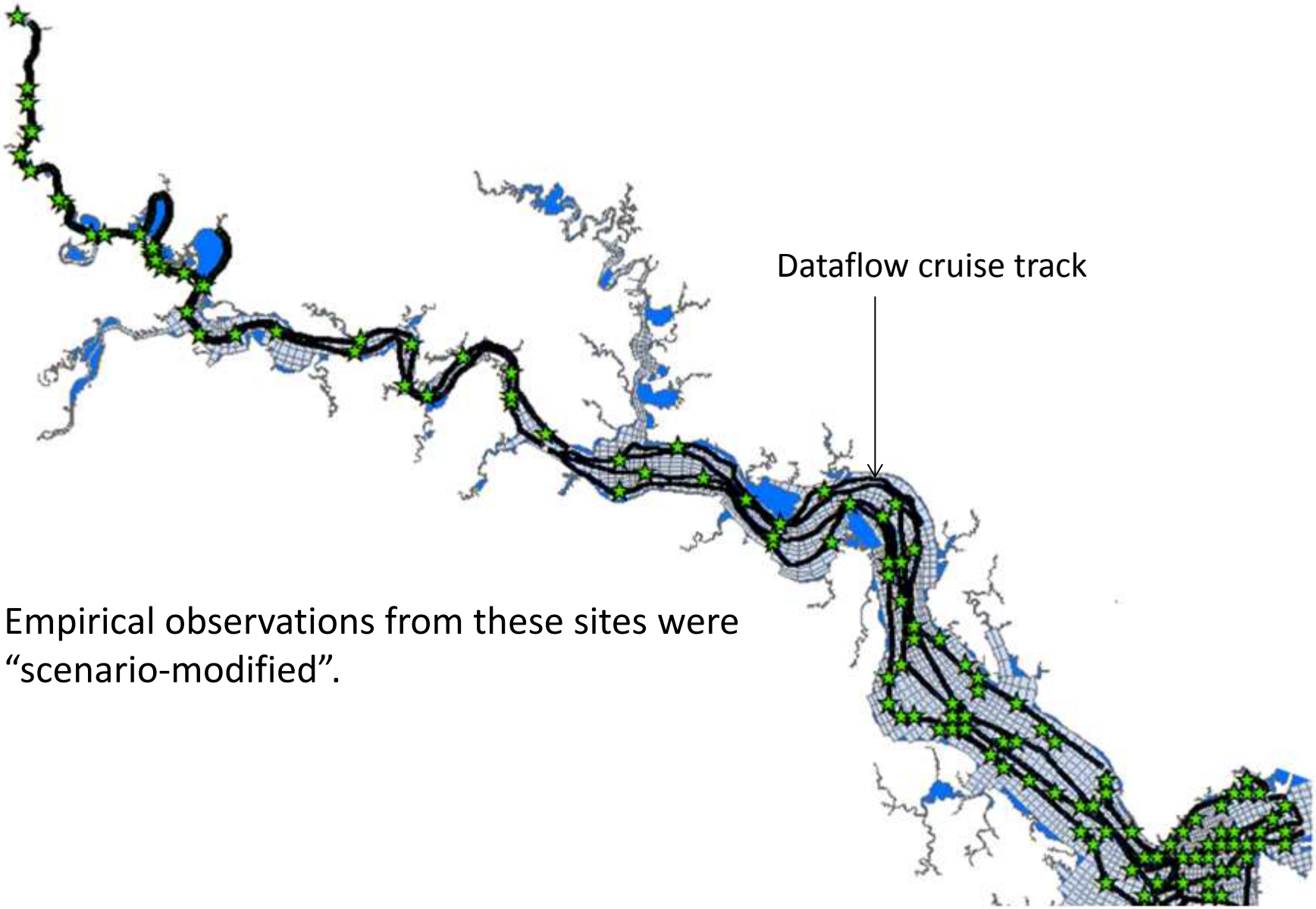
In response to concerns expressed at the last RAP meeting, the James River modeling team has shifted its focus to the 2005-2013 period.

- 2005-2013 loadings and hydrology
- 2005-2013 observations (fixed station and Dataflow) for "scenario-modification"

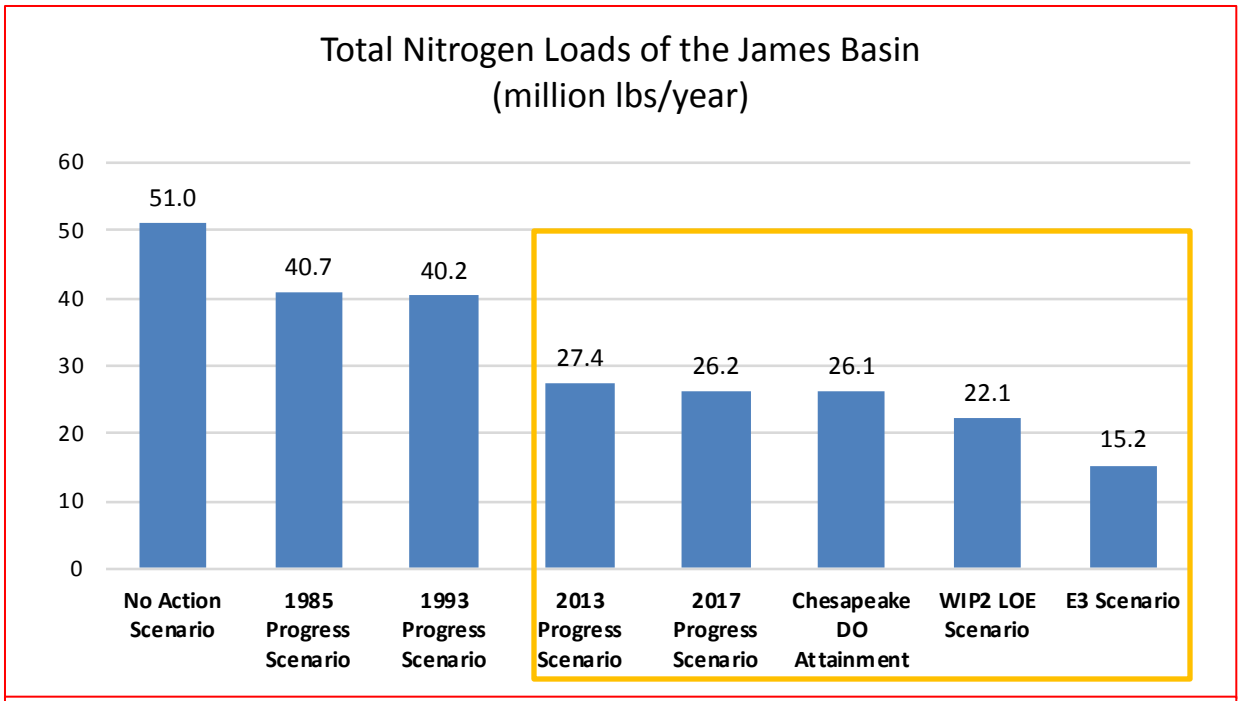
Justification for using 2005-2013 simulation period:

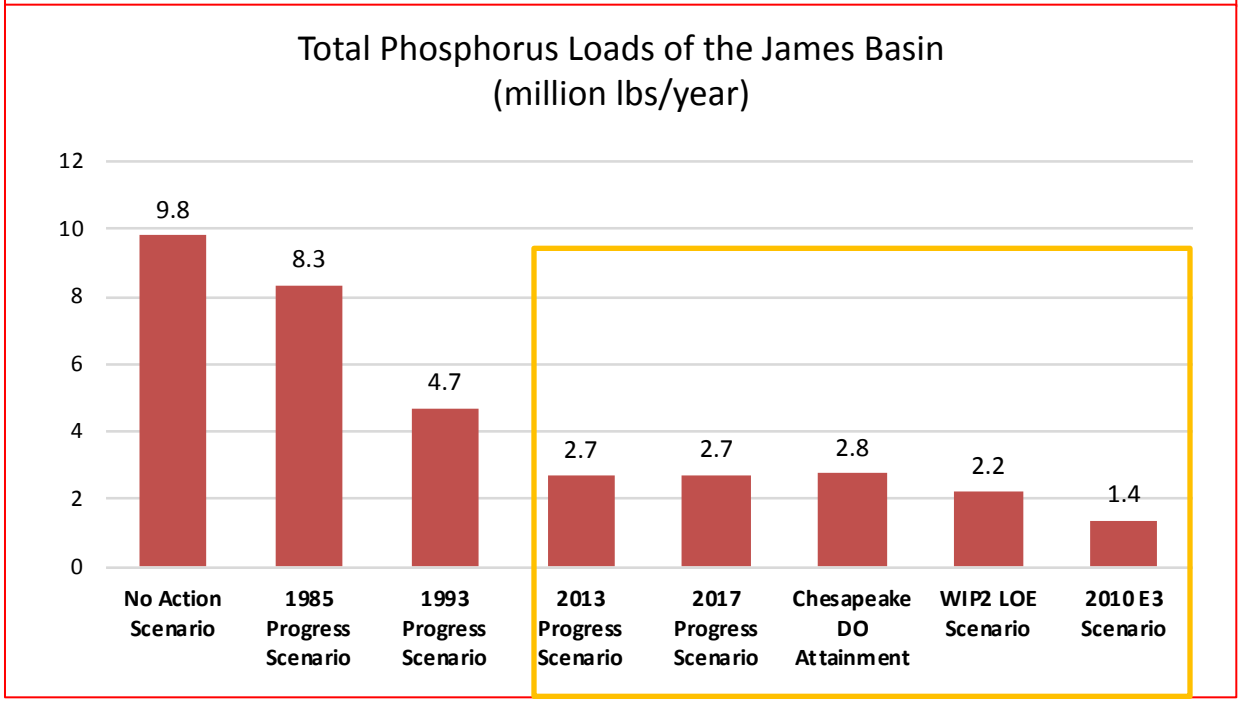
- The 2005-2015 monitoring data were used to derive alternative criteria. Most of these alternative criteria are developed to maintain *current* chlorophyll concentrations. **The 2005-2013 period better reflects current chlorophyll concentrations than the 1991-2000 period.**

- The 2005-2013 monitoring datasets are much more spatially and temporally intensive than the 1991-2000 datasets. **Scenario-modifying the former produces more confident determinations of "attainability" than the latter.**



Empirical observations from these sites were "scenario-modified".


Total Nitrogen Loads of the James Basin
(million lbs/year)
60
50
40
30
20
10
0
51.0
40.7
40.2
27.4
26.2
26.1
22.1
15.2
No Action Scenario
1985 Progress Scenario
1993 Progress Scenario
2013 Progress Scenario
2017 Progress Scenario
Chesapeake DO Attainment
WIP2 LOE Scenario
E3 Scenario


Total Phosphorus Loads of the James Basin
(million lbs/year)
12
10
8
6
4
2
0
9.8
8.3
4.7
2.7
2.7
2.8
2.2
1.4
No Action Scenario
1985 Progress Scenario
1993 Progress Scenario
2013 Progress Scenario
2017 Progress Scenario
Chesapeake DO Attainment
WIP2 LOE Scenario
2010 E3 Scenario

Baseline

Current Criteria, Current Assessment Procedure

Values are excessive space-time exceedence rates%

Red indicates nonattainment

SPRING	Baseline				
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005-2007	0.0	0.0	0.0	1.4	21.8
2006-2008	0.0	0.0	0.0	0.0	0.0
2007-2009	0.0	0.0	10.1	0.0	0.0
2008-2010	0.0	0.0	10.1	0.0	2.4
2009-2011	0.0	0.0	10.1	0.0	2.4
2010-2012	0.0	8.0	0.0	0.0	2.4
2011-2013	0.0	8.0	0.0	2.7	0.0

SUMMER	Baseline				
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005-2007	7.0	0.0	0.0	0.0	10.5
2006-2008	0.0	0.0	0.0	3.9	1.5
2007-2009	20.5	7.4	0.0	8.5	5.6
2008-2010	38.2	21.1	0.0	12.1	5.8
2009-2011	51.9	45.9	0.0	5.7	1.7
2010-2012	37.7	52.5	0.0	0.9	0.0
2011-2013	19.1	52.6	0.0	0.0	0.0

Cumulative Frequency Distribution

Proposed Criteria, Proposed Assessment Procedure

Values are seasonal chl means (ug/l)

Red indicates proposed criteria exceedences

SPRING	Baseline				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	2	4	11	**8**	**11**
2006	6	8	10	6	5
2007	5	6	4	4	7
2008	3	4	7	6	5
2009	7	7	**26**	6	6
2010	4	4	7	5	**10**
2011	7	8	6	4	6
2012	**10**	**13**	2	5	4
2013	5	5	5	**8**	5

SUMMER	Baseline				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	14	13	9	**10**	**9**
2006	9	10	8	6	6
2007	8	11	4	5	7
2008	12	15	8	**9**	**8**
2009	**26**	22	7	6	**8**
2010	**30**	**25**	10	4	3
2011	20	**33**	7	4	4
2012	15	**29**	2	3	**8**
2013	20	22	5	4	6

Segment-wide averaging in space and time

Historical Seasonal Chlorophyll Means (ug/l)

1991-2000

SPRING	Baseline				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
1991	**10**	**12**	**14**	**17**	**9**
1992	**9**	**11**	10	**12**	**11**
1993	3	3	3	4	**13**
1994	8	9	3	5	8
1995	**12**	**12**	6	7	5
1996	**9**	**11**	**18**	**10**	**20**
1997	**13**	**15**	**15**	**13**	**9**
1998	8	8	**14**	4	6
1999	**10**	**17**	13	**12**	**9**
2000	8	**12**	12	6	7
SUMMER	Baseline				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
1991	21	**26**	**14**	5	7
1992	**24**	**27**	**16**	6	**8**
1993	**41**	**48**	**13**	7	7
1994	20	24	10	3	7
1995	13	11	5	4	**9**
1996	7	8	6	5	**12**
1997	**53**	**58**	**15**	**10**	**8**
1998	**30**	**31**	10	6	**9**
1999	17	16	**14**	**11**	**17**
2000	**24**	**29**	8	5	**11**

2005-2013

SPRING	Baseline				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	2	4	11	**8**	**11**
2006	6	8	10	6	5
2007	5	6	4	4	7
2008	3	4	7	6	5
2009	7	7	**26**	6	6
2010	4	4	7	5	**10**
2011	7	8	6	4	6
2012	**10**	**13**	2	5	4
2013	5	5	5	**8**	5
SUMMER	Baseline				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	14	13	9	**10**	**9**
2006	9	10	8	6	6
2007	8	11	4	5	7
2008	12	15	8	**9**	**8**
2009	**26**	22	7	6	**8**
2010	**30**	**25**	10	4	3
2011	20	**33**	7	4	4
2012	15	**29**	2	3	**8**
2013	20	22	5	4	6

Observed seasonal means. Red indicates exceedences of proposed criteria.

Baseline

Current Criteria, Current Assessment Procedure

Values are excessive space-time exceedence rates%

Red indicates nonattainment

SPRING	Baseline				
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005-2007	0.0	0.0	0.0	1.4	21.8
2006-2008	0.0	0.0	0.0	0.0	0.0
2007-2009	0.0	0.0	10.1	0.0	0.0
2008-2010	0.0	0.0	10.1	0.0	2.4
2009-2011	0.0	0.0	10.1	0.0	2.4
2010-2012	0.0	8.0	0.0	0.0	2.4
2011-2013	0.0	8.0	0.0	2.7	0.0

SUMMER	Baseline				
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005-2007	7.0	0.0	0.0	0.0	10.5
2006-2008	0.0	0.0	0.0	3.9	1.5
2007-2009	20.5	7.4	0.0	8.5	5.6
2008-2010	38.2	21.1	0.0	12.1	5.8
2009-2011	51.9	45.9	0.0	5.7	1.7
2010-2012	37.7	52.5	0.0	0.9	0.0
2011-2013	19.1	52.6	0.0	0.0	0.0

Proposed Criteria, Proposed Assessment Procedure

Values are seasonal chl means (ug/l)

Red indicates proposed criteria exceedences

SPRING	Baseline				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	2	4	11	**8**	**11**
2006	6	8	10	6	5
2007	5	6	4	4	7
2008	3	4	7	6	5
2009	7	7	**26**	6	6
2010	4	4	7	5	**10**
2011	7	8	6	4	6
2012	**10**	**13**	2	5	4
2013	5	5	5	**8**	5

SUMMER	Baseline				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	14	13	9	**10**	**9**
2006	9	10	8	6	6
2007	8	11	4	5	7
2008	12	15	8	**9**	**8**
2009	**26**	22	7	6	**8**
2010	**30**	**25**	10	4	3
2011	20	**33**	7	4	4
2012	15	**29**	2	3	**8**
2013	20	22	5	4	6

Red blocks are **3-year** periods in nonattaiment

Baseline

Current Criteria, Current Assessment Procedure

Values are excessive space-time exceedence rates%

Red indicates nonattainment

SPRING	Baseline				
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005-2007	0.0	0.0	0.0	1.4	21.8
2006-2008	0.0	0.0	0.0	0.0	0.0
2007-2009	0.0	0.0	10.1	0.0	0.0
2008-2010	0.0	0.0	10.1	0.0	2.4
2009-2011	0.0	0.0	10.1	0.0	2.4
2010-2012	0.0	8.0	0.0	0.0	2.4
2011-2013	0.0	8.0	0.0	2.7	0.0

SUMMER	Baseline				
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005-2007	7.0	0.0	0.0	0.0	10.5
2006-2008	0.0	0.0	0.0	3.9	1.5
2007-2009	20.5	7.4	0.0	8.5	5.6
2008-2010	38.2	21.1	0.0	12.1	5.8
2009-2011	51.9	45.9	0.0	5.7	1.7
2010-2012	37.7	52.5	0.0	0.9	0.0
2011-2013	19.1	52.6	0.0	0.0	0.0

Proposed Criteria, Proposed Assessment Procedure

Values are seasonal chl means (ug/l)

Red indicates proposed criteria exceedences

SPRING	Baseline				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	2	4	11	**8**	**11**
2006	6	8	10	6	5
2007	5	6	4	4	7
2008	3	4	7	6	5
2009	7	7	**26**	6	6
2010	4	4	7	5	**10**
2011	7	8	6	4	6
2012	**10**	**13**	2	5	4
2013	5	5	5	**8**	5

SUMMER	Baseline				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	14	13	9	**10**	**9**
2006	9	10	8	6	6
2007	8	11	4	5	7
2008	12	15	8	**9**	**8**
2009	**26**	22	7	6	**8**
2010	**30**	**25**	10	4	3
2011	20	**33**	7	4	4
2012	15	**29**	2	3	**8**
2013	20	22	5	4	6

Red blocks are **6-year** periods in nonattaiment

Latest preliminary modeling results

2013 Progress

Current Criteria, Current Assessment Procedure

Values are excessive space-time exceedence rates%

Red indicates nonattainment

SPRING	2013 Progress				
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005-2007	0.0	0.0	0.0	0.8	21.8
2006-2008	0.0	0.0	0.0	0.0	0.0
2007-2009	0.0	0.0	0.0	0.0	0.0
2008-2010	0.0	0.0	0.0	0.0	0.0
2009-2011	0.0	0.0	0.0	0.0	0.0
2010-2012	0.0	0.0	0.0	0.0	0.0
2011-2013	0.0	0.0	0.0	0.5	0.0

SUMMER	2013 Progress				
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005-2007	0.0	0.0	0.0	0.0	10.5
2006-2008	0.0	0.0	0.0	0.0	0.0
2007-2009	15.4	4.6	0.0	0.0	0.0
2008-2010	20.8	15.9	0.0	0.4	0.0
2009-2011	32.2	40.7	0.0	0.0	0.0
2010-2012	21.2	50.0	0.0	0.0	0.0
2011-2013	15.4	52.2	0.0	0.0	0.0

Proposed Criteria, Proposed Assessment Procedure

Values are seasonal chl means (ug/l)

Red indicates criteria exceedences

SPRING	2013 Progress				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	1	3	8	7	**11**
2006	3	5	8	5	4
2007	3	5	3	4	6
2008	2	4	5	6	5
2009	4	5	**22**	5	6
2010	4	3	5	4	**10**
2011	5	6	5	3	6
2012	**9**	**11**	2	5	4
2013	4	5	4	7	5

SUMMER	2013 Progress				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	9	11	7	**8**	**8**
2006	5	8	7	5	6
2007	6	10	3	4	6
2008	7	14	7	7	**8**
2009	20	19	5	5	7
2010	21	20	8	3	3
2011	18	**31**	6	4	4
2012	13	**28**	2	3	**8**
2013	18	20	5	4	6

DRAFT

Three-year nonattainment

Six-year nonattainment (none predicted)

2017 Progress

Current Criteria, Current Assessment Procedure

Values are excessive space-time exceedence rates%

Red indicates nonattainment

SPRING	2017 Progress				
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005-2007	0.0	0.0	0.0	0.8	21.8
2006-2008	0.0	0.0	0.0	0.0	0.0
2007-2009	0.0	0.0	0.0	0.0	0.0
2008-2010	0.0	0.0	0.0	0.0	0.0
2009-2011	0.0	0.0	0.0	0.0	0.0
2010-2012	0.0	0.0	0.0	0.0	0.0
2011-2013	0.0	0.0	0.0	0.0	0.0

SUMMER	2017 Progress				
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005-2007	0.0	0.0	0.0	0.0	10.5
2006-2008	0.0	0.0	0.0	0.0	0.0
2007-2009	6.8	9.1	0.0	0.0	0.0
2008-2010	10.7	17.8	0.0	0.0	0.0
2009-2011	20.5	42.7	0.0	0.0	0.0
2010-2012	16.6	45.8	0.0	0.0	0.0
2011-2013	12.1	46.9	0.0	0.0	0.0

DRAFT

Proposed Criteria, Proposed Assessment Procedure

Values are seasonal chl means (ug/l)

Red indicates criteria exceedences

SPRING	2017 Progress				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	1	3	7	6	10
2006	3	5	8	4	4
2007	2	4	3	4	6
2008	2	3	5	5	4
2009	4	4	22	5	6
2010	3	3	5	4	9
2011	4	6	4	3	5
2012	8	10	2	4	3
2013	4	5	4	7	5

SUMMER	2017 Progress				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	9	12	7	7	7
2006	4	7	6	5	5
2007	5	9	2	3	5
2008	6	14	7	7	7
2009	20	20	5	4	7
2010	18	18	8	3	3
2011	16	29	6	4	4
2012	12	27	2	2	7
2013	17	20	4	4	5

Three-year nonattainment

Six-year nonattainment (none predicted)

DO Attainment

Current Criteria, Current Assessment Procedure

Values are excessive space-time exceedence rates%

Red indicates nonattainment

SPRING	DO Attainment				
period	**JMSTFU**	**JMSTFL**	**JMSOH**	**JMSMH**	**JMSPH**
2005-2007	0.0	0.0	0.0	1.1	21.8
2006-2008	0.0	0.0	0.0	0.0	0.0
2007-2009	0.0	0.0	1.0	0.0	0.0
2008-2010	0.0	0.0	1.0	0.0	0.0
2009-2011	0.0	0.0	1.0	0.0	0.0
2010-2012	0.0	0.0	0.0	0.0	0.0
2011-2013	0.0	0.0	0.0	0.6	0.0

SUMMER	DO Attainment				
period	**JMSTFU**	**JMSTFL**	**JMSOH**	**JMSMH**	**JMSPH**
2005-2007	0.0	0.0	0.0	0.0	10.5
2006-2008	0.0	0.0	0.0	0.0	0.0
2007-2009	1.8	4.2	0.0	0.0	0.0
2008-2010	5.9	16.3	0.0	0.0	0.0
2009-2011	15.1	41.1	0.0	0.0	0.0
2010-2012	17.5	53.3	0.0	0.0	0.0
2011-2013	12.9	53.5	0.0	0.0	0.0

DRAFT

Proposed Criteria, Proposed Assessment Procedure

Values are seasonal chl means (ug/l)

Red indicates criteria exceedences

SPRING	DO Attainment				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	1	3	8	7	**9**
2006	3	6	8	4	3
2007	3	4	3	4	5
2008	2	3	5	5	5
2009	5	5	**24**	5	5
2010	4	4	6	5	8
2011	5	6	5	3	5
2012	**9**	**11**	2	5	3
2013	4	5	4	7	4

SUMMER	DO Attainment				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	9	11	8	7	7
2006	4	7	6	5	5
2007	6	9	3	3	5
2008	7	15	7	7	6
2009	18	19	7	5	6
2010	**22**	22	9	3	2
2011	17	**31**	7	4	4
2012	13	**30**	2	3	7
2013	17	20	5	4	5

Three-year nonattainment

Six-year nonattainment (none predicted)

WIP2

Current Criteria, Current Assessment Procedure

Values are excessive space-time exceedence rates%

Red indicates nonattainment

SPRING	WIP2				
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005-2007	0.0	0.0	0.0	0.8	21.8
2006-2008	0.0	0.0	0.0	0.0	0.0
2007-2009	0.0	0.0	0.0	0.0	0.0
2008-2010	0.0	0.0	0.0	0.0	0.0
2009-2011	0.0	0.0	0.0	0.0	0.0
2010-2012	0.0	0.0	0.0	0.0	0.0
2011-2013	0.0	0.0	0.0	0.0	0.0

SUMMER	WIP2				
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005-2007	0.0	0.0	0.0	0.0	10.5
2006-2008	0.0	0.0	0.0	0.0	0.0
2007-2009	0.9	2.5	0.0	0.0	0.0
2008-2010	4.7	14.3	0.0	0.0	0.0
2009-2011	13.7	39.1	0.0	0.0	0.0
2010-2012	15.1	49.0	0.0	0.0	0.0
2011-2013	10.7	40.9	0.0	0.0	0.0

Proposed Criteria, Proposed Assessment Procedure

Values are seasonal chl means (ug/l)

Red indicates criteria exceedences

SPRING	WIP2				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	1	3	7	6	8
2006	3	5	8	4	3
2007	2	4	3	3	5
2008	2	3	5	4	5
2009	4	5	**21**	5	5
2010	4	3	5	4	8
2011	5	6	4	3	4
2012	8	10	2	4	3
2013	4	5	4	6	4

SUMMER	WIP2				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	8	10	7	7	6
2006	4	6	6	4	5
2007	6	8	2	3	5
2008	6	14	6	6	6
2009	16	17	5	4	6
2010	20	19	7	2	2
2011	15	**28**	6	3	4
2012	12	**26**	1	2	7
2013	15	17	4	3	4

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Three-year nonattainment

Six-year nonattainment (none predicted)

How much is chlorophyll reduced under the WIP2 scenario in each segment?

SUMMER	WIP2				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005					
2006					
2007					
2008					
2009					
2010					
2011					
2012					
2013					

Median % change relative to baseline

-20% to -10%	
-30% to -20%	
-40% to -30%	
-99% to -40%	

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E3

Current Criteria, Current Assessment Procedure

Values are excessive space-time exceedence rates%

Red indicates nonattainment

SPRING	E3				
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005-2007	0.0	0.0	0.0	0.7	21.8
2006-2008	0.0	0.0	0.0	0.0	0.0
2007-2009	0.0	0.0	0.0	0.0	0.0
2008-2010	0.0	0.0	0.0	0.0	0.0
2009-2011	0.0	0.0	0.0	0.0	0.0
2010-2012	0.0	0.0	0.0	0.0	0.0
2011-2013	0.0	0.0	0.0	0.0	0.0

SUMMER	E3				
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005-2007	0.0	0.0	0.0	0.0	10.5
2006-2008	0.0	0.0	0.0	0.0	0.0
2007-2009	0.0	1.1	0.0	0.0	0.0
2008-2010	0.0	4.7	0.0	0.0	0.0
2009-2011	0.0	17.0	0.0	0.0	0.0
2010-2012	0.0	15.0	0.0	0.0	0.0
2011-2013	0.0	10.9	0.0	0.0	0.0

Proposed Criteria, Proposed Assessment Procedure

Values are seasonal chl means (ug/l)

Red indicates criteria exceedences

SPRING	E3				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	1	2	4	4	7
2006	2	4	7	3	3
2007	1	2	1	2	4
2008	1	2	2	4	4
2009	1	1	**16**	4	4
2010	1	2	2	2	6
2011	2	3	2	1	4
2012	4	5	1	3	3
2013	1	2	1	4	4

SUMMER	E3				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	5	8	4	5	6
2006	2	3	4	3	4
2007	3	6	1	2	4
2008	4	12	4	4	5
2009	13	13	3	3	5
2010	13	12	4	2	2
2011	9	18	3	2	3
2012	7	17	1	1	6
2013	9	10	2	3	4

Three-year nonattainment (none predicted)

Six-year nonattainment (none predicted)

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Summary of New Preliminary Results

	2013 Progress	2017 Progress	DO Attain't	WIP2	E3
Current Criteria, Current Assessment Method					
Proposed Mean Criteria, Proposed Assessment Method (1 exceedence in 3 years)					
Proposed Mean Criteria, Proposed Assessment Method (2 exceedences in 6 years)					

Nonattainment predicted under scenario

Full attainment predicted under scenario

Assessment Period Options	Arguments for…	Arguments against…
Three-Year	• Allows for more rapid detection of impairment. • Consistent with how toxics are assessed. • Consistent with how Bay DO criteria are assessed.	• False positives are more likely. • May be unnecessarily restrictive since chlorophyll isn't a direct cause of aquatic life harm.
Six-Year	• Allows for more confident assessments. • Consistent with how DEQ assesses most conventional parameters. • The longer period is more amenable to attainability analysis given the absence of a critical period.	• Impairment will take longer to detect. • Back-to-back exceedences could occur more frequently. This could have implications on aquatic life recovery.

DEQ is proposing to adopt a six-year assessment period for James River chlorophyll.

DEQ is also proposing an additional set of criteria for added protection, given the leniency of a longer assessment period.

Proposed seasonal mean criteria

The following site-specific seasonal mean criteria should not be exceeded in a segment more than twice over six consecutive spring or summer seasons.

Designated Use	Chlorophyll-*a* µg/l	Chesapeake Bay Program Segment	Temporal Application
Open water	8	JMSTF2	March 1 - May 31 (spring)
	10	JMSTF1	
	13	JMSOH	
	7	JMSMH	
	8	JMSPH	
	21	JMSTF2	July 1 - September 30 (summer)
	24	JMSTF1	
	11	JMSOH	
	7	JMSMH	
	7	JMSPH	

Proposed seasonal mean criteria

The following site-specific seasonal mean criteria should not be exceeded in a segment more than twice over six consecutive spring or summer seasons.

Designated Use	Chlorophyll-*a* µg/l	Chesapeake Bay Program Segment	Temporal Application
Open water	8	JMSTF2	March 1 - May 31 (spring)
	10	JMSTF1	
	13	JMSOH	
	7	JMSMH	
	8	JMSPH	
	21	JMSTF2	July 1 - September 30 (summer)
	24	JMSTF1	
	11	JMSOH	
	7	JMSMH	
	7	JMSPH	

These criteria are developed to protect against both long- and short-term effects on aquatic life caused by phytoplankton.

However, short-term effects can still occur even when these criteria are attained. This is a problem.

The following site-specific seasonal mean criteria should not be exceeded in a segment more than twice over six consecutive spring or summer seasons.

Proposed seasonal mean criteria

Designated Use	Chlorophyll-*a* µg/l	Chesapeake Bay Program Segment	Temporal Application
Open water	8	JMSTF2	March 1 - May 31 (spring)
	10	JMSTF1	
	13	JMSOH	
	7	JMSMH	
	8	JMSPH	
	21	JMSTF2	July 1 - September 30 (summer)
	24	JMSTF1	
	11	JMSOH	
	7	JMSMH	
	7	JMSPH	

The solution to this problem is dual criteria.

The following site-specific chlorophyll-*a* concentrations at the specified duration should not occur more than 10% of the time over six consecutive summer seasons.

Proposed short-duration criteria

Chlorophyll-*a* µg/l	Chesapeake Bay Program Segment	Spatial Application	Duration
52	JMSTF2	River mile 95 to downstream boundary of JMSTF2	1-Month median
52	JMSTF1	Upstream boundary of JMSTF1 to river mile 67	1-Month median
34	JMSTF1	River mile 67 to downstream boundary of JMSTF1	1-Month median
--	JMSOH	Entire segment	--
59	JMSMH	Entire segment	1-Day median
20	JMSPH	Entire segment	1-Day median

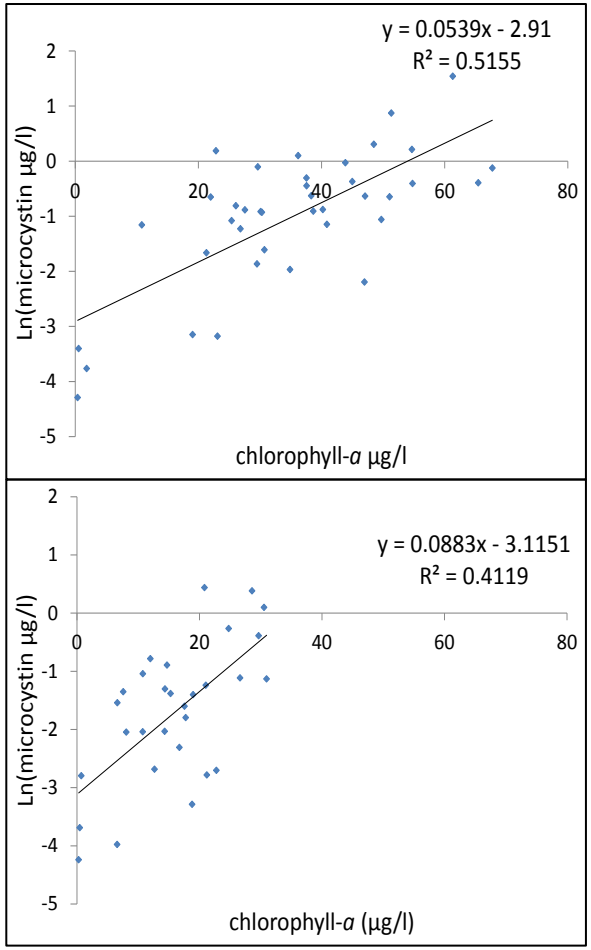

Figure 7. Scatterplots of chlorophyll-a and microcystin concentrations. Top) Samples collected at station TF5.5A (upper portion of JMSTFL). Bottom) Samples collected at station TF5.6 (lower portion of JMSTFL).

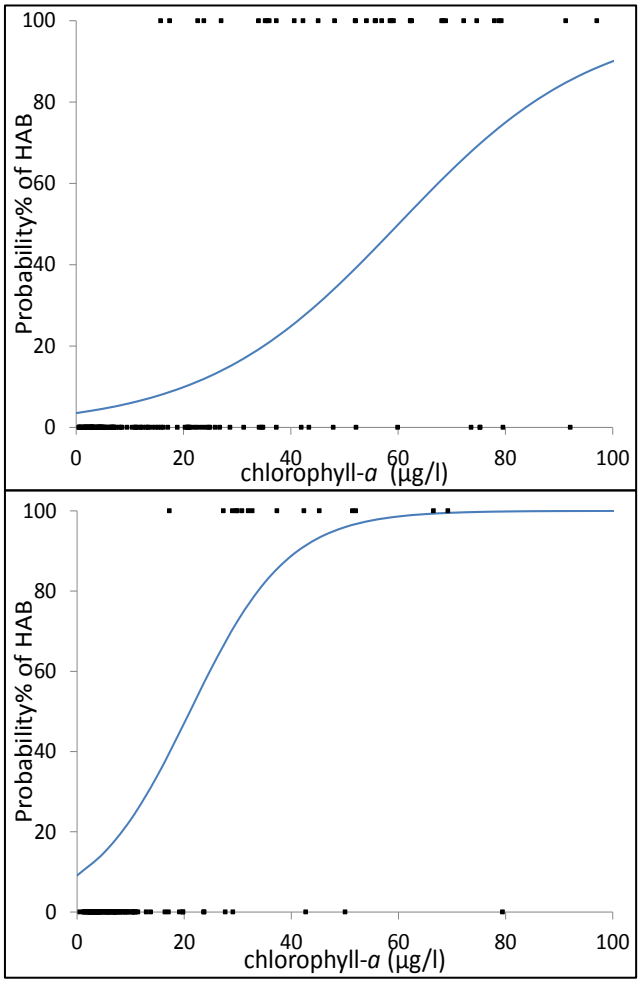

Figure 8. Logistic regression models predicting the probability of harmful cell densities of *C. polykrikoides* over a range of chlorophyll-a concentrations in JMSMH (top) and JMSPH (bottom).

Short-duration criteria are derived directly from statistical models relating ambient chlorophyll and HAB metrics.

What are the preliminary attainment results using both sets of proposed criteria?

Baseline

Values are seasonal chl means (ug/l)
Red indicates proposed mean criteria exceedences
Red blocks are **6-year** periods in nonattaiment

SPRING	Baseline				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	2	4	11	**8**	**11**
2006	6	8	10	6	5
2007	5	6	4	4	7
2008	3	4	7	6	5
2009	7	7	**26**	6	6
2010	4	4	7	5	**10**
2011	7	8	6	4	6
2012	**10**	**13**	2	5	4
2013	5	5	5	**8**	5

SUMMER	Baseline				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	14	13	9	**10**	**9**
2006	9	10	8	6	6
2007	8	11	4	5	7
2008	12	15	8	**9**	**8**
2009	**26**	22	7	6	**8**
2010	**30**	**25**	10	4	3
2011	20	**33**	7	4	4
2012	15	**29**	2	3	**8**
2013	20	22	5	4	6

Nonattainment

Exceedence rates of short-duration criteria
Red indicates excessive rates (> 10%)

SUMMER	Baseline				
Period	lower JMSTFU	upper JMSTFL	lower JMSTFL	JMSMH	JMSPH
2005-2010	0%	0%	0%	0%	5%
2006-2011	6%	**12%**	0%	0%	5%
2007-2012	6%	**12%**	0%	0%	8%
2008-2013	6%	**12%**	0%	0%	8%

Nonattainment

2013 Progress

Values are seasonal chl means (ug/l)
Red indicates proposed mean criteria exceedences
Red blocks are **6-year** periods in nonattaiment

SPRING	2013 Progress				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	1	3	8	7	**11**
2006	3	5	8	5	4
2007	3	5	3	4	6
2008	2	4	5	6	5
2009	4	5	**22**	5	6
2010	4	3	5	4	**10**
2011	5	6	5	3	6
2012	**9**	**11**	2	5	4
2013	4	5	4	7	5

SUMMER	2013 Progress				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	9	11	7	**8**	**8**
2006	5	8	7	5	6
2007	6	10	3	4	6
2008	7	14	7	7	**8**
2009	20	19	5	5	7
2010	21	20	8	3	3
2011	18	**31**	6	4	4
2012	13	**28**	2	3	**8**
2013	18	20	5	4	6

Full Attainment

Exceedence rates of short-duration criteria
Red indicates excessive rates (> 10%)

SUMMER	2013 Progress				
Period	lower JMSTFU	upper JMSTFL	lower JMSTFL	JMSMH	JMSPH
2005-2010	0%	0%	0%	0%	0%
2006-2011	6%	**12%**	0%	0%	0%
2007-2012	6%	**12%**	0%	0%	0%
2008-2013	6%	**12%**	0%	0%	0%

Nonattainment

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Criteria Option	2013 Progress	2017 Progress	DO Attainment	WIP2	E3
Option 1 **3-year: mean criteria only** (1 exceedence allowed)					
Option 2 **6-year: mean criteria only** (2 exceedences allowed)					
Option 3 **6-year: mean criteria + short-duration criteria** (2 exceedences allowed for mean criteria, 10% exceedence rate for short-duration criteria					

Nonattainment is predicted

Full attainment is predicted

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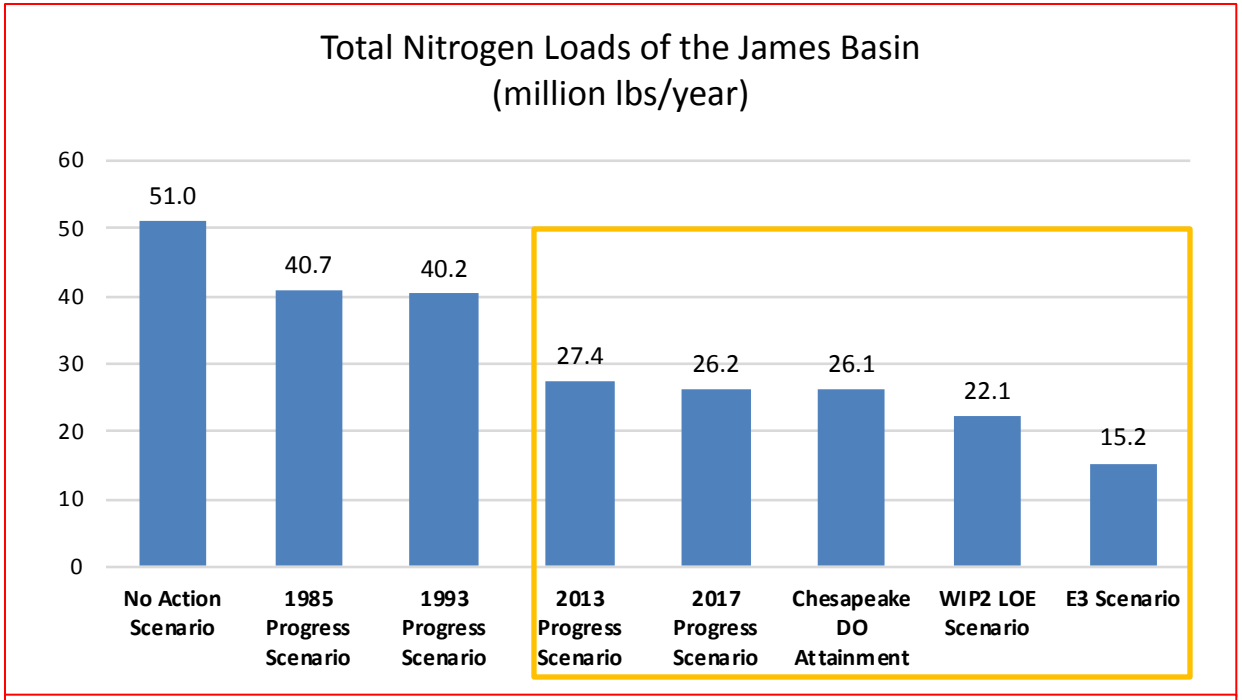
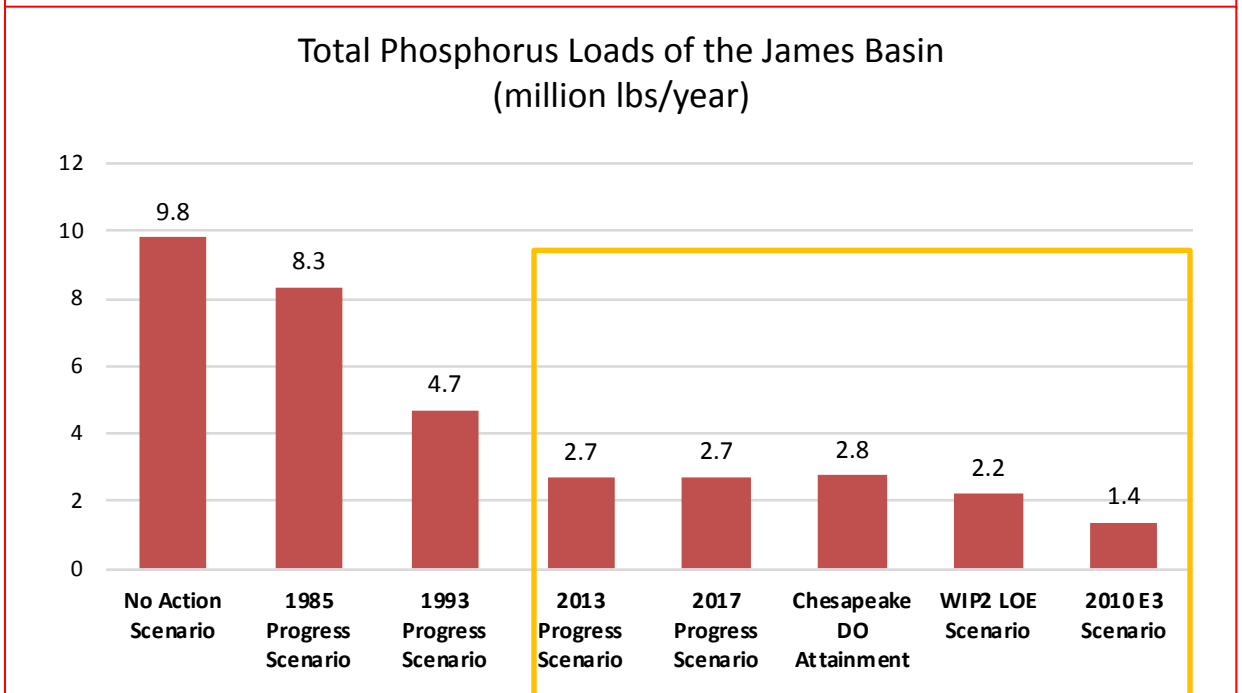
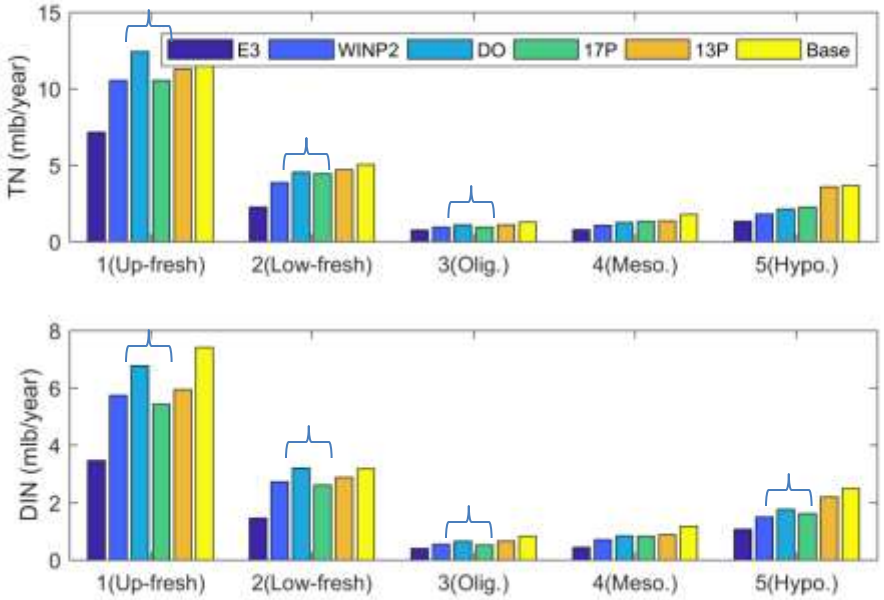
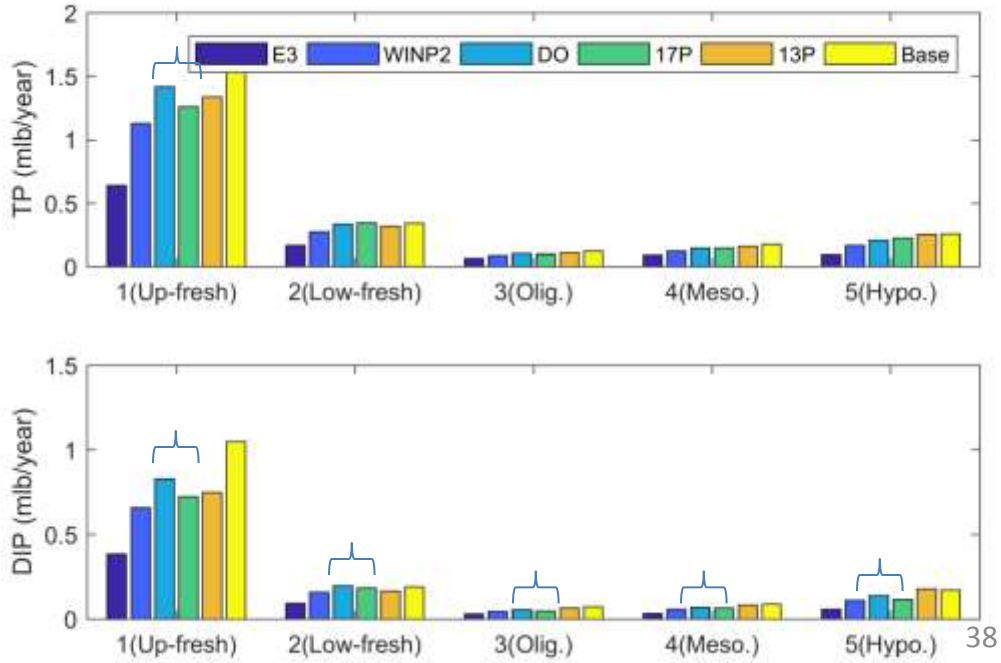

Total Nitrogen Loads of the James Basin
(million lbs/year)
60
50
40
30
20
10
0
51.0
40.7
40.2
27.4
26.2
26.1
22.1
15.2
No Action Scenario
1985 Progress Scenario
1993 Progress Scenario
2013 Progress Scenario
2017 Progress Scenario
Chesapeake DO Attainment
WIP2 LOE Scenario
E3 Scenario


Total Phosphorus Loads of the James Basin
(million lbs/year)
12
10
8
6
4
2
0
9.8
8.3
4.7
2.7
2.7
2.8
2.2
1.4
No Action Scenario
1985 Progress Scenario
1993 Progress Scenario
2013 Progress Scenario
2017 Progress Scenario
Chesapeake DO Attainment
WIP2 LOE Scenario
2010 E3 Scenario



Loads were slightly higher under the DO Attainment scenario than the 2017 Progress scenario.



What’s next?

VAMWA scenarios to be run through the James River water quality model

Loads

Scenario	Upper Estuary Above Fall Line	Upper Estuary Below Fall Line	Lower Estuary (HRSD)	Notes
"B" TMDL Chl-a Stage 1B	Typical POTW=WQMP/WGP (TN=6, TP=0.41 mg/L) Industrial=WQMPR	Typical POTW= WQMP/WGP (TN=5, TP=0.41 mg/L) Industrial=WQMPR	HRSD TN=3.554 Mlb/yr HRSD TP=0.318 Mlb/yr (Typically TN=6.500, TP=0.582 mg/L) No Industrials Present	• Represents TN WLA reductions in progress for Lower Estuary by HRSD for Jan. 2022 • Represents TP reductions effective Feb. 2017 WGP reissuance for Upper and Lower Estuary
"B+" P Sensitivity Stage 1B+	All POTW & Industrial TN= Same as Stage 1B All POTW TP=0.2 mg/L (-50% from 1B) All Industrial TP=Same % Reduction	All POTW & Industrial TN= Same as Stage 1B All POTW TP=0.2 mg/L (-50% from 1B) All Industrial TP=Same % Reduction	HRSD TN=Same as Stage 1B HRSD TP=0.109 Mlb/yr (0.2 mg/l)	• Testing sensitivity to P-only reductions • Results could be used interpolate effects of intermediate P reductions (e.g., TP=0.3 mg/L)
"C" Intermediate Scenario 1C	Typical POTW Reductions TN=5 mg/L (-17% from 1B) TP=0.3 mg/L (-25%) Indus=Same % Reduction	Typical POTW Reductions TN=4 mg/L (-20% from 1B) TP=0.3 mg/L (-25%) Indus=Same % Reduction	HRSD TN= 2.734 Mlb/yr HRSD TP= 0.164 Mlb/yr (TN=5 mg/L, TP=0.3 mg/L)	
"B/D" Seasonal Hybrid	Scenario B as Annual Avg Scenario D as Summer Avg (May – Sept)	Scenario B as Annual Avg Scenario D as Summer Avg (May – Sept)	Scenario B as Annual Avg Scenario C as Summer Avg (May – Sept)	• Testing sensitivity to timing of nutrient loads
"D" Intermediate Scenario 1D	Typical POTW Reductions TN=4 mg/L (-33% from 1B) TP=0.2 mg/L (-50%) Indus=Same % Reduction	Typical POTW Reductions TN=4 mg/L (-20% from 1B) TP=0.2 mg/L (-50%) Indus=Same % Reduction	HRSD TN= 2.187 Mlb/yr HRSD TP= 0.109 Mlb/yr (TN=4 mg/L, TP=0.2 mg/L)	
"E" TMDL Chl-a Stage 2	Base on Input Deck Used to Achieve Chl-a Attainment During 2010 TMDL Model	Base on Input Deck Used to Achieve Chl-a Attainment During 2010 TMDL Model	Base on Input Deck Used to Achieve Chl-a Attainment During 2010 TMDL Model	• Need DEQ to supply 2010 input deck for PS WLAs for review to finalize this scenario

Credit: George Tolton

Questions?

Credit: George Tolton

Credit: Tony Silvia