Attainment Results of CBP Scoping Scenarios (using 2005-2013 loadings) run through the VIMS Eutrophication Model

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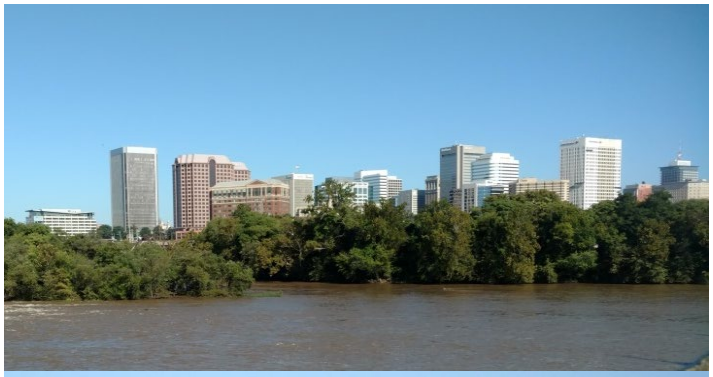
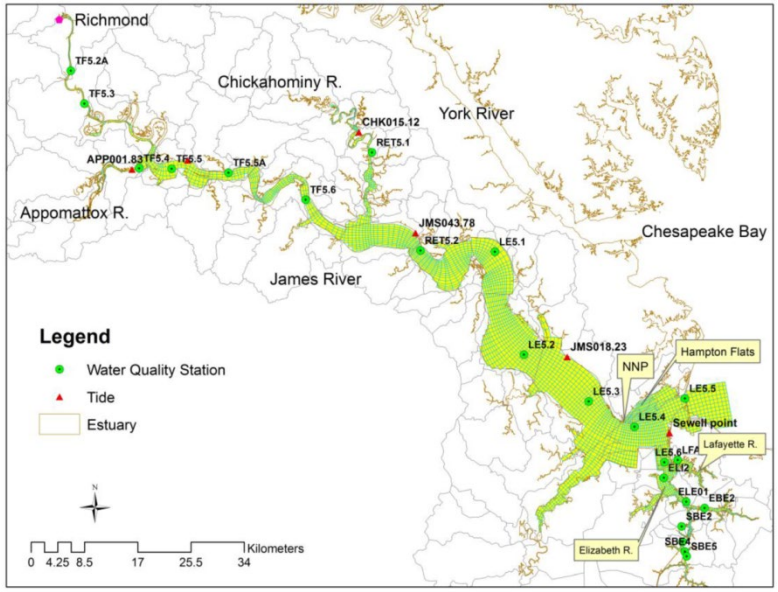
Modeling Workgroup Quarterly Review
February 19, 2019



VADEQ has…

- developed an alternative set of chlorophyll-a criteria for the James River estuary.
- developed an alternative assessment methodology for James R. chlorophyll-a criteria.
- contracted with VIMS to develop a water quality model specific to the James River that will help inform management decisions.



Seasonal Mean Criteria

Chlorophyll-a µg/l CURRENT	Chlorophyll-a µg/l PROPOSED	Chesapeake Bay Program Segment	Temporal Application
10	8	JMSTF2	March 1 -May 31
15	10	JMSTF1	
15	13	JMSOH	
12	7	JMSMH	
12	8	JMSPH	
15	21	JMSTF2	July 1 - September 30
23	24	JMSTF1	
22	11	JMSOH	
10	7	JMSMH	
10	7	JMSPH	

Chlorophyll-a µg/l CURRENT	Chlorophyll-a µg/l PROPOSED	Chesapeake Bay Program Segment	Temporal Application
10	8	JMSTF2	March 1 -May 31
15	10	JMSTF1	
15	13	JMSOH	
12	7	JMSMH	
12	8	JMSPH	
15	21	JMSTF2	July 1 - September 30
23	24	JMSTF1	
22	11	JMSOH	
10	7	JMSMH	
10	7	JMSPH	

Seasonal Mean Criteria

Provide protection against long-term and short-term adverse effects

Proposed Short-Duration Criteria (new!)

Provide additional protection against toxic HABs

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

Chlorophyll-a µg/l CURRENT	Chlorophyll-a µg/l PROPOSED	Chesapeake Bay Program Segment	Temporal Application
	8	JMSTF2	March 1 -May 31
	10	JMSTF1	
	13	JMSOH	
	7	JMSMH	
12	8	JMSPH	
15	21	JMSTF2	July 1 - September 30
23	24	JMSTF1	
22	11	JMSOH	
10	7	JMSMH	
10	7	JMSPH	

For proposed criteria: ->

No to be exceeded more than twice in six years (segment-season)

Seasonal Mean Criteria

Provide protection against long-term and short-term adverse effects

Proposed Short-Duration Criteria (new!)

Provide additional protection against toxic HABs

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

Not to be exceeded more than 10% of the time at the specified duration

Proposed Assessment methodology (i.e., how monitoring data are to be analyzed)

1-Day Median Criteria

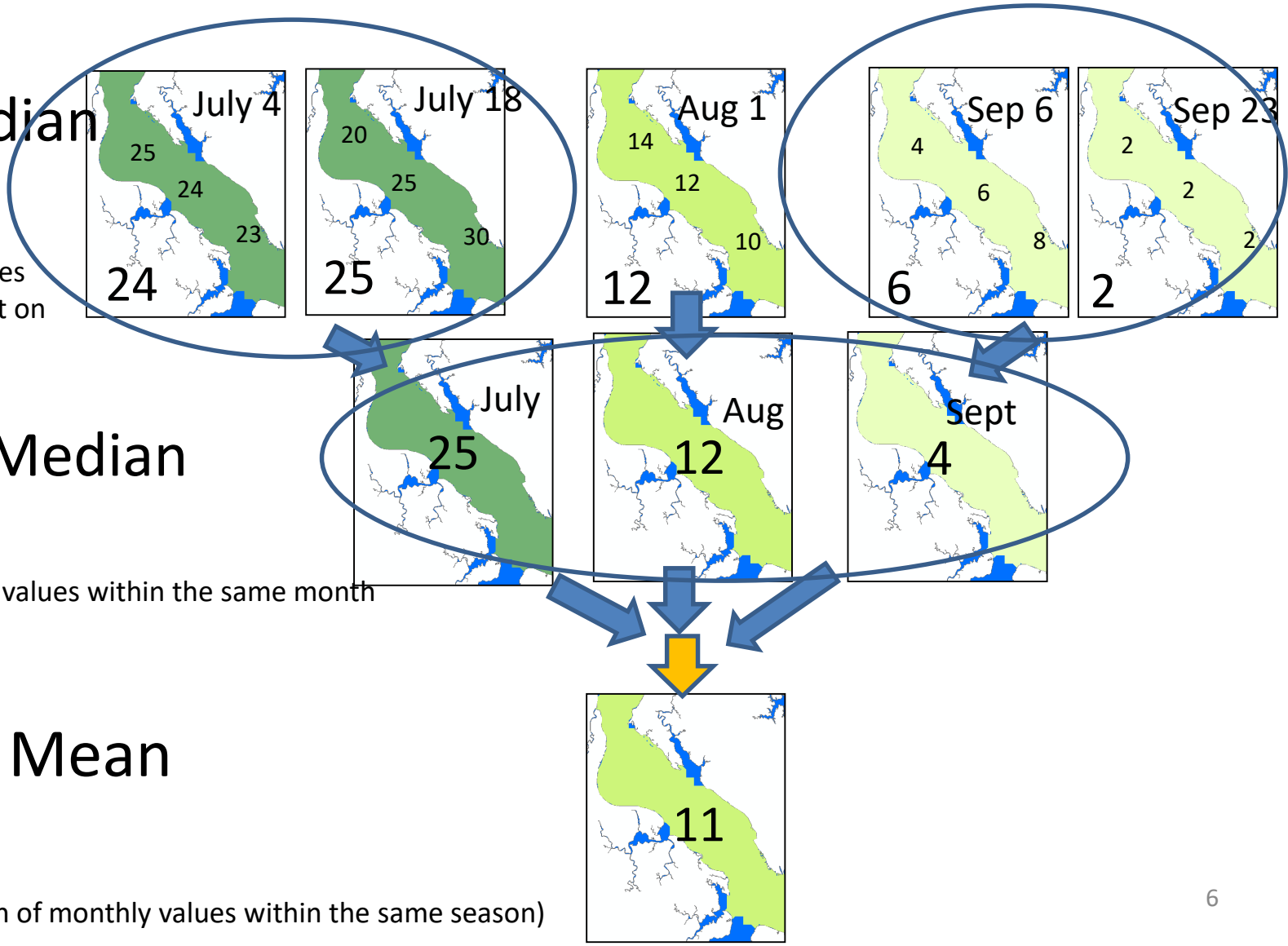
(The median of samples collected in a segment on the same day)

1-Month Median Criteria

(The median of daily values within the same month

Seasonal Mean Criteria

(The geometric mean of monthly values within the same season)



At the April 2018 Modeling Workgroup meeting…

VADEQ expressed its desired for the 2005-2013 scenario loadings estimated by the Bay Watershed Model.

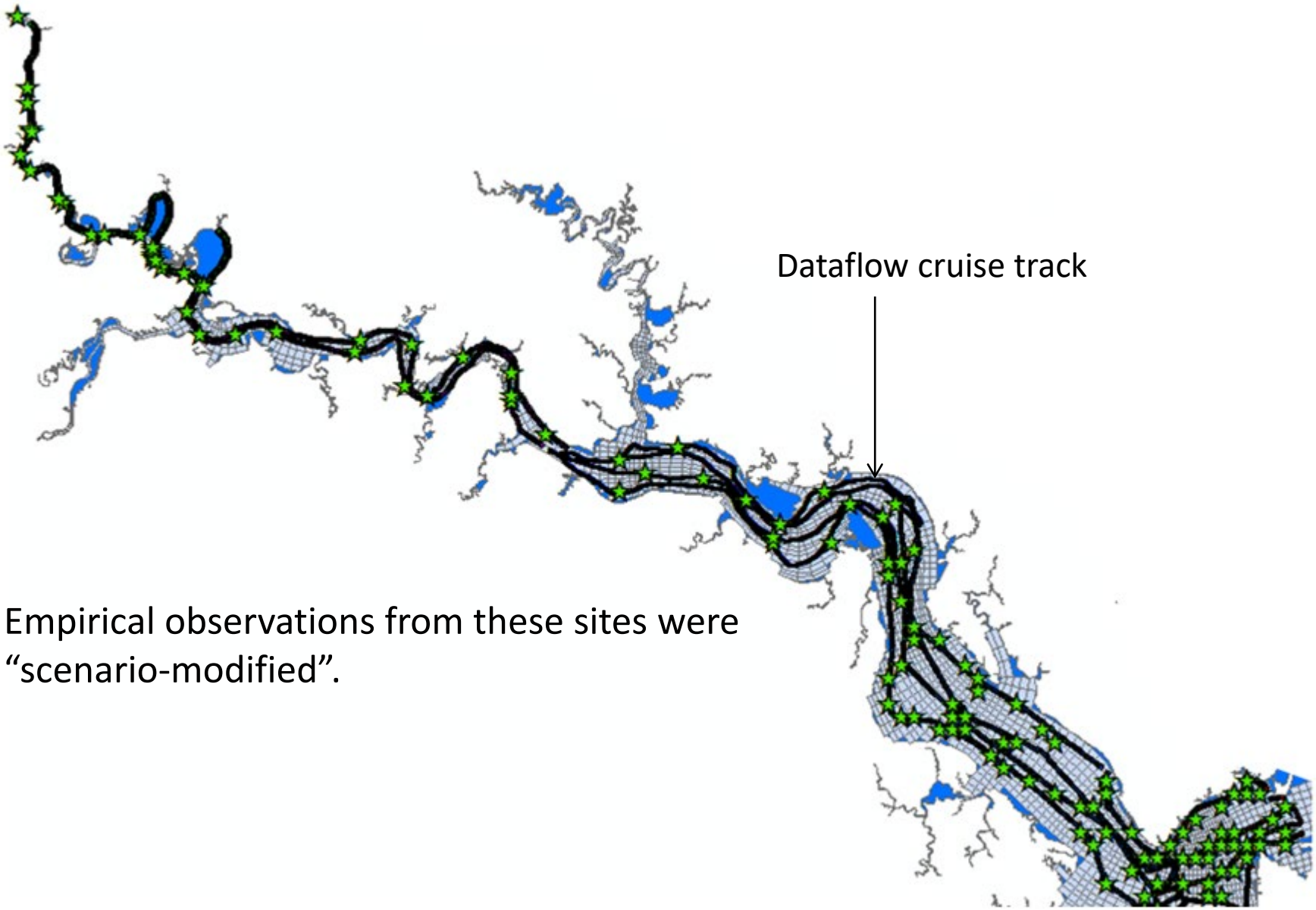
Justification for using 2005-2013 loadings:

- The 2005-2013 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.

The James River modeling team has shifted its focus to the 2005-2013 period.

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



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

The following CBP scenarios that have been run through the VIMS eutrophication model:

- 2013 Progress
- 2017 Progress
- DO Attainment
- WIP2
- E3

Baseline

Current Criteria, Current Assessment Procedure

Values are excessive space-time exceedence rates%

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

Three-year non-attainment

Proposed Seasonal Mean Criteria, Proposed Assessment Procedure

Values are seasonal chl means (µg/l)

Red indicates 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

Baseline

Current Criteria, Current Assessment Procedure

Values are excessive space-time exceedence rates%

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

Three-year non-attainment

Proposed Seasonal Mean Criteria, Proposed Assessment Procedure

Values are seasonal chl means (µg/l)

Red indicates 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

Six-year non-attainment

Exceedance Frequencies of Proposed Short-Duration Criteria

Not to be exceeded more than 10% of the time

SUMMER	Baseline				
Period	lower JMSTFU	upper JMSTFL	lower JMSTFL	JMSMH	JMSPH
2005-2010	0%	0%	0%	0%	6%
2006-2011	0%	**12%**	0%	0%	6%
2007-2012	0%	**12%**	0%	0%	10%
2008-2013	0%	**12%**	0%	0%	9%

close!

NON-ATTAINMENT

Assessment Results for Current Criteria for Each Scoping Scenario, Processed via the 10% CFD

2013 Progress

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	0.6	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	14.2	7.5	0.0	0.0	0.0
2008-2010	23.2	18.7	0.0	0.0	0.0
2009-2011	34.8	43.6	0.0	0.0	0.0
2010-2012	25.7	49.1	0.0	0.0	0.0
2011-2013	16.2	51.5	0.0	0.0	0.0

2017 Progress

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	5.4	9.6	0.0	0.0	0.0
2008-2010	10.0	16.3	0.0	0.0	0.0
2009-2011	20.8	41.2	0.0	0.0	0.0
2010-2012	18.6	43.1	0.0	0.0	0.0
2011-2013	13.5	50.0	0.0	0.0	0.0

DO Attainment

SPRING	DO Attainment				
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	0.9	0.0	0.0
2008-2010	0.0	0.0	0.9	0.0	0.0
2009-2011	0.0	0.0	0.9	0.0	0.0
2010-2012	0.0	0.0	0.0	0.0	0.0
2011-2013	0.0	0.0	0.0	1.6	0.0

SUMMER	DO Attainment				
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005-2007	0.0	0.5	0.0	0.0	10.5
2006-2008	0.0	1.2	0.0	0.0	0.0
2007-2009	2.0	7.3	0.0	0.0	0.0
2008-2010	6.6	17.6	0.0	0.0	0.0
2009-2011	17.4	41.1	0.0	0.0	0.0
2010-2012	19.8	52.4	0.0	0.0	0.0
2011-2013	14.8	52.7	0.0	0.0	0.0

Three-year non-attainment

WIP2

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	1.2	2.6	0.0	0.0	0.0
2008-2010	5.0	14.3	0.0	0.0	0.0
2009-2011	14.1	39.1	0.0	0.0	0.0
2010-2012	15.7	48.2	0.0	0.0	0.0
2011-2013	11.4	40.9	0.0	0.0	0.0

E3

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	1.3	0.0	0.0	0.0
2008-2010	0.0	4.9	0.0	0.0	0.0
2009-2011	0.5	17.5	0.0	0.0	0.0
2010-2012	0.2	14.4	0.0	0.0	0.0
2011-2013	0.0	10.3	0.0	0.0	0.0

Assessment Results for Proposed Criteria for Each Scoping Scenario, Processed via Proposed Assessment Procedure

2013 Progress

SPRING	2013 Progress				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	1	3	7	6	**10**
2006	3	4	8	4	4
2007	2	4	4	4	6
2008	1	3	5	5	5
2009	5	5	**19**	5	6
2010	4	4	6	5	**10**
2011	5	7	5	3	6
2012	**9**	**11**	2	4	4
2013	5	6	5	7	5
SUMMER	2013 Progress				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	8	11	7	7	**8**
2006	5	8	6	5	6
2007	4	10	2	4	6
2008	6	12	6	7	7
2009	20	20	5	5	7
2010	**22**	20	8	3	3
2011	18	**31**	6	4	4
2012	14	**28**	2	3	**8**
2013	19	21	4	4	5

2017 Progress

SPRING	2017 Progress				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	1	3	7	6	**10**
2006	3	4	8	4	3
2007	2	4	3	4	6
2008	1	3	5	5	5
2009	4	5	**19**	5	6
2010	3	3	6	4	**9**
2011	5	6	5	3	5
2012	**9**	**11**	2	4	4
2013	4	5	4	7	5
SUMMER	2017 Progress				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	7	12	7	7	7
2006	4	7	6	5	5
2007	4	8	2	3	5
2008	6	12	6	6	7
2009	21	20	4	4	6
2010	18	18	7	3	3
2011	17	**29**	6	3	4
2012	12	**26**	2	2	7
2013	18	20	5	4	5

DO Attainment

SPRING	DO Attainment				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	1	4	7	7	**8**
2006	4	6	8	4	2
2007	2	4	3	4	5
2008	2	3	5	5	5
2009	5	5	**21**	5	5
2010	4	4	6	5	8
2011	5	7	5	3	4
2012	**9**	**12**	2	4	3
2013	5	6	5	7	3
SUMMER	DO Attainment				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	8	12	8	7	7
2006	4	8	6	5	5
2007	5	15	3	3	5
2008	6	14	7	6	6
2009	19	19	6	4	6
2010	**22**	22	9	3	3
2011	19	**32**	6	4	4
2012	13	**29**	2	3	7
2013	18	20	3	4	5

WIP2

SPRING	WIP2				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	1	3	7	6	8
2006	3	5	8	3	2
2007	2	4	3	3	5
2008	2	3	5	4	4
2009	5	5	**18**	5	5
2010	4	3	5	4	8
2011	5	6	5	3	4
2012	8	11	2	4	3
2013	4	5	4	6	4
SUMMER	WIP2				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
2005	8	11	7	6	7
2006	4	7	6	4	4
2007	4	11	2	3	4
2008	6	11	6	5	6
2009	18	17	5	4	5
2010	20	19	7	2	2
2011	16	**29**	5	3	3
2012	12	**26**	1	2	6
2013	15	17	3	3	4

E3

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

☐ Six-year non-attainment (none predicted)

Exceedance Frequencies of Proposed Short-Duration Criteria

2013 Progress

SUMMER	2013 Progress				
Period	lower JMSTFU	upper JMSTFL	lower JMSTFL	JMSMH	JMSPH
2005-2010	0%	0%	0%	0%	5%
2006-2011	0%	**12%**	0%	0%	5%
2007-2012	0%	**12%**	0%	0%	9%
2008-2013	0%	**12%**	0%	0%	9%

2017 Progress

SUMMER	2017 Progress				
Period	lower JMSTFU	upper JMSTFL	lower JMSTFL	JMSMH	JMSPH
2005-2010	0%	0%	0%	0%	5%
2006-2011	0%	6%	0%	0%	5%
2007-2012	0%	6%	0%	0%	6%
2008-2013	0%	6%	0%	0%	7%

DO Attainment

SUMMER	DO Attainment				
Period	lower JMSTFU	upper JMSTFL	lower JMSTFL	JMSMH	JMSPH
2005-2010	0%	0%	0%	0%	4%
2006-2011	0%	**12%**	0%	0%	4%
2007-2012	0%	**12%**	0%	0%	5%
2008-2013	0%	**12%**	0%	0%	5%

WIP2

SUMMER	WIP2				
Period	lower JMSTFU	upper JMSTFL	lower JMSTFL	JMSMH	JMSPH
2005-2010	0%	0%	0%	0%	4%
2006-2011	0%	6%	0%	0%	4%
2007-2012	0%	6%	0%	0%	5%
2008-2013	0%	6%	0%	0%	5%

E3

SUMMER	E3				
Period	lower JMSTFU	upper JMSTFL	lower JMSTFL	JMSMH	JMSPH
2005-2010	0%	0%	0%	0%	2%
2006-2011	0%	0%	0%	0%	2%
2007-2012	0%	0%	0%	0%	4%
2008-2013	0%	0%	0%	0%	4%

Non-Attainment Attainment

Scenario 2005-2013 loadings	Current Criteria	Proposed Seasonal Mean Criteria	Proposed Short-Duration Criteria
Baseline			
2013 Progress			
2017 Progress			
DO Attainment			
WIP2			
E3			

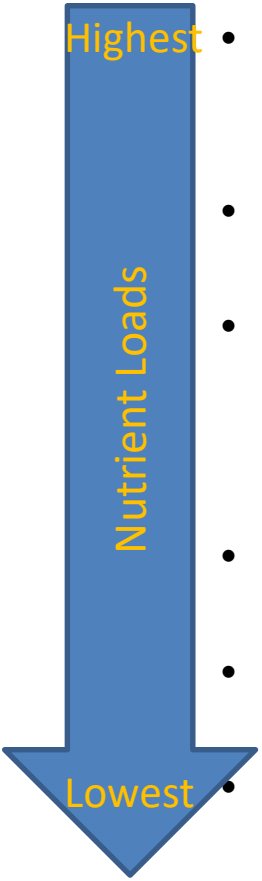
Non-Attainment Attainment

Scenario 2005-2013 loadings	Current Criteria	Proposed Seasonal Mean Criteria	Proposed Short-Duration Criteria
Baseline			
2013 Progress			
2017 Progress			
DO Attainment			
WIP2			
E3			

Scenario 1991-2000 loadings	Current Criteria	Proposed Seasonal Mean Criteria	Proposed Short-Duration Criteria
Baseline			
2013 Progress			
DO Attainment			
WIP2			
E3			

VAMWA Scenario Descriptions

Each scenario represents a different PS loading



- VAMWA B: 2017 Watershed General Permit Waste Load Allocations. **Most comparable to the CBP DO Attainment Scenario**
- VAMWA B+: Same TN loads as VAMWA B; tests sensitivity to TP reductions
- VAMWA B/D: Non-summer TN and TP loads are same as VAMWA B. Summer loads are same as VAMWA D (above fall line and upper estuary) and VAMWA C (lower estuary).
- VAMWA C: Intermediate scenario.
- VAMWA D: Intermediate scenario.
- VAMWA E: **Watershed Implementation Plan II Level of Effort**, estimated to achieve existing James River chlorophyll criteria the CBP Watershed Model (Phase 5.3.2) and Time Variable Sediment Transport Water Quality Model.

All VAMWA Scenarios assume WIP2 NPS controls

Summary of Criteria Assessment Results

Chesapeake Bay Program Scoping Scenarios

	Existing Criteria	Proposed Seasonal Mean Criteria	Proposed Short-Duration Criteria
Observed 2005-2013			
2013 Progress			
2017 Progress			
DO Attainment			
WIP2			
E3			

VAMWA Point Source Scenarios

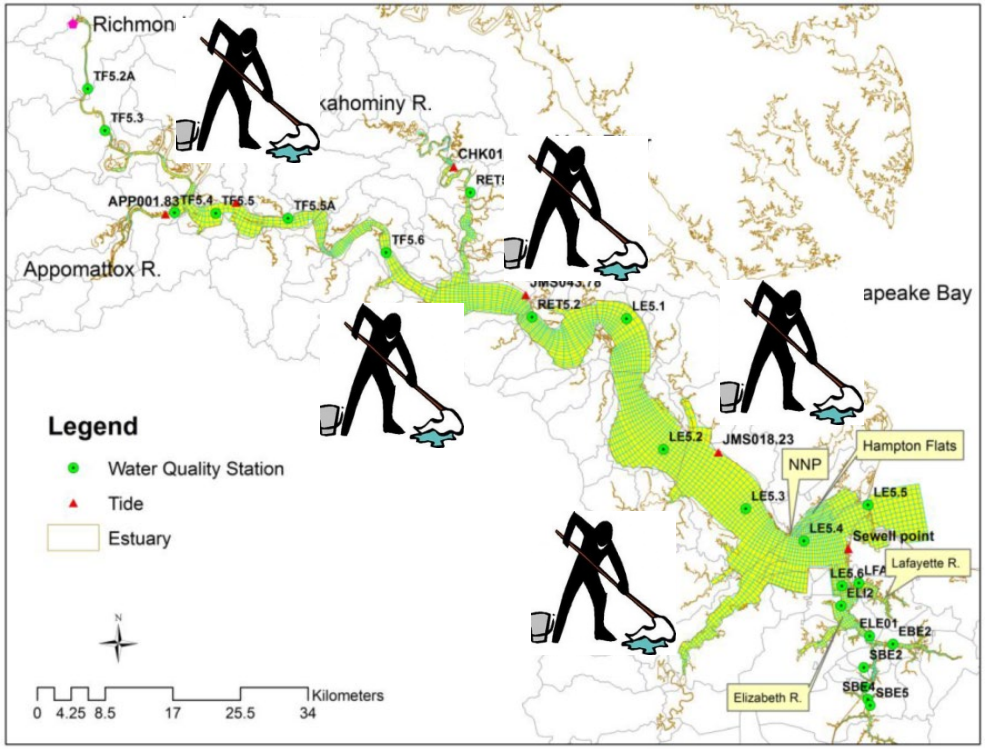
	Existing Criteria	Proposed Seasonal Mean Criteria	Proposed Short-Duration Criteria
VAMWA B			
VAMWA B+			
VAMWA B/D			
VAMWA C			
VAMWA D			
VAMWA E			

Non-attainment predicted under scenario

Full attainment predicted under scenario

Where are we at now?

- Public comment period on proposed amendments ends March 22nd.
- Modeling results will be used to inform modifications to the Water Quality Management Plan for the James River basin.



Questions?