VA uses an instantaneous minimum criterion to assess DO in its streams, rivers, and lakes.

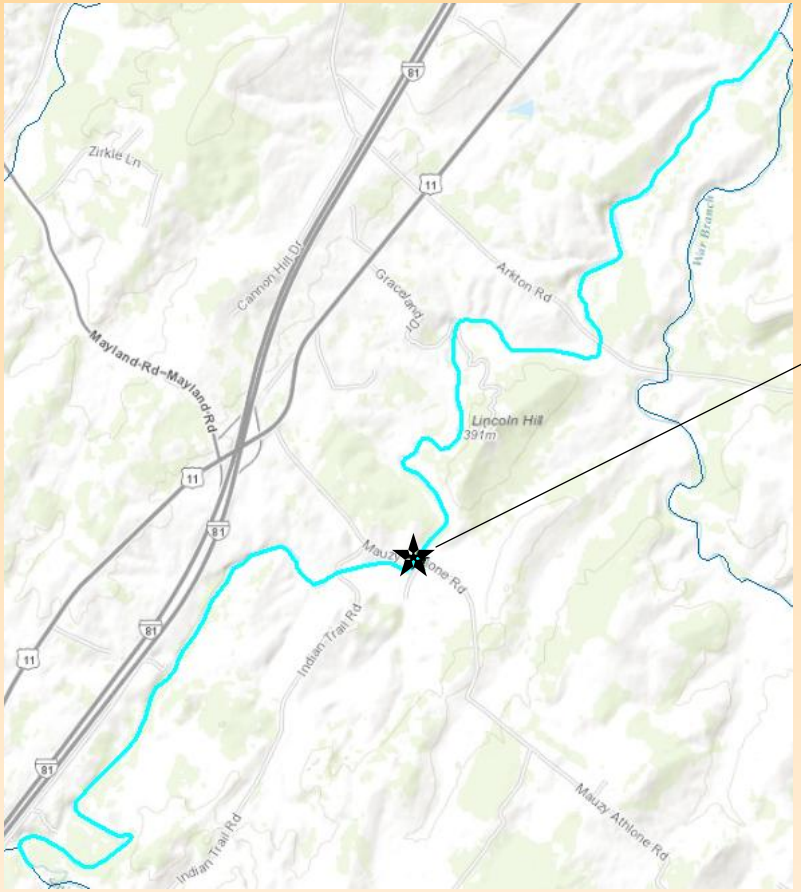
VA Water Quality Standards

9VAC25-260-50. Numerical criteria for dissolved oxygen, pH, and maximum temperature.***

CLASS	DESCRIPTION OF WATERS	DISSOLVED OXYGEN (mg/l)****		pH	Max. Temp. (°C)
		Min.	Daily Avg.		
I	Open Ocean	5.0	--	6.0-9.0	--
II	Estuarine Waters (Tidal Water-Coastal Zone to Fall Line)	4.0	5.0	6.0-9.0	--
III	Nontidal Waters (Coastal and Piedmont Zones)	4.0	5.0	6.0-9.0	32
IV	Mountainous Zones Waters	4.0	5.0	6.0-9.0	31
V	Stockable Trout Waters	5.0	6.0	6.0-9.0	21
VI	Natural Trout Waters	6.0	7.0	6.0-9.0	20
VII	Swamp Waters	*	*	3.7-8.0*	**

The assessment of the IM is fairly straightforward:

- Sample DO at a station that is representative of a stream segment.
- Apply a "10% rule" to the dataset to determine non-attainment.



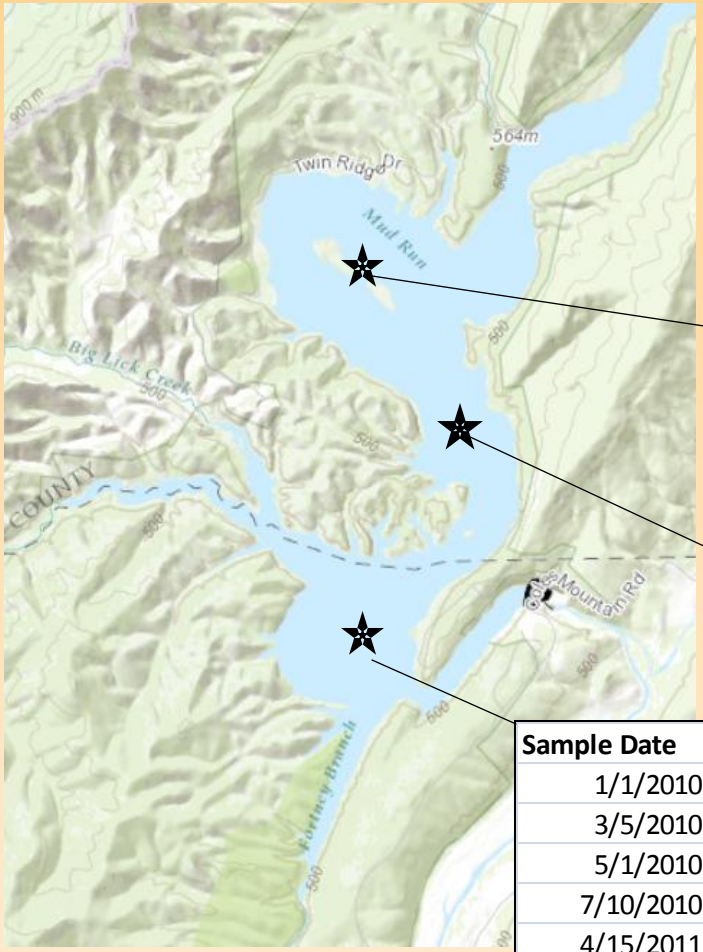
~10 mile stream segment

Sample Date	DO (mg/l)	IM violation?
1/1/2010	6.4	
3/5/2010	5.3	
5/1/2010	3.2	yes
7/10/2010	5.9	
4/15/2011	6.4	
5/12/2011	8.1	
10/15/2011	9.5	
5/1/2012	2.5	yes
9/16/2012	5.7	
10/13/2012	4.5	
11/1/2012	6.7	

↓

2 violations out of 11 samples =
18% violation rate =
FAIL

For lakes, data from multiple stations can be pooled.



Sample Date	DO (mg/l)
3/4/2012	5.6
5/5/2012	6.8
7/9/2012	3.9
10/2/2012	8.8

Sample Date	DO (mg/l)
7/10/2010	6.7
8/6/2011	8.4
9/1/2011	6.7

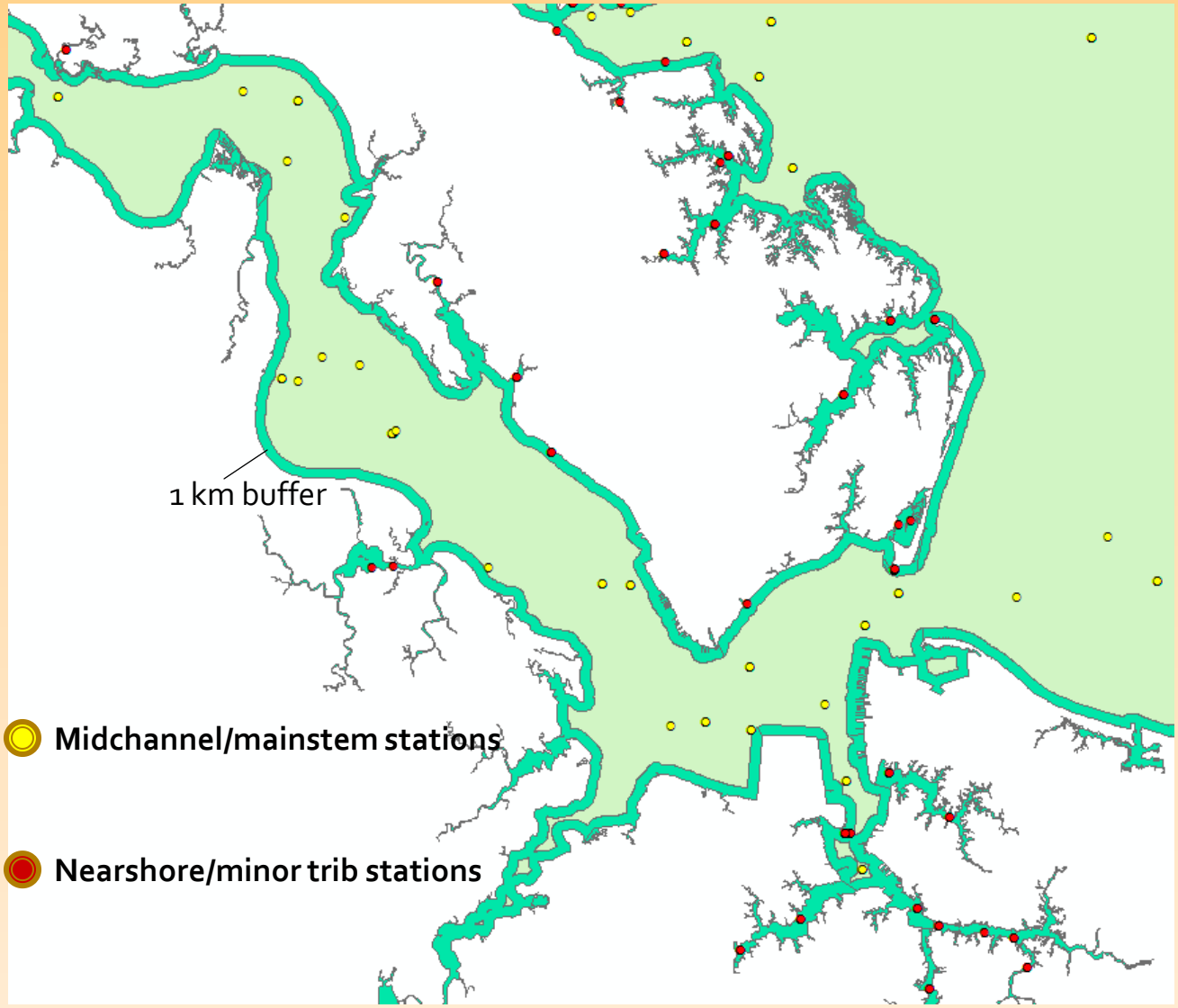
Sample Date	DO (mg/l)
1/1/2010	6.4
3/5/2010	5.3
5/1/2010	3.2
7/10/2010	5.9
4/15/2011	6.4
5/12/2011	8.1
10/15/2011	9.5
5/1/2012	2.5
9/16/2012	5.7
10/13/2012	4.5
11/1/2012	6.7

3 violations out of 18 samples = 16% violation rate = FAIL

This methodology presumes the dataset is temporally and spatially representative.

How might this method be tweaked for the Chesapeake Bay assessment?

- Separation of shallow and deeper waters.
- Separation of continuous monitoring data from fixed station data.
- Maybe a lower violation rate "rule"?



For the 2014 assessment dataset, I classified stations by proximity to the shoreline.

The "shallow" stations include most of those situated in minor tributaries.

I calculated violation rates for the summertime IM Open Water criterion at the two kinds of fixed stations and continuous monitoring stations during the 2010-2012 data window. Only the first 6 meters were evaluated for simplicity's sake.

	VIOLATION RATE% (> 10% = FAIL)					
SEGMENT*	MIDCHANNEL/ MAINSTEM FIXED	NEARSHORE/ MINOR TRIB FIXED	ALL FIXED	SHALLOW COMMON		NO. OF FIXED STATION DATA POINTS
POTOH	0	0	0			50
JMSOH	0	0	0			75
CRRMH	0	13	11.4			61
RPPMH	13	0	11.3			363
ELIPH	2	1.4	1.9			159
JMSPH	0	0	0			251
JMSMH	0	1.9	0.7			272
JMSTF	0	0.8	0.6			325
YRKPH	7.5	1.9	2.3	3.4		514
YRKMH	4.7	1.3	1.5	4.9		323
CB5MH	1.6	3.3	1.8			394
PIAMH	0	0	0			96
CB8PH	0	nodata	0			336
MOBPH	0.2	0.4	0.3	4.1		2163
CB7PH	0.5	0	0.5			1029
POCMH	0	0	0			60
RPPOH	0	0	0			58
PMKTF	0	0	0			309
CB6PH	0.5	0	0.4	2.2		672
POTMH	nodata	3.3	3.3			30
POTTF	nodata	0	0			75
CHKOH	nodata	0	0			44
EBEMH	nodata	0	0			51
APPTF	nodata	0	0			62
RPPTF	nodata	0	0			155
MPNOH	nodata	17.4	17.4			69
MPNTF	nodata	0	0			49
PMKOH	nodata	32	32			19
LAFMH	nodata	2.9	2.9			68
SBEMH	nodata	23	23			39
WBEMH	nodata	0	0			25

When a 10% rule is applied, five segments fail the IM criterion. These segments also fail the 30-Day Mean Criterion.

* Underlined segments are those that fail the OW 30-Day Mean

	VIOLATION RATE% (> 1% = FAIL)					
SEGMENT*	MIDCHANNEL/ MAINSTEM FIXED	NEARSHORE/ MINOR TRIB FIXED	ALL FIXED	SHALLOW CONMON		NO. OF FIXED STATION DATA POINTS
POTOH	0	0	0			50
JMSOH	0	0	0			75
CRRMH	0	13	11.4			61
RPPMH	13	0	11.3			363
ELIPH	2	1.4	1.9			159
JMSPH	0	0	0			251
JMSMH	0	1.9	0.7			272
JMSTF	0	0.8	0.6			325
YRKPH	7.5	1.9	2.3	3.4		514
YRKMH	4.7	1.3	1.5	4.9		323
CB5MH	1.6	3.3	1.8			394
PIAMH	0	0	0			96
CB8PH	0	nodata	0			336
MOBPH	0.2	0.4	0.3	4.1		2163
CB7PH	0.5	0	0.5			1029
POCMH	0	0	0			60
RPPOH	0	0	0			58
PMKTF	0	0	0			309
CB6PH	0.5	0	0.4	2.2		672
POTMH	nodata	3.3	3.3			30
POTTF	nodata	0	0			75
CHKOH	nodata	0	0			44
EBEMH	nodata	0	0			51
APPTF	nodata	0	0			62
RPPTF	nodata	0	0			155
MPNOH	nodata	17.4	17.4			69
MPNTF	nodata	0	0			49
PMKOH	nodata	32	32			19
LAFMH	nodata	2.9	2.9			68
SBEMH	nodata	23	23			39
WBEMH	nodata	0	0			25

When a 1% rule is applied, 14 segments fail the IM criterion. All except two also fail the 30-Day Mean. Also:

-All segments w/ CONMON fail

-2 segments fail just on CONMON violations (MOBPH and CB6PH).

-1 segment fails just on "shallow" violations (JMSMH)

* Underlined segments are those that fail the OW 30-Day Mean

	VIOLATION RATE% (> 10 + >1% = FAIL)					
SEGMENT*	MIDCHANNEL/ MAINSTEM FIXED	NEARSHORE/ MINOR TRIB FIXED	ALL FIXED	SHALLOW COMMON		NO. OF FIXED STATION DATA POINTS
POTOH	0	0	0			50
JMSOH	0	0	0			75
CRRMH	0	13	11.4			61
RPPMH	13	0	11.3			363
ELIPH	2	1.4	1.9			159
JMSPH	0	0	0			251
JMSMH	0	1.9	0.7			272
JMSTF	0	0.8	0.6			325
YRKPH	7.5	1.9	2.3	3.4		514
YRKMH	4.7	1.3	1.5	4.9		323
CB5MH	1.6	3.3	1.8			394
PIAMH	0	0	0			96
CB8PH	0	nodata	0			336
MOBPH	0.2	0.4	0.3	4.1		2163
CB7PH	0.5	0	0.5			1029
POCMH	0	0	0			60
RPPOH	0	0	0			58
PMKTF	0	0	0			309
CB6PH	0.5	0	0.4	2.2		672
POTMH	nodata	3.3	3.3			30
POTTF	nodata	0	0			75
CHKOH	nodata	0	0			44
EBEMH	nodata	0	0			51
APPTF	nodata	0	0			62
RPPTF	nodata	0	0			155
MPNOH	nodata	17.4	17.4			69
MPNTF	nodata	0	0			49
PMKOH	nodata	32	32			19
LAFMH	nodata	2.9	2.9			68
SBEMH	nodata	23	23			39
WBEMH	nodata	0	0			25

When a "hybrid %" rule is applied, 9 segments fail the IM criterion. The hybrid approach treats low- and high-frequency datasets differently ("10% rule" and "1% rule", respectively).

* Underlined segments are those that fail the OW 30-Day Mean

Conclusions:

-The simplicity of the IM ("shall not be less than…") necessitates a simple, straight-forward method.

- We can modify current methodology to handle the challenges of the Bay.

- These challenges include the differences in the habitats being monitored, as well the nature of the data collected at different stations.