Maintaining Resilience of Stormwater and Restoration Practices

PROGRESS UPDATE -- USWG

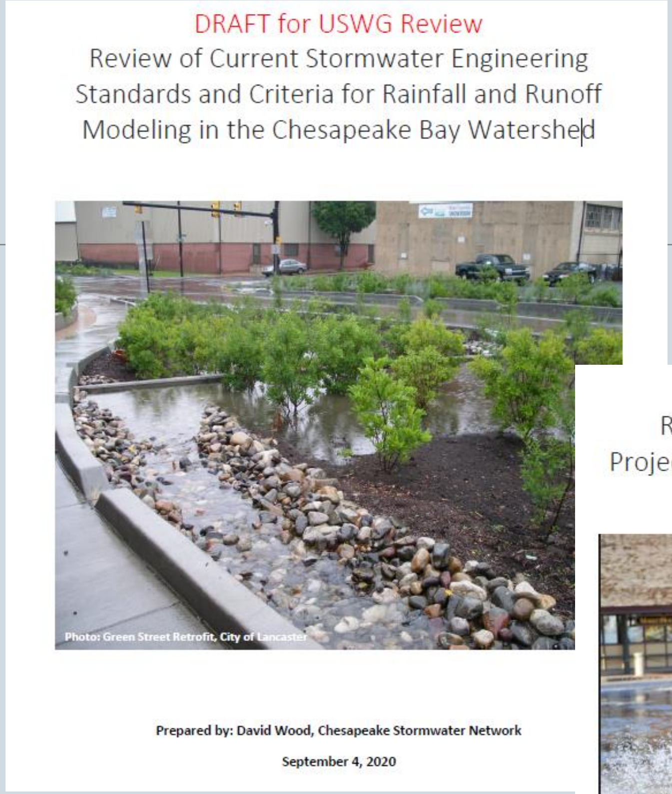
SEPTEMBER 15, 2020

Agenda

- Memo 2: Review of Current Stormwater Engineering Standards and Criteria for Rainfall and Runoff Modeling in the Chesapeake Bay Watershed

- Memo 3: Review of Recent Research on Climate Projections for the Chesapeake Bay Watershed

- Looking for Feedback

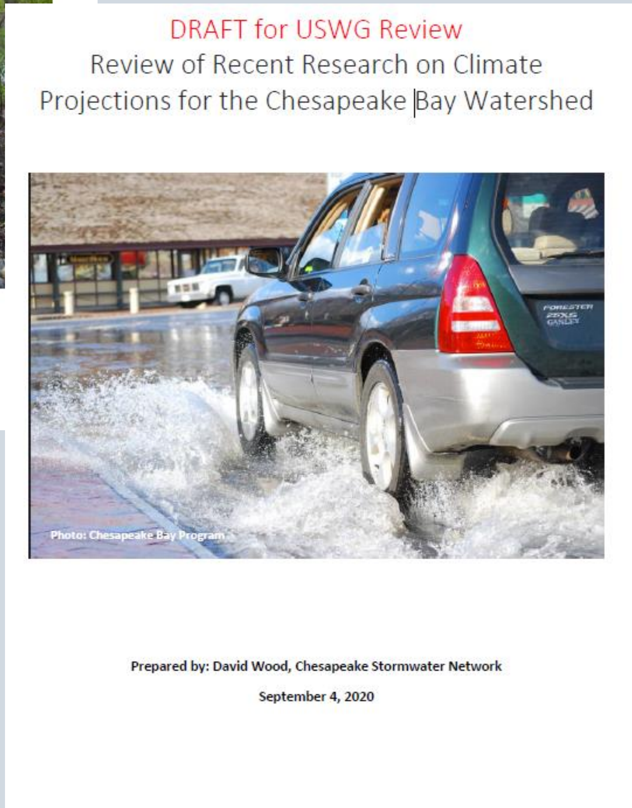

DRAFT for USWG Review

Review of Current Stormwater Engineering Standards and Criteria for Rainfall and Runoff Modeling in the Chesapeake Bay Watershed

Photo: Green Street Retrofit, City of Lancaster

Prepared by: David Wood, Chesapeake Stormwater Network

September 4, 2020


DRAFT for USWG Review

Review of Recent Research on Climate Projections for the Chesapeake Bay Watershed

Photo: Chesapeake Bay Program

Prepared by: David Wood, Chesapeake Stormwater Network

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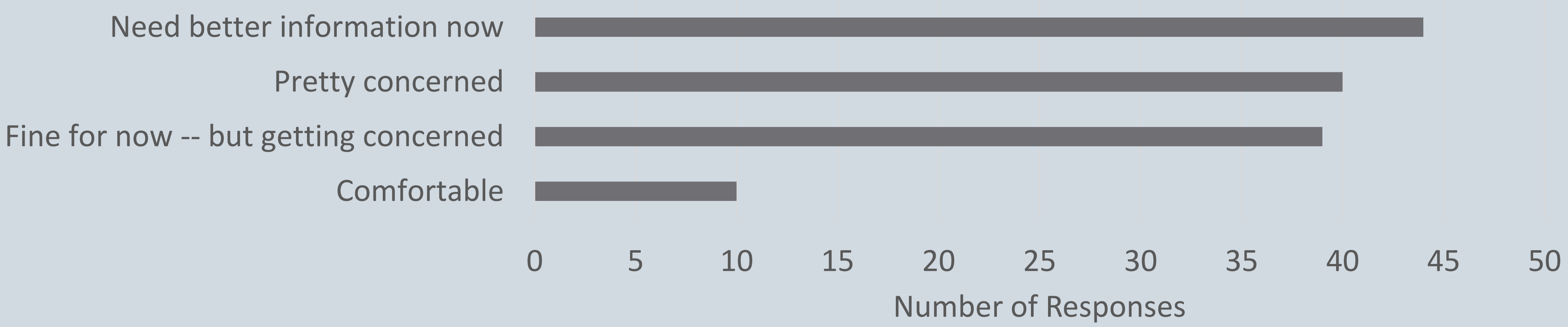
Memo 2

From Memo 1:

How comfortable are you with the quality and utility of the engineering design criteria on future rainfall intensity provided to you by state and/or federal authorities in your community?



https://chesapeakestormwater.net/wp-content/uploads/dlm_uploads/2020/02/FINAL-Climate-Change-and-Stormwater-Survey-Memo.pdf

Takeaway 1: Floodplain Maps

- Floodplain hazard maps are used to establish zoning and building standards, set infrastructure and emergency plans, and prepare for and respond to floods.
- FEMA's National Flood Insurance Program (NFIP) is the primary driver for updating floodplain maps
- NFIP does not provide comprehensive coverage across the watershed.
- Of NFIP communities, 52% have not had their FEMA floodplain hazard map updated in the last five years and 26% have not been updated in the last 10 years.

Table 2. Communities Participating in FEMA's National Flood Insurance Program (FEMA, 2020a)

State	Communities in NFIP	Communities in CRS
Delaware	50	11
District of Columbia	1	0
Maryland	147	15
New York	1,506	50
Pennsylvania	2,472	34
Virginia	290	25
West Virginia	278	10

Takeaway 2: Stormwater Models

- More than just design standards need to be considered

- H&H models simulate how water will move through a watershed and need finer resolution

- The hydrologic principles behind the models haven't changed much, but some of the climate-based assumptions have not been recently revisited.

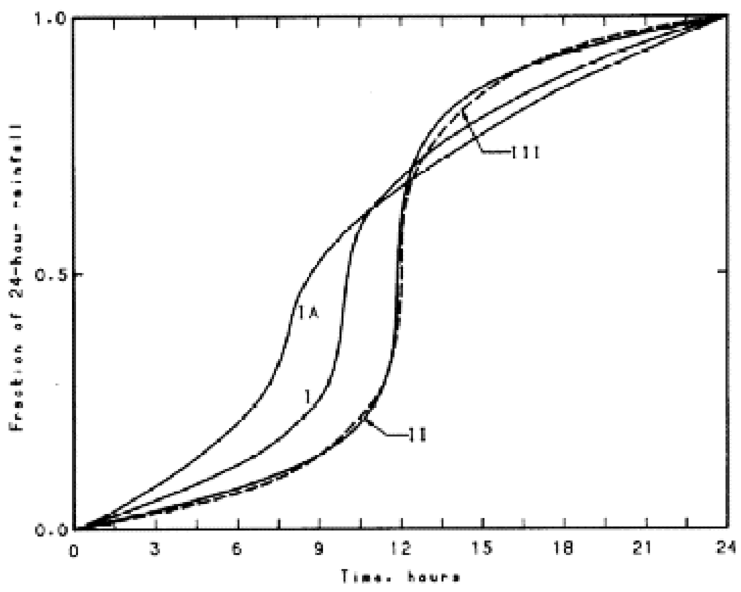


Figure B-1.—SCS 24-hour rainfall distributions.

Takeaway 3: Historical Changes

- The precipitation data sources referenced in state design manuals vary significantly by age of record.
- Atlas 14, the most recent precipitation data for the Chesapeake Bay Region, only covers through 2000, and some designers still use even older data sources, like TP-40.
- There are already significant increases in the 100-year storm volume observed between Atlas 14 and TP-40.

Table 6. Comparison of precipitation totals for the 24-hour storm event from TP-40 and Atlas 14 Volume 2. All values are in inches per hour.

Recurrence Interval	Method	Harrisburg, PA	Annapolis, MD	Virginia Beach, VA	D.C.	Laurel, DE	Martinsburg, WV
2-Year	TP-40*	3.5	3.2	3.8	3.2	3.5	2.9
	Atlas 14**	2.67	2.97	3.37	2.89	3.14	2.61
10-Year	TP-40	4.7	5.2	5.9	5.2	5.6	4.7
	Atlas 14	4.29	4.97	5.58	4.77	5.28	4.06
100-Year	TP-40	6.8	7.5	8.9	7.5	7.8	6.7
	Atlas 14	7.41	8.63	9.37	8.28	9.16	6.37

*Data estimated by interpolating from TP-40 Maps
**AMS-based precipitation frequency estimates from NOAA Atlas 14 Volume 2

Takeaway 4: Variable Criteria

- Each state and the District of Columbia uses different design criteria.
- Within states, there is even more variability

Takeaway 5: Next Gen Design

- With one or two exceptions, the most recent wave of state stormwater manual updates occurred between 2006-2013.
- To date, specific consideration of climate resilience has not been built into any state stormwater design manual in the form of revised sizing criteria or other specific design enhancements.
- Climate resilience efforts identified in the state Watershed Implementation Plans have focused on providing planning tools and risk assessments rather than regulatory levers that would drive changes to engineering design practice.

Memo 3

Temperature

- As temps rise, the air can hold more moisture, leading to more intense storms
- Increasing temps are a mixed bag for WQ
- Potential impacts on vegetation-dependent BMPs

Table 1. Change in temperature (°F) as compared to 1995 (Source: CBP, 2019)

Geography	**Year 2025**	**Year 2035**	**Year 2045**	**Year 2055**
Delaware	1.85	2.45	2.97	3.47
Maryland	1.96	2.57	3.13	3.62
Virginia	1.93	2.54	3.11	3.55
Pennsylvania	2.11	2.72	3.40	3.82
District of Columbia	1.98	2.59	3.17	3.65
West Virginia	2.03	2.66	3.28	3.73
New York	2.14	2.77	3.47	3.92
CB Watershed	**2.02**	**2.65**	**3.26**	**3.71**

Stream Flow

- Over the last 60 years, climatic trends have caused a change of 50 percent or more in one or more streamflow attributes at two-thirds of USGS stream gaging sites

- Higher streamflow impacts nutrient and sediment transport and delivery.

- Risk to developed urban floodplains, and “on-line” BMPs such as stream restoration practices.

Table 3. Percent change in simulated flow as compared to 1995 (1991-2000) (CBP, 2019)

Geography	**Year 2025**	**Year 2035**	**Year 2045**	**Year 2055**
Delaware	0.99%	2.46%	2.46%	3.79%
Maryland	2.56%	3.91%	3.91%	4.60%
Virginia	1.73%	3.11%	3.11%	5.56%
Pennsylvania	2.30%	3.67%	3.67%	3.70%
District of Columbia	0.59%	0.83%	0.83%	1.06%
West Virginia	0.76%	2.00%	2.00%	4.27%
New York	4.98%	5.97%	5.97%	4.49%
CB Watershed	2.37%	3.70%	3.70%	4.48%

Sea Level Rise

"Blue-sky" or high tide flooding has increased by a factor of 10 over the past 50 years,

Tidal flooding expected to exceed 30 days per year in over 20 cities in the Northeast by 2050 under the most conservative emissions scenario.

Impacts:

- Accelerated shoreline erosion,
- Prevents the use of infiltration BMPs in areas with high water tables,
- may result in new load sources from frequently inundated urban areas.

Table 4. Sea Level Rise (ft) used in the 2019 CBP Climate Assessment (CBP, 2019)

Geography	**Year 2025**	**Year 2035**	**Year 2045**	**Year 2055**
Chesapeake Bay	0.7	1.0	1.4	1.7

Precipitation

Rainfall volume and intensity both expected to increase

Assuming historical climate data is representative of future conditions can lead to underestimate of extreme precipitation events

Intense storm events are more likely to:

- Bypass treatment in stormwater BMPs.
- Require more frequent maintenance to address erosion at inlets, clogging of filter media, and other potential performance-altering impacts

Table 2. Percent change in rainfall volume as compared to 1995 (CBP, 2019)

Geography	**Year 2025**	**Year 2035**	**Year 2045**	**Year 2055**
Delaware	2.06%	3.10%	4.14%	6.23%
Maryland	3.09%	4.13%	4.92%	6.70%
Virginia	2.56%	3.68%	5.23%	6.50%
Pennsylvania	3.28%	4.46%	5.07%	6.32%
District of Columbia	3.14%	4.11%	5.07%	6.83%
West Virginia	2.72%	3.73%	5.23%	6.53%
New York	5.00%	6.09%	5.99%	6.24%
CB Watershed	**3.11%**	**4.23%**	**5.19%**	**6.44%**

Downscaling Studies

- Stormwater models require precipitation at finer resolutions than is produced by global and regional climate models
- Projection and downscaling methods vary, and different approaches may yield significantly different results.
- Five Chesapeake Bay downscaling studies from the past 5 years were analyzed
- To date, there are limited examples of projections being used to update design sizing criteria

Table 6. Summary of Select Mid-Century Rainfall Intensity Projections (in/hr) in downscaling studies[1].

Study (Projection Location)[2]	Duration	Frequency	Atlas 14	Mid-Century Projection	Percent Change
New York (Elmira)	1hr	2yr	1.02	1.10	8%
		10yr	1.51	1.53	1%
		100yr	2.34	2.56	9%
	24hr	2yr	0.10	0.12	20%
		10yr	0.16	0.17	6%
		100yr	0.24	0.28	17%
Maryland Eastern Shore (Easton)	1hr	2yr	1.47	2.1	9%
		10yr	2.15	3.0	16%
		100yr	3.16	4.5	27%
	24hr	2yr	0.139	0.2	44%
		10yr	0.217	0.3	32%
		100yr	0.375	0.5	33%
Virginia Beach	1hr				
	24hr	2yr	3.37	4.4	31%
		10yr	5.58	6.5	16%
		100yr	9.37	11.9	27%

Other Memo Highlights

Summary of common downscaling methodologies

More details on the methodologies used for each Chesapeake Bay study

Review of CBPO, National Climate Assessment, and IPCC projections for each climate impact

Next Steps

Review and Feedback

Please review memos and provide questions, edits or feedback by October 9

Modeling WG presentation in October

Finalize memos at next USWG meeting

Coming Soon

Memo 4: BMP vulnerability assessment and potential design adaptations

Joint meeting with MWG and CRWG