What are Our Options for Factoring in Consideration of Climate Change into the Phase III WIPs

Presented to:
Management Board
November 17, 2016

Chesapeake Bay Program
Science. Restoration. Partnership.

Key Messages

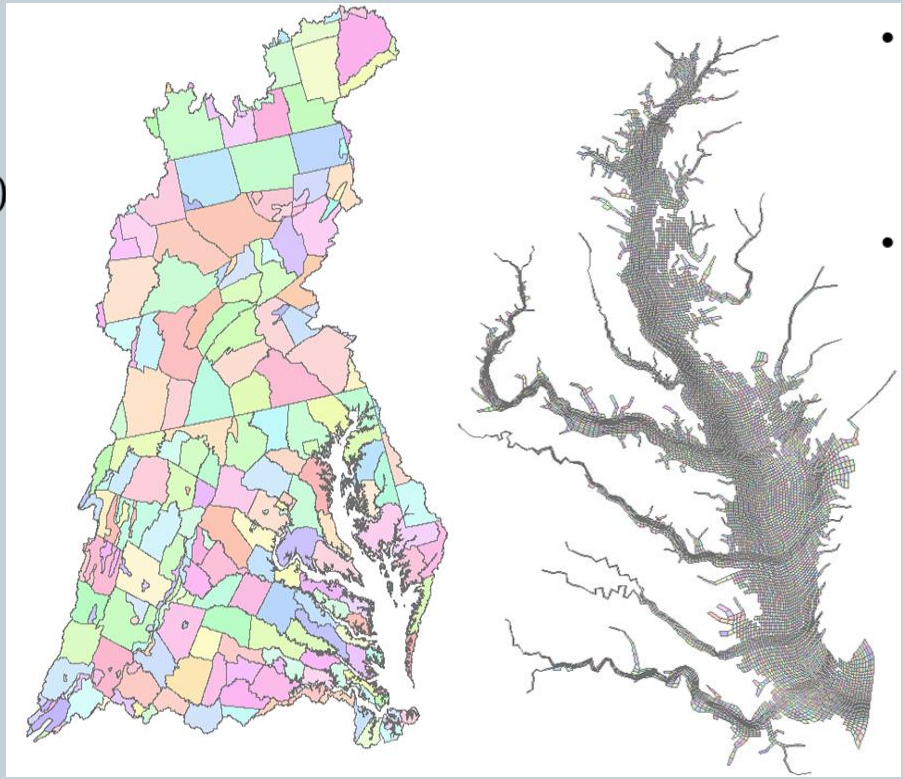
- Assessment approach informed by sound science.
  - Next Steps: Scientific peer reviews of the representation of climate change by the CBP models will be conducted by the CBP Scientific and Technical Advisory Committee (STAC).
- Current efforts are to frame initial future climate change scenarios based on estimated 2025 (potential TMDL application) and 2050 conditions (future condition scoping scenario application).
  - Next Steps: Management Board concurrence on the WQGIT approval of the climate assessment approach using both 2025 and 2050 climate change analyses with an associated uncertainty investigation.
- The CBP Models are under development, with the current (*Beta* 3) version to be replaced by *Beta* 4 in December 2016 and a final version in March 2017.
  - Next Steps: The preliminary climate change analyses are being refined with additional 2025 and 2050 scenarios and others as proposed by CBP decision makers.
- Range of options have been developed for how and when climate considerations could be addressed within Phase III WIPs.
  - Next Steps: Consideration of full range of options and partnership decision for how and when to factor climate considerations into the Phase III WIPs.

Climate Change Assessment Procedures Approved by WQGIT on November 14, 2016

1. Use the same CBP assessment tools that were applied in the 2010 allocation.
2. Partition the influence of climate change into separate elements of watershed flows and loads, storm intensity, increased estuarine temperatures, sea level rise, and ecosystem influences including loss of tidal wetland attenuation with sea level rise, as well as other ecosystem influences.
3. Frame initial future climate change scenarios based on estimated 2025 (potential TMDL application) and 2050 conditions (future condition scoping scenario application) and other conditions as directed.
4. Develop an uncertainty estimate of the climate change assessment.

Model Climate Inputs – Initial Scenario Runs

- Precipitation Volume
  - 2025: +3.1% (long term trends)
  - 2050: +7.3% (RCP* 4.5)
- Temperature: RCP 4.5
  - 2025: +1.05 ^{0}C
  - 2050: +2.08 ^{0}C
- CO_2 Concentration: Meinhausen, Malte, et al, (2011)
  - 2025: 427 ppm
  - 2050: 487 ppm



- Sea Level Rise: CRWG**
  - 2025: +0.3 m
  - 2050: +0.5 m
- Temperature: RCP 4.5
  - 2025: +0.95 ^{0}C
  - 2050: +1.86 ^{0}C

*RCP 4.5 signifies a specific Representative Concentration Pathway scenario as defined by the Intergovernmental Panel on Climate Change

**Based upon guidance provided by the Climate Resiliency Workgroup

2025 Climate Inputs – Proposed Approach

Year	Variable	Input	Parameter	Sensitivity	Used for Uncertainty
2025	CO_2	427 ppm	Stomatal resistance	very low	no
	Potential Evapotranspiration	Hamon Method	PET with high temperature response	high	yes
		Hargreaves Method	PET with moderate temperature response	high	yes
	Temperature	RCP 2.6	Monthly median of 32 member ensemble of climate change models	low in tidal water; moderate as influence on PET	yes
		RCP 4.5	Monthly median of 32 member ensemble of climate change models	low in tidal water; moderate as influence on PET	yes
		RCP 8.5	Monthly median of 32 member ensemble of climate change models	low in tidal water; moderate as influence on PET	yes
	Precipitation	Historical	With Observed Intensity	moderate	yes
		Historical	Without Intensity	moderate	yes
	Sea Level Rise	0.2 m	Bay Hydro Model	low	no
		0.3 m	Bay Hydro Model	low	no
		0.4 m	Bay Hydro Model	low	no

Key:

Recommended approach

Useful to examine range of uncertainty

Full uncertainty approach

2050 Climate Inputs - Proposed Approach

Year	Variable	Input	Parameter	Sensitivity	Used for Uncertainty
2050	CO_2	487 ppm	Stomatal resistance	very low	no
	Potential Evapotranspiration	Hamon Method	PET with high temperature response	high	yes
		Hargreaves Method	PET with moderate temperature response	high	yes
	Temperature	RCP 2.6	Monthly median of 32 member ensemble of climate change models	low in tidal water; moderate as influence on PET	yes
		RCP 4.5	Monthly median of 32 member ensemble of climate change models	low in tidal water; moderate as influence on PET	yes
		RCP 8.5	Monthly median of 32 member ensemble of climate change models	low in tidal water; moderate as influence on PET	yes
	Precipitation	RCP 2.6*	10 percentile of precip w/ observed intensity	moderate	yes
			10 percentile of precip w/o observed intensity	moderate	yes
			median precip w/ observed intensity	moderate	yes
			median precip w/ observed intensity	moderate	yes
			90 percentile of precip w/ observed intensity	moderate	yes
			90 percentile of precip w/o observed intensity	moderate	yes
		RCP 4.5*	With Observed Intensity	moderate	yes
			Without Intensity	moderate	yes
		RCP 8.5*	With Observed Intensity	moderate	yes (w/90 percentile)
			Without Intensity	moderate	yes
	Sea Level Rise	0.3 m	Bay Hydro Model	low	no
		0.5 m	Bay Hydro Model	low	no
		0.8 m	Bay Hydro Model	low	no

Key: Recommended approach Useful to examine range of uncertainty Full uncertainty approach

* Each 2.6, 4.5, and 8.5 RCP scenario for 2050 is generated from a 32 member ensemble of climate change models with assessments of the 10 percentile precipitation, median precipitation, and 90 percentile precipitation.

Modeling Summary – Preliminary Results

- Estimated influence of changes in tidal wetland attenuation is small in 2025 and 2050 because of little change in overall tidal wetland area, but wetland type changes and tidal wetland loss is estimated to increase beyond 2050.

- The range of the influence of estimated watershed loads in future climate change conditions using observed (87 year) increase of precipitation volume (Karen Rice) and precipitation intensity (Karl and Knight) depends on the evapotranspiration method chosen.

- Current estimated 2025 increase in nitrogen and phosphorus watershed loads are about a 2%. The estimated 2050 load increase is about 5% for both nitrogen and phosphorus.

Modeling Summary

- Scientific peer reviews of the representation of climate change by the CBP models will be conducted by the CBP Scientific and Technical Advisory Committee (STAC).

- This is a work in progress. Still to come are additional Phase 6 Watershed Model climate change scenarios that can be used to inform decision making and develop the uncertainty analysis.

- The Bay Model hydrodynamic simulation of the 2025 sea level rise has just been competed.

Guiding Principles

WIP Development:

- Capitalize on "Co-Benefits"
- Account for and integrate planning and consideration of existing stressors
- Align with existing climate resiliency plans and strategies
- Manage for risk and plan for uncertainty
- Engage local agencies and leaders

WIP Implementation:

- Reduce vulnerability
- Build in flexibility and adaptability
- Adaptively manage

Range of Climate Change Policy Options

Draft Options	Description
#1: Factor Climate Change into the Bay's Assimilative Capacity (2025/2050).	The annual total nutrient and sediment pollutant loads that the CB ecosystem can assimilate and still meet the four Bay jurisdictions' CB water quality standards will be revised based on 2025 or 2050 climate change projections (i.e., CBWQSTM climate model results) that result in a direct affect the Bay's ecosystem and internal processes.
#2: Factor Climate Change into Phase III WIP' Base Conditions (2025/2050)	Use either the 2025 or 2050 climate projection scenarios as base conditions (informed by CBWM climate modeling results) in the establishment of the jurisdictions' Phase III WIPs. The climate change projection would be an added load that the jurisdictions would need to address in addition to their Phase III WIP planning targets.
#3: Commit to Factor Climate Change into the Bay's Assimilative Capacity (Option 1) and/or into Phase III WIP Base Conditions (Option 2) with Deferred Implementation until 2025 or beyond.	The projected impacts of climate change in 2025 and 2050 will be assessed and relayed to the jurisdictions, but they will not be explicitly factored into the Bay's Assimilative Capacity or incorporated into the Phase III WIP Base Conditions. However, the partnership would establish a timeframe (e.g., 2025, 2030, 2035, etc.) for when climate considerations would be factored into the TMDL and/or Base Conditions.
#4: Factor Climate Change into a Bay TMDL Margin of Safety.	Allocate a specific pollutant load reduction as "explicit" margin of safety to account for any lack of knowledge concerning the relationship between load and waste-load allocations and achieving the four Bay jurisdictions' CB water quality standards.

Range of Climate Change Policy Options

Draft Options	Description
#5: Factor Climate Change into Phase III WIP BMP Optimization.	During the development of Phase III WIPs, jurisdictions' would prioritize the selection of BMPs that will better mitigate the anticipated increased nitrogen, phosphorus and sediment loads due to the projected effects of climate change through 2025 or 2050.
#6: Adaptively Manage Phase III WIP BMP Implementation (Post Phase III WIP development).	During each two-year milestone development period, jurisdictions would evaluate the performance of existing BMPs, assessing and documenting BMP performance, including identifying the contribution of seasonal, inter-annual climate variability and weather extremes on BMP performance.
#7: Factor Climate Change into Programmatic Commitments with Set Expectations.	The projected impacts of climate change in 2025 and 2050 will be assessed and relayed to the jurisdictions. Jurisdictions would provide a narrative that describes their programmatic commitments to address climate change in their Phase III WIPs. Jurisdictions are expected to consult the Guiding Principles when developing their narratives. Narratives may vary among jurisdictions, but would include a description of their method (s) for gathering and assessing scientific data and information, their conclusions based on that information, and how those conclusions guide their programmatic commitments.
#8: Factor Climate Change into Programmatic Commitments with No-Set Expectations.	The projected impacts of climate change in 2025 and 2050 will be assessed and relayed to the jurisdictions. Jurisdictions would narratively demonstrate how they are addressing climate change in their Phase III WIPs. No prescriptive guidance or specific expectations would be established.

Packages and Alternatives

Quantitative/Most Comprehensive		Qualitative/ Comprehensive	
Option 1: Assimilative Capacity	**Option 2:** Base Conditions	**Option 5:** BMP Optimization	**Option 6:** Adaptively Manage
Quantitative/ Comprehensive		**Qualitative/ Least Comprehensive**	
Option 3: Commit with Deferred Imp.	**Option 4:** Margin of Safety	**Option 7:** Programmatic with Set Expectations	**Option 8:** Programmatic with No Set Expectations

WQGIT Recommendations

- Adopt the Climate Resiliency Workgroup's full range of options for when and how to factor climate change considerations into the Mid-point Assessment in preparation for final decisions in spring 2017.

- Approval of general approach to the climate change assessment procedures

2017 Midpoint Assessment
Climate Integration Timeline

Key Upcoming Partnership Decisions:

- **December 2016*:** Proposed climate change assessment procedures.
- **December 2016*:** Proposed ranges of options for when and how to factor climate change considerations into the jurisdictions Phase III WIPs with decisions in spring 2017 informed by the outcomes of the proposed climate change assessment procedures.
- **May 2017*:** When and how to incorporate climate change considerations into the Phase III WIPs as the partners work on the draft Phase III WIP planning targets due in June 2017.
- **December 2017**: Final Phase III WIP planning targets fully reflect partnership decision regarding how and when to incorporate climate change considerations.

* Date of PSC approval – WQGIT and MB recommendations will be made in preceding months