Modeling Workgroup Quarterly Review

October 5, 2021

Event Webpage and Materials: Link

This meeting was recorded for internal use to assure the accuracy of meeting notes.

Action Items:

- ✓ STAC will invite Isabella to present her work when she is ready. They will explore the possibility of using that work as a communication tool.
- ✓ Individuals who wish to support the guidance of the optimization team should email Lew in October to be included in shaping their work.
- ✓ Once the data most recent data from Chesapeake Conservancy has finished QA/QC, Andy will look to incorporate any updates to the model boundaries.

9:00   Announcements and Amendments to the Agenda – Mark Bennett, USGS and Dave Montali, Tetra Tech

Dave Montali announced upcoming events of interest to Modeling Workgroup members, such as the CERF in early November, the joint meeting of the Climate Resiliency Workgroup and Urban Stormwater Workgroup on October 18 & 19, the Water Quality Goal Implementation Team (WQGIT) Meetings on October 12 and 25-27, and the Chesapeake Community Research Symposium 2022 (ChesCRS22).

9:05   [Options for Watershed Model Phase 7 Work Plan – Gary Shenk, USGS-CBPO](#)

In a preview of a presentation Gary will make to the WQGIT later in October, the options of emphasis in the Phase 7 Work Plan will be reviewed including fine scale (NHD-scale) modeling, improvement in the physical process simulation, quantifying co-benefits, improved evaluation of Bay TMDL water quality standards, changing nutrient input calculations, improvement of the climate change simulation, and an uncertainty quantification.

Gary presented an overview of the timeline of the watershed model and projections towards 2025 and 2035 with the different planning targets along the way. He also set up the conversations that will be happening both meeting days. Priorities are decided by the WQGIT, and guidance will be provided at the upcoming October 2021 meeting. Gary demonstrated the two existing priorities we know will happen and listed a table of priorities and modeling actions with an explanation of each point and the associated benefits of each. For example, he showed the difference between finer resolution model and spatially explicit CAST, Physical Process improvement, nutrient application, WQ Standards Assessment, Uncertainty Quantification, which is highly desired by STAC.

10:00 Discussion of Phase 7 Options

Lew expressed that the presentation was a good overview of the cutting-edge science surrounding coastal estuarine and watershed modeling. Kristin Saunders said thank you for reflecting the recommendations generally from the other goal teams and stated the overview was

a great view into what is being done. Normand Goulet agreed and asked about what the 2025 and Phase approach should look like. He expressed the need for stability coming into 2025, such as sticking with Phase 6 and then switching to Phase 7 afterwards. Gary and Lew agreed, with Lew adding that there will need to be a significant period of time dedicated to analysis of 2025 using Phase 6 and that determining new plans for 2035 may have to wait until 2026. James Martin added that 2025 progress will not be able to be assessed until 2026, so maybe 2025 is the ideal time to plan for 2035.

Karl Berger asked about a spatially explicit CAST and if finer scale results would invalidate broader results. Gary responded by saying that is the crux of the question and asked if having two of three components (land use and delivery, but not management) for understanding the load is useful. Olivia Devereux commented that most users of CAST are local planners and that they would utilize land use to for finer scale planning, less about reporting. Olivia stated support for increasing the resolution of phosphorus numbers for urban areas. Norm Goulet pushed back against Olivia saying this will never be used by developers at the site level in determining new BMPs in urban areas. Bill Keeling, KC Filippino, and James Martin agreed with Norm and Bill questioned the accuracy of the finer spatial resolution and its usefulness. Gary said that his claim is that compared to the current model, it's not that it will be more accurate at the land river segment scale, but that instead it will be more accurate at the aggregated scale and that Bill has a good question because the accuracy of the fine scale still needs to be determined. Gary said that he isn't arguing for any particular perspective but is instead bringing these options for the partnership to determine. Olivia clarified that she wasn't suggesting CAST could be used for site specific planning, but instead is more useful at the aggregate scale. Norm said that this model implies higher accuracy than what is possible with the polygon drawing option. James Martin made a related comment about potential value in targeting implementation, but said implementation should be targeted at the heat map, most affected basin scale level at the finest. James also said unless the other 2000 users are paying for the refinements to the system, the focus of P7 modeling system should be addressing Partnership Bay Agreement outcomes, principally water quality

Guido Yactayo asked a question about improving climate change modeling, saying "I believe global climate models downscaling is the greater source of uncertainty in climate change assessments, not watershed models. Are we going to reassess downscaling methods and results?" Gary responded by saying that this relates to conflicting STAC workshop recommendations, where the partnership agreed to extrapolate on observed climate records, but that the partnership will be asking the same question again soon regarding whether or not to utilize global climate models.

Dave Montali asked about and the soil Phosphorus simulation on developed land regarding lag time. Gary said that there is good research on this which suggests lag times are extensive and Dave asked if that is something requiring more investigation. Dave also brought up that credit buffers for livestock in Phase 6 are too high and wants to know how to bring up suggestions about this at the WQGIT so that the buffers can be revised. Gary said maybe the watershed technical committee could take it up. Bill agreed with Dave saying that perhaps an overgeneralized number of livestock was applied to West Virginia, so that the default number

needs to be lower Bill also suggested recalibrating Phase 6 instead of a long development process.

KC Fillipino asked about how local monitoring networks, like the stormwater water quality network in Hampton Roads, fits in to Phase 7? How/where will that data be used? Gary replied saying that this data can be used in four ways: direct calibration, contribution to the overall knowledge of the watershed, contribution to local work on waterways, comparison of trends to CAST.

In the chat James Martin asked about groundwater loads, saying "If a significant portion of stream N loads are derived from groundwater, and we do not account for this as a source currently, effectively we are assuming that the loads are originating on the landscape and are being reduced by BMPs. If we were to account for this source explicitly, and attribute the loads accordingly, E3 would reduce less load. Perhaps the reductions we are targeting are beyond E3." Karl Berger added "Maybe as a result we are assuming progress where it is not actually occurring; in addition, we may be prioritizing the wrong type of BMP to control something that they can't control, like septic system overload over time." Gary responded saying "we do account for groundwater loads. Each land use has a stormwater and groundwater component of loading in the dynamic model. CAST doesn't care about the timing of load delivery so it lumps storm and groundwater together. The dynamic model explicitly deals with groundwater lag. They have the same overall load for E3, but the dynamic model predicts that it will be decades before we see all the reductions."

In the chat James Martin asked "Do our BMPs in CAST only influence the stormwater fraction of the load? Do infiltration practices simply convert stormwater loads to groundwater loads?" Gary answered saying that "BMPS influence both surface and groundwater. My understanding of infiltration practices is that they promote adsorption of some species and they put nitrate in the groundwater where some if it might be denitrified." Karl Berger responded "I don't think CAST has that septic system load over time built into it, which appears to be one key finding of the Fairfax County monitoring program." Gary responded to Karl, saying that "CAST has changes in septic system loads mirroring changes in population on septic and the location of those septics. I don't know if CAST and the Fairfax monitoring match up." KC Filippino followed up "To James and Karl's point, the groundwater signal in our network is mostly inorganic N, stormwater is mostly organic (possibly refractory) N, our BMPs aren't being implemented based on speciation and infiltration is pretty tough to do down here so we're likely not doing much to reduce that inorganic component from groundwater. Definitely don't think we're modeled that differently though." Gary responded to KC saying "It was very interesting to see that Hampton storm sewer system was acting a bit like agricultural tile drains -- gathering groundwater and quickly routing it to surface." Karl Berger suggested "Maybe we should build a workshop around how the results from intensive local monitoring programs and the watershed model match up and don't match up. Sort of like what Isabella is doing, but at a more local scale." KC Filippino agreed with Karl, saying "We've had several forums where our data is discussed (and understand we're only in year 6 f data collection) but we really would like to see the connections to the model as this was why this network was developed." Gary agreed that it is a great idea and said that if you want it integrated into a STAC workshop, those proposals would be early next year.

10:30 **Phase 7 WSM Development – Gopal Bhatt (Penn State)**

Prior presentations on the Development of Phase 7 watershed model included overview of (a) an initial prototype of the CalCAST, a time-averaged spatially distributed hydrology model of medium resolution NHDplus, and (b) an initial, operational prototype of a time-varying, dynamic spatially distributed hydrology model with hourly simulation of NHDplus scale streamflow. Building on prior work, the presentation will provide an overview, analysis, and results of an initial prototype for linking the two models for moving towards a fuller integration of Phase 7 Dynamic Model with the Phase 7 CalCAST.

Gopal presented on the time averaged hydrology model – CalCAST, providing a brief overview of model development and results. Next, Gopal presented on an initial, operational prototype of a dynamic model of hydrology, including river segmentation, simulation, and results. He then presented on the prototype for CalCAST - Dynamic Model Hydrology Linkage. He then outlined the next steps, which included: extend the simulation period up to 2020 (+6 years); additional analyses of CalCAST→DM prototype to understand how it impacted other hydrograph indices; refine and expand CalCAST model for additional hydrologic indices; continue to further investigate CalCAST→DM linkage, refine data processing tools, and strategies for refining the linkage.

10:45 Discussion of Phase 7 WSM Development

James Martin asked why does the simulation period only go up to 2020? Gopal Bhatt said that this was primarily because the rainfall and precipitation data for the hydrology has been available and the plan is to extend the simulation each calendar year once new data is available. The simulation will be expanded each year so that in 2023 data for 2024 will be available in the simulation.

Lew Linker made a comment on slide 22 about the NHD scale Dynamic Model informed by CalCAST being an improvement in measuring precipitation. James Martin disagreed with Lew here. Lew asked what are the essential functions that make a difference here and is there technical ability to determine temperature and precipitation at a finer scale? Gopal responded saying that there is more statistical fidelity due to additional monitoring stations and watershed characteristics, which makes the NHD scale Dynamic Model informed by CalCAST is a better representation at finer scale. Gopal also said that yes, temperature and precipitation can be represented at the NHD scale. Gopal include that segmenting counties into areas of low and high rainfall was done carefully, with only differences of greater than 10% being salient. Lew agreed that temperature and precipitation are very important drivers and that increasing resolution, and that increasing resolution to be finer than a county scale is a major development. Lisa Beatty said "I agree the boundaries discussed need to be solidified and be uniform. The difference between county, HUC 12, and land river segment greatly include many aspects in CAST. You will be comparing apples to oranges if the scale is not consistent. We need to decide what the default scale is for these models." Lew responded saying that scale will be discussed at the WQGIT. Gary also added that scale is consistent when aggregated and that HUC 12 can be aggregated. Gary included that NHD is being prioritized so that it can be standardized across the watershed.

Lisa mentioned that Pennsylvania works at the county scale and Gary said that any future model will include the ability the roll up NHD to county scale.

In response to Lisa's question above, Olivia Devereux said the following in chat "Lisa, the answer to your question about CAST is on CASTS' website under FAQs. Why am I not receiving credit for all the BMP implementation in a HUC? If the geography submitted for a report is HUC, then the data will show the amount credited for the area in the HUC. Calculations are performed for land-river segments and then the portion that falls within a HUC is attributed to that HUC. The difference in the acres credited between your input and the BMP report is simply due to scale. You are submitting for a HUC, and calculations in CAST are done on land-river segments (lrsegs). Consider a HUC that is equal to portions of two lrsegs as 50% of one lrseg and 100% of other lrseg and each segment had an equal area for that load source. Lrseg 1 = 100 acres with 50% in HUC. Lrseg 2 = 100 acres with 100% in HUC. HUC acres = 150 acres. 100 acres of BMP submitted in HUC. 33 acres go to lrseg 1. 66 acres go to lrseg 2 which is 100 % credited in the 2 lrsegs. Report geographic scale is by the HUC which has 33 acres in lrseg 1 (all of lrseg 1 not just the HUC portion because that is how BMPs are processed on the lrseg scale) 66 acres in lrseg 2 So credited for the HUC = 33 * 0.5 because only half of lrseg 1 is in the HUC + 66 = 16.6666 + 66 = 82.6666. The link to the FAQ is https://cast.chesapeakebay.net/Documentation/Faqs and that particular question is under Understanding Results. For the observant participant who noted that 33+66=99, I did the calculation with decimals and with the decimals, it adds to 100." Lisa responded by saying "Thank you for clarifying that NHD segments are differentiated into counties. PA focuses all of their CAST runs to the county scale that are tied to the Phase 3 WIP."

James Martin asked in chat: "What years are used for the average rainfall, intensity and PET?" Gopal responded that "figures on Slide 23 are for 1985-2014. However, CalCAST is using annual data for the calibration by matching the years with years with observations."

Normand Goulet asked in chat "And what was the averaging period?" Gopal responded saying "Norm, assuming your question was in reference to Slides 21 and 22 showing spatial variability in simulated water yield for cropland and forest -- the averaging period was 1991-2000."

George Onyullo asked what does NHD county mean? Gary responded that it means NHD segments cut by county, essentially taking the land-river segments for much smaller watersheds and aggregating them up to the county level.

11:00 **Testing Watershed Properties as Candidate Predictors of Long-Term Average Streamflow & Comparison of Modeled and Monitored Nutrient Trends and Other Watershed Analyses – Isabella Bertani, UMCES**
The presentation will provide an update on analyses aimed at obtaining an appropriate comparison between the output of the Phase 6 Dynamic Watershed Model and flow normalized loads from WRTDS. In addition, discussion of work on testing watershed properties as predictors of long-term average streamflow will provide an overview of tests performed to assess the ability of different watershed properties to improve calibration of CalCAST. CalCAST is the Phase 7 time-averaged model of streamflow at the NHDplus 1:100K scale.

For the first presentation, Isabella gave a brief recap of the July Quarterly meeting, which included CalCAST Hydrology Model Development and candidate predictors of stream flow. She also discussed the impacts of withdrawals, abandoned coal mine land, a removed station, and the topographic wetness index. She concluded that most likely a hybrid calibration approach will be needed (combination of relevant watershed properties and P6-like approach). For the second presentation, Isabella provided an update on comparing modeled and monitored nutrient trends, which has two major objectives: help understand and communicate where and why monitoring data and CAST do not match, plus how those differences can be reconciled, and inform future refinements of the watershed model. Isabella then explained the differences between CAST and WRTDS, specifically the methodology and the results. She then discusses how classification trees can be used to advance the next step of combining into one parametric model.

11:30   Discussion of Modeled and Monitored Nutrient Trend Comparisons and Other Watershed Analyses

On the first presentation, Lew Linker made a comment on slide 8 about Phase 6 withdrawals compared to NHD segment withdrawals. Isabella said that withdrawal information is still being updated so although there has been no calibration differences so far, the withdrawals are more accurately placed and this is a perquisite for further analysis. James Martin asked some clarifying questions about the withdrawal graphics, particularly what types of withdrawals and if the right and left graphics were equal to each other. Isabella clarified that this only includes surface withdrawals, specifically public supply and irrigation, not those that are permitted and that the two graphics are equal. Normand Goulet has concern about this depiction of withdrawals as it doesn't include non-permitted withdrawals which are common in Virginia due to thresholds. Isabella replied that the withdrawal data still has issues, but that it currently is being worked on and they are reaching out to the states to get more accurate data. Norm expressed his apprehension at the attempts to model withdrawals at a higher resolution, saying that the TMDL should be prioritized above water supply given that in Virginia they are being required to use this model for water supply despite data issues. Gary, Lew, and Dave said that they hear what is being said, but the model provides a lot of benefit beyond the TMDL to many other partners that require water supply, and withdrawals do impact the TMDL significantly in some places.

On the second presentation, James Martin asked about the calibration of the model time frame in comparison to the monitoring data. Gary responded that they are focusing on calibration to space right now, and the question to the partnership is "how do we calibrate to time as there are fewer inputs?" Gary also said we cannot change anything right now to calibrate over time as these metrics are determined by each GIT.

Bill Keeling has concerns about accuracy of smaller areas farther away from measurements and the fall line. Gary said that he hears the concern, but that spatially things have held up well so far.

Karl Berger hopes that this project will ultimately yield the difference in trends between CAST and WRTDS. Isabella agreed that this is the goal, to have a quantitative analysis explaining the difference.

Denice Wardrop expressed that this was a powerful use of CART, very informative in an exploratory manner. She hoped that this could be used to communicate externally once completed. Isabella said that eventually yes, this should be used externally, but right now it is not ready. Denice said that the Modeling Workgroup should provide Isabella with the feedback she needs. Gary added that Isabella briefs the Factors Influencing group biweekly on this work and that they help provide feedback. Denice invited Isabella to bring this work to STAC when she feels it is ready.

Lisa Beatty asked "Is the new hydrology data from Chesapeake Conservancy going to be included in Phase 7 and this extra detailed data influence the methodologies." Gary responded saying that they have great data, but once they have finished mapping it and we understand the data via studies, then we can incorporate it.

11:45 BREAK

12:45 [Optimization Update: Integration with CAST – Gregorio Toscano, Kalyan Deb, Pouyan Nejadhashemi, Sebastian Hernandez-Suarez, and Julian Blank, MSU](#)
The initial integration of the optimization framework with CAST will be presented. The approach uses CAST to validate the initial settings and evaluate the proposed solution. Progress on the web interface needed for the CBP user testing by the Optimization Guidance Group will be discussed.

Gregorio provided context for Objective 1: Understanding the CAST system and Development of an Efficient Single-objective Hybrid Optimization Procedure. He then outlined the six accomplishments their team had made in terms of optimization. Next, Gregorio demonstrated the webapp they developed and walked through its usage, while Kalyan provided some examples of how to use the webapp and emphasized that this is an iterative, explorative process. They concluded with next steps that stated decision making will be included in the future of the app, along with other features.

1:15 Optimization Discussion
Lew Linker asked a scale question about a single county vs a collection of counties in terms of how the optimization works. Kalyan Deb responded that "you will get differences if you optimize for one county vs five that include that county because it optimizes based on the selected." Lew followed up asking "could the state run a globalized optimization, then ask counties to run at regional and individual level? Is this an application strategy?" Kaylan responded "yes, this can be useful for academic research and help illuminate discussions as you can run at many types of scales." Lew then asked "When might this be ready so we can connect it with users? Want to showcase this at a guidance meeting. Please let us know when the statistical accuracies for values are ready." Pouyan Nejadhashemi responded that "what was demonstrated today is ready. However, improvements will include providing a default starting number for different parameters." Lew suggested including measurements for accuracy for when demonstrating this tool at the guidance meeting.

Pouyan provided a brief overview of optimization incentives and upcoming meeting plans to address these issues. James Martin asked what the timeline is for identifying the full group of practices and are they tied to urban, rural categories? Pouyan responded that there is no

limitation for technical linking. The focus so far has been reading to CoreCAST on BMP. Kalyan indicated that the comments from Dave and Olivia regarding land use will be considered and integrated in further work on the project. Kalyan also responded that the project is still very much in progress and that they will be receptive to comments from the guidance group/team. Dave, James, and George indicated they will be part of the team to help the optimization efforts.

Guido Yactayo asked "Is the tool available to test? Will this be part of the future version of CAST?" Pouyan responded that this is possible to be included, and if this is the will of the group it can be done.

George Onyullo asked "Could the tool be made amenable to uses such as supporting nutrient trading?" Pouyan said this is possible to be included, and if this is the will of the group it can be done. George offered to be a part of the guiding committee.

In the chat, James Martin said the following on "Optimization Incentives: There are many incentive programs used to drive BMP selection and implementation. They include cost-share and grant programs in each sector. Not sure I understand how the NRCS (or other program) incentive information helps the optimization. A user may want to preferentially select practices that are supported by these programs, but the specifics of cost-share rates for a particular practice from one or more programs only changes who pays, not the total cost of implementing the practice. Additionally, it may be preferential to use the optimization to drive program design. The optimization would find a low cost solution, then the programs could be established/modified using the optimization outputs to help make the practices cost-neutral for the implementor." Karl Berger responded "that could work for agriculture programs, but he doesn't see it working for urban BMP incentives."

1:30   [High-Resolution Land, Tidal Water, and Tidal Wetland Boundaries to Inform the Phase 7 Models – Andy Fitch, USGS](#)
The high-resolution Phase 7 Models require an attention to detail not previously needed in the lower spatial resolution Phase 6 Models. Andy will describe work to differentiate at high spatial resolution the Watershed Model and Tidal Bay Model domains. In addition, the 2017 land use/land cover data will be used to identify wetlands within or intersecting with the tidal shoreline boundary. The resulting tidal wetland areas will be a tabulated as part of the Watershed Model land cover, but will be simulated in the new tidal Bay model.

Andy reviewed previous actions and decisions regarding the boundaries between land, tidal water, and tidal wetlands, providing context for the presentation. He then discussed the development of MHHW shoreline layer and the 2017 Landcover data and noted its limitations.

2:00   Discussion of High-resolution Landscape Characterization
Lew Linker made a comment on slide 5 and indicated that this work is important because it defines the boundaries of models. He asked more specifically "Where does the watershed model end and where does estuarine model begin?" Gary responded saying that "It's really important to know difference between tidal and non-tidal. Forest location, like hummocks, is less important because it doesn't impact our decision making from the watershed model." Dave questioned if

that really doesn't cause problems. Nicole and Lew said that unless there are channels in the wetlands, it doesn't matter too much because those small forest areas would function as wetlands.

James Martin asked about the implication of this wetland boundary on creating more shoreline. Gary and Andy agreed this is a good point. To generate a shoreline layer, it may be come down to expanding the wetland class to get rid of the channels and then put open water boundary there. The tidal boundary would be farther inland and would include tidal wetlands.

Lisa Beatty said "Thank you for your work on tidal wetlands. Is some of these same investigations be done for non-tidal wetlands with focus on emerging agriculture wetlands. I know that the Chesapeake Conservancy is slated to have their wetland data available on the viewer by December 2021 - Feb 2022." Andy and Denice responded that the Chesapeake Conservancy data is incorporated. Lisa replied that the data being used is an older iteration of the Chesapeake Conservancy data and it is currently undergoing QA/QC. Andy said that once QA/QC is completed, they plan to incorporate the new data.

Denice Wardrop asked if there is anything that is gained from distinguishing this from NWI? Andy replied that NWI was used to inform the creation of the old layer, but he needs to check in with Peter Claggett's team to confirm. Regardless, the NWI source material was probably outdated, and he is not sure what value there is from comparing. Denice followed up by asking "Is there intent to combine the new shoreline with the VIMS shoreline data for then usage in the estuarine model?" Andy replied that there were quite a few gaps at a fine scale which would have required a lot of work, so therefore that data was not prioritized. Lew stated that he defers to Andy here, but it appears him that this data is superior than NWI.

2:15 **Transport and Fate of Oxidized and Reduced Atmospheric Emissions – Jesse Bash and Sarah Benish, EPA-ORD**

Progress on estimating the transport and fate of atmospheric emissions of oxidized nitrogen (NOx) and ammonium (NH_4^+) will be presented. The analysis centers on the question, "For a nitrogen emission source from different regions in the Chesapeake watershed, what is the fraction that is deposited to a particular region or point?". In addition, the analysis can be used to estimate reductions in nitrogen deposition to the Chesapeake watershed and tidal Bay under future conditions of greater penetration of electric vehicles into the existing mobile fleet, greater wind and solar electric generation, and other types of future economic conditions.

Sarah presented an overview of EQUATES (EPA's Air QUAlity TimE Series Project) and its applications, including the newest updates and corrections to depositions. She explored model parameters and results of CMAQ (Community Multiscale Air Quality Model) and then used ISAM (Integrated Source Apportionment Method) to explain and demonstrate the spatial components of oxidized nitrogen deposition and different sources, such as mobile emissions and poultry. She then concluded with a summary of the models that have been run and their results, followed by the next steps of calculating efficiency and applying corrections to EQUATES and ISAM.

2:40   Discussion of the Transport and Fate of Oxidized and Reduced Atmospheric Emissions

Lew commented on slide 14 that deposition rates broken down by cause and region with temporal factors are considerations that are useful contributions to this model.

Karl Berger asked on slide 30 if this model can be used to go ten, twenty years out and plus in Electric vehicle considerations. Sarah responded that this still needs some careful consideration, but theoretically it is possible to model mobile sources going forward. Gary added that this analysis can look at BMPs as well.

Gary asked a clarifying question if reduced deposition is directly related to reduced loads, which Sarah confirmed is correct. Jesse added that in reality, there would be a small non-zero component, but it was not measured because they are quite minor and not relevant here.

Karl Berger asked "So unlike water environment, air N does not transform from oxidized to reduced?" Sarah responded that oxidized could come down later downwind, but that ammonia normally doesn't make it down because of its short life.

Lew commented that based on slide 22 seasonal winds have significant impacts and loads can have little impact on the watershed because of their input within the watershed.

Joe Wood asked are there any assumptions included here about ammonia controls from poultry? In other words, is any level of litter amendment assumed here? Jesse responded they are using animal specific emissions based on a model out of Carnegie Mellon and that he doesn't think the model is making assumptions about poultry. Jesse also mentioned that this is all documented on the NEI website. Animal NH3 emissions are described in section 4.5 in the 2017 NEI documentation. https://www.epa.gov/sites/default/files/2021-02/documents/nei2017_tsd_full_jan2021.pdf Jesse also stated that county and state level data are available at https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data.

3:00   Dynamic Reservoir Operation Rules and Evaporation Simulation Impact on Model Goodness of Fit in Lake Anna – Rob Burgholzer and Joseph Kleiner, DEQ

> The VAHydro operational rules model combines edge of stream inflows from the Phase 6 model with a temperature-based regression model of power plant evaporative cooling, and a detailed simulation of reservoir release rules required by the Virginia Water Protection Permit for the operation of the nuclear power plant in Lake Anna. This approach provides for improved goodness of fit in both downstream flows and lake surface elevation drawdown during drought conditions.

Robert began with an overview of the Virginia Department of Environmental Quality water supply modeling and a high-level overview of the general methodology. He then used Lake Anna as a case study to evaluate where the Bay Model went well and where it could be improved. He also looked in detail at cooling and evaporation, including a regression equation for simulating additional evaporation which was much more effective at modeling summer drawdown rates than those that do not include surface water temperature.

3:20   Discussion of Dynamic Reservoir Operation Rules

Lew commented that this has been very eye opening as there hasn't been enough focus on evaporative losses. Lew added that these withdrawals have implications for climate change, sea level rise, and total flow, especially for going beyond 2035. Lew said that given this importance withdrawals will be included in Phase 7 and this work will be considered in development. Robert added that the model has been leveraged to help calibrate to land use and water flows, which is a huge benefit over the current methods of water supply modeling. Gary agreed that this presentation is a good response to Gopal and Isabella's presentation on determining empirical flow.

Dave asked "Am I right to take away from this that we should be focused on larger reservoirs with warmer temperatures and electric power plants?" Robert responded that for simple reservoirs, one should definitely focus on those with electric power plants and the low hanging fruit, such as the 0.25-5 size class. Robert also indicated that for reservoirs of all sizes, measurements should be included

3:35   ADJOURN

Participants: Bill Keeling, Lew Linker, Alexander Gunnerson, Breck Sullivan, Alana Hartman, Ariana Johns, Bhanu Paudel, Dave Montali, Gary Shenk, George Onyullo, Gopal Bhatt, Guido Yactayo, Isabella Bertani, James Martin, Jesse Bash, John Clune, Karl Berger, Katherine Filippino, Kyle Hinson, Lisa Beatty, Mukhtar Ibrahim, Mindy Neil, Normand Goulet, Rebecca Murphy, Richard Tian, Carlington Wallace, Cathy Wazniak, Sarah Benish, Teresa Koon, Sam Merrill, Jim George, Kristin Saunders, Nicole Cai, Elizabeth Hoffman, Olivia Devereux, Robert Burgholzer, Suzanne Trevena, Neil Ganju, Hassan Mirsajadi, Patrick Thompson, Renee Karrh, Xia Xie, Tom Parham, Qian Zhang, Denice Wardrop, Pouyan Nejadhashemi, Sebastian Hernandez-Suarez, Kalyanmoy Deb, Clint Gill, Andy Fitch, Jeff Sweeny, Gregorio Toscano, Mark Bennet, D Austin, Lee McDonnell, Joe Wood, Joseph Kleiner, Ryan Green

===

9:00   Announcements and Amendments to the Agenda – Mark Bennett, USGS and Dave Montali, Tetra Tech

9:05   Overview of the Phase 7 Main Bay Model (MBM) and Multiple Tributary Models (MTMs) – Lew Linker, EPA-CBPO
Elements of a presentation to be made to the WQGIT on October 25-26 including an overview of the Main Bay Model (MBM) and the associated fine-scale Multiple Tributary Models (MTMs) of the tidal Bay and their utility to the CBP Partnership in the assessment of 2035 climate impacts will be reviewed. How the MBM and MTM teams will be organized and the preparation for the MBM and MTM work that is now underway will be presented.

Lew began with an overview of the Chesapeake Bay Program's Bay Model products, specifically the MBM, MTMs, and the next generation bay model. He also previewed presentations later in the day regarding grid work and basins for the Patuxent, Corsica, Potomac, and James. He outlined major lessons learned from prototype MTMs and the modeling timeline from 2021-2026, before concluding with next steps.

9:35   Discussion of the MBM and MTM overview.
Dave Montali asked "Who will work on the tributaries that don't have a dedicated team? I understand it's still undetermined as we are waiting on funding." Lew responded that Richard and Nicole are the main points of contact, but once the MTM teams are fully developed in 2022, it theoretically could be contracted out with the support of Richard and Nicole. Dave followed up asking "Why are focusing on the Patuxent as opposed to the Rappahannock? I am concerned about consistency." Lew responded that we are following the direction of the Bay Program partners in determining which of the tributaries are developed.

Marjy Friedrichs asked, "It seems like we are going backwards by having a model for each tributary? Isn't this in contradiction with what STAC asked for? I believe we need multiple models for each tributary considering what we learned from the ecosystem workshop." Gary agreed that there is significant value in having multiple models for each tributary but said in the past we haven't been able to implement it due to lack of funds as that would mean redirecting away from other models. Gary said he believes we are still fulfilling what STAC is asking for because we are including multiple models across different geographies. Lew responded, saying kudos to Marjy for developing a prototype for the Choptank and agreed with Marjy that this approach is in terms of what is best for science, but that we need to also consider what is best for management. Lew argued that CMAQ and CMAS are a legitimate way to do multiple models and that there are already multiple models within the bay. Marjy asked a follow up "is the tributary model RFA going to say that we can use different models? Will we be limited by this?" Lew said that will not be possible in the RFA, so Marjy responded "how will this address model

structural uncertainty?" Gary responded that yes, it won't address model structural uncertainty, but the success of CMAQ suggests there is a path forward with Marjy's work. Lew suggested using the James as an example in terms of chlorophyll here. Lisa asked, "can we elevate this or move it to further discussion since there is some contention here?" Lew and Gary responded that this discussion has been going on for quite a while and this would only result in a lateral move.

Karl Berger asked, "who will be the decision makers on which tributaries are focused on and what will the funding look like?" Lew responded that right now we have a budget of zero, but we are optimistic that if we do find funding that we could get three people plus Richard and Nicole. We will get a list from the WQGIT in terms of the MTM priority applications.

James Martin asked, "what will the next RFA do differently?" Lew responded with the James as an example, saying that they would be able to learn from the other MTMs and the MBM and they will also include new grid sizes and resolutions.

James Martin said given development schedule and funding, should we prioritize a single MBM? What are the implications if we cannot get funding? Lew replied that if we are able to fund it, we could get in Q1 2022, a RFA in the summer, a MTM team in place by end of 2022. But if no funding is acquired, we would have a large cutback for the MBM immediately but would still deliver feasible results, depending on the resources available, on time. James expressed his struggle trying to weigh MTM vs MBM considering the logistics of what is feasible. Lew responded that he felt that isn't a true tradeoff as there only enough resources allocated for the MBM.

In the chat, James followed up asking "How much funding is needed for the 3 and 5 MTM vision you shared. I think it is critical if the Partnership is going to move forward with this, that there is commitment to "find the funding". I want to help! I will engage our Management Board and PSC members to communicate this need to CBPO, R3 and EPA leadership." Lew replied saying "Thanks for that question James. For five Multiple Tributary Models (MTMs) we anticipate an annual cost of $150k. The MTM work would continue for 5 years - 3 years for MTM development 2022-2024 and two years for MTM application 2025-2026 for assessment of all tidal TMDLs as directed/requested by CBP DMs."

Lisa Beatty stated, "I do think that there are concerns about any methods concerning the model there should be a transparent discussion in the Water Technical WG for larger comment to those signatory and at large members." Gary replied that's an interesting point, saying that The WTWG has historically been involved in BMP discussions, mainly in the watershed. Gary added that we're moving the focus of estuarine simulation up into the shallow areas affected by BMPs, they may be more interested.

10:00 **Corsica River Shallow Water Simulation – Jeremy Testa, UMCES**
       Findings of a study of shallow water processes in the simulation in the Corsica River with SCHISM will be discussed.

Jeremy began but explaining key processes in shallow water systems and how challenges become opportunities in this context. He looked at a few different locations before narrowing in

on the Corsica River and why it is a prime example to investigate. He finished by discussing the simulation of the Corsica River using SCHISM.

10:30 Discussion of Corsica River Shallow Water Processes

Lew commented on slide 8 that these shallow waters experience fierce productivity during the day and the diurnal cycles of dissolved oxygen are especially challenging. Lew asked, "Do you anticipate there being a contribution to oxygen levels from the Marsh?" Jeremy responded that presumably it is, adding that there may be some oxygen from the creeks, but a lot of oxygen is sucked up by turbidity. Each tide is pulling out the oxygen, more so than the diurnal influences. Additionally, there are big differences spatially.

Dave asked, "Is this is a natural condition?" Jeremy said that yes, he thinks this is a natural condition. Jeremy added "big oxygen sags as it leaves marsh, but you don't see it as much in river because of dilution. Practical point in terms of modeling is that you need to understand how much of a contribution this condition is and to isolate eutrophication." Lew added that Richard has a similar point, where to understand dissolved oxygen, one must understand where the tidal wetlands are.

Lew asked Jeremy about the temperature data and the implication of high values in some locations. Jeremy responded that these values need further investigation.

10:45 Initial Set-up of a MTM in the Tidal Patuxent River - Richard Tian, UMCES

> Richard will provide insights into an initial trial setup of a MTM using the Patuxent River as an example. In addition, Richard will present his experience in using the unstructured grid models of FVCOM and SCHISM in the Corsica River simulation.

Richard presented on the process of determining the scale and new grid for the Patuxent River, explaining the constraints on resolution leading to the iterative process that determined the new grid and number of cells. He then showcased results of movement, DO, and temperature models, including FVCOM and SCHISM for the Corsica River.

11:15 Discussion of the Patuxent River initial MTM setup

Lew commented on slide 28 the importance of tidal wetlands on temperature correction in regards to the Corsica Modeling group. Richard added that the respiration of wetland is temperature regulated and much higher in summer. If including the temperature resolution, the response of dissolved oxygen will be more effective.

Dave, while thinking about consistency, asked, "Is the grid work resolution of the Patuxent practical?" Lew replied that the resolution of the MTM grids will depend on the direction provided by the WQGIT in terms of which tributaries to focus on.

James Martin asked, "What is the vertical resolution in the 1m LIDAR cell? Considering variability in x,y grid where we used a standard 1.5 m for vertical. Why wouldn't we use that again here?" Richard replied that is a good question and that in the Corsica the resolution is very fine. Lew added that an orthogonal grid is no longer used, except for perhaps in shipping channels. Lew also referred back to previous comments about resolution.

11:30 <u>Initial Set-up of a MTM in the Tidal James River – Nicole Cai, VIMS</u>

> Nicole will describe work in an initial trial set up of a MTM in the tidal James River drawing from her experience in simulating the York with an unstructured grid model.

Nicole presented an overview of her dissertation and its connection to the bridge between the MBM and MTMs, specifically the importance of using unstructured grids for shallow waters. She then focused on the James River grid methodology and results as a case study, focusing on sensitivity tests, shipping channels, and outlining next steps. She also focused on pilot work on the York River grid and on linking the NHD segments to estuarine model.

12:00 Discussion of the James River initial MTM setup

Lew commented that James Martin's points are signals that this is a challenge, but Nicole and Richard are appreciated for leading the way in piloting these projects,

Lew asked, "what would happen if we expanded the grid to the Elizabeth and Lynnhaven? Would that be helpful and how would that impact timing?" Nicole replied, "I have already applied high resolution grid to Elizabeth so it shouldn't be a problem. Lynnhaven shouldn't be a problem because there is already a project on it, but I question if it's necessary." Lew asked James Martin if he would be willing to take lead on prioritizing efforts in the James River. James Martin replied that he might not be the best person for the job but that he would be happy to help. He also added that his priority would be to address problematic tributaries. Lew added that whatever ends up happening in the MBM needs to include the Lynnhaven. Nicole added that an attempt should be made to avoid boundary condition issue with the James River.

Richard asked if it necessary to reach out to MDE and DEQ about which tributaries need to have the highest resolution? Lew added that we have done that and are now asking the Modeling workgroup for their comments.

James Martin commented that the other priorities from the WQGIT beyond the TMDL, like endangered species or restored oyster reefs, would be ideal to be considered. Richard mentioned that criteria assessment in Maryland is planning to delist the fishing bay area and intensive monitoring, and wonders if this monitoring is critical for the tributary models. Dave Montali asked if problem segments in previous aspects of the model would be considerations for resolution. Lew responded that he believes areas that have experienced these issues might see improvements with changes in scale, such as the shipping channels of the James River. Richard said he agrees with Dave that previous segments with issues should be prioritized in aspects of scale. James Martin followed up asking if there is a way to know if an unstructured grid or MTM will help with the mentioned problem segments. Nicole responded that in a follow up to her paper on hypoxia in the main bay, they are trying to address these issues and she suspects that resolution is definitely a consideration and they are testing to understand these issues. Gary added that the focus should be on problem segments that are not realistically responding to changes in sea level rise or management. Lew suggested that the upper Patuxent and the Elizabeth might be cases where resolution needs to be reconsidered and that previous conversations about the problem segments should be revisited.

In the chat, Kristin Saunders said, "The jurisdictions did identify priority areas in the US Army Corps comprehensive plan (one per jurisdiction). It may make sense to start there to verify those priority areas are still their focus but beyond those locations, goal implementation teams may have multiple priority areas within a geographic region. The link to the plan is here https://www.nab.usace.army.mil/Missions/Civil-Works/Chesapeake-Bay-Comprehensive-Plan/." Kristin added that BMPs can also be factors here beyond just water quality. She stated that the Corps also went into detail on potential projects and this could be a good resource to use. Kristin says she can be a link to the GITs and added that a lot of the detail is also in the appendices to the plan, so one may need to dig a little bit into each jurisdiction-specific opportunities at the local level.

12:15 STAC Climate Change 2.0 Workshop Report – Gary Shenk, USGS
Gary Shenk will give an overview of the STAC Climate Change 2.0 Workshop Report and the recommendations that resulted.

Gary explained that the purpose of the STAC Climate Change 2.0 Workshop report was to provide guidance on the models and assessment framework used to assess the effect of climate change on the TMDL and that the report is coming out now because work has been focused on implementing recommendations. He then provided an overview of near-term recommendations, progress updates, and how successful they have been implemented. Gary concluded with long-term recommendations, which include: develop a new estuarine model; continue development of climate-related watershed model capabilities with particular attention to BMP effectiveness; create a more sophisticated evaluation framework that incorporates various sources of uncertainty.

12:45 Discussion of STAC Climate Change 2.0 Workshop Report
Karl Berger asked, "Can you please provide the link to Isabella's research on nutrient speciation to which Gary just referred?" Kyle Hinson replied with a link to Isabella's recent paper on Nitrogen speciation: https://doi.org/10.1111/1752-1688.12951

Dave asked regarding the use of uncertainty in decision making on slide 20, is it correct to assume we are in 0.5 data? Gary replied that we are, but that is purely circumstantial as this is a non-real example data. Gary added that they are aiming for a more accurate model than a conservative one. Dave said that managers do not want to deal with uncertainty in the TMDL and Gary responded that is one of the issues. George Onyullo made the case for going to finer scale as he said that there will be uncertainty at any scale, but at least at a finer scale there is a better understanding of what that uncertainty looks like. Lew agreed and said that finer scale can help resolve issues like land use, temperature, and precipitation.

Lew added that the STAC workshop was well run and the notes are thorough, making them a useful resource.

Kyle Hinson asked, "how do we put a label on accuracy without running all possible future climate scenarios?" Gary responded that this is based on the Bay Program's decision around a climate model and the subsequent extrapolation of historical data. Lew commented that projected trend from observations are used for the shorter term and that GCMs have been used for the

longer term, with a mixture used in between. Kyle followed up asking, "how will this affect 2035 goals?" Gary responded that's a good question and that there will be further discussion around extrapolation compared to GCMs in 2024 as seasonality changes are currently being left out. Dave added that these discussions are part of the necessary climate assessment.

1:00   ADJOURN
The next full quarterly meeting will be in January, but many will be in attendance at WQGIT meeting this month.

Participants: Dave Montali, Lew Linker, Alexander Gunnerson, Karl Berger, Kristin Saunders, Robert Burgholzer, Isabella Bertani, Gary Shenk, Norm Goulet, Ariana Johns, George Onyullo, Carrington Wallace, Richard Tian, Jesse Bash, Gopal Bhatt, Bill Keeling, Denice Wardrop, Guido Yactayo, James Martin, Katherine Filippino, Lisa Beatty, Marjy Friedrichs, Sarah Benish, Mark Bennet, Sam Merrill, Neil Ganju, Suzanne Trevena, Mukhtar Ibrahim, Kyle Hinson, Jeremy Testa, Elizabeth Hoffman, Nicole Cai, Hassan Mirsajadi, Joey Kleiner, Jim George, Cassie Porter