APPENDIX A. MINUTES FROM MEETINGS FOR GIT#1 PHYSICOCHEMICAL INDICATORS

Mark Southerland and Rory Coffey
Tetra Tech

REVISED
21April2025

CBP GIT#1 Physicochemical Indicators

Minutes from Meetings for Research and Data Discovery

1. Interstate Commission on the Potomac River Basin (ICPRB) Meeting

5March2025

Mark Southerland
Rory Coffey

Rikke Jepsen, ICPRB Aquatic Ecologist II

Rikke included points from Claire Buchanan, ICPRB in the discussion and said she would forward any additional ideas from Emily Young, ICPRB Living Resources Data Manager, and Mike Mallonee, ICPRB.

Claire and Rikke believe that continuous data for DO, pH, conductivity, and temperature is more valuable than discrete measurements.

Physicochemical ancillary data are submitted by state, county, and other monitoring organizations to ICPRB for Chessie BIBI from sources including the WQ Portal and will be available for 2018-2024 in May 2025.

Rikke agreed that Kelly Maloney and USGS team would be important to interview.

Rory asked about thoughts on how to determine thresholds relative to reference (or of concern), e.g., from state WQS and EPA ecoregional thresholds. Rikke agreed with challenge of ecoregional thresholds where reference are not available, e.g., Coastal Plain.

Rikke described the overhaul of MDE's Biological Stressor Identification (BSID) method for stressor indicators. It is a multi-year project and includes a literature review and evaluation of stressor identification methods in Integrated Reports of PA, VA, and WV.

Scale and assessment units are also important considerations.

Rikke followed up the interview with the following links:

- CBP Data Hub (DataHub - Home), specifically "CBP Water Quality Data (1984-present)"
    - Mike Mallonee is the water quality data manager (mmallone@chesapeakebay.net)

- Pennsylvania's eutrophication cause method (pp 9-20 in PA's Water Quality Assessment Methodology). Uses %DO sat calculated from continuously monitored DO and temp to identify impairment caused by excess nutrients.
- EPA Stressor Identification Guidance Document
- Virginia DEQ stressor analysis First link under resources (Stressor Analysis in Virginia: Data Collection and Stressor Thresholds) -> Section 4: Stressor Thresholds
- A lot to wade through but potentially useful PA Integrated Reports
- Also potentially useful: WV Integrated Reports

2. Maryland Department of the Environment (MDE) Meeting

19March2025

Mark Southerland
Rory Coffey

Denise Clearwater, Special Projects Coordinator, Water and Science Administration, MDE

Denise recommends searching the gray literature, including restoration projects and using Google Scholar to find theses. Mark said Tetra Tech is reviewing the Water Quality Integrated Reports from each state and can use them to identify unpublished state, county (especially Baltimore, Fairfax, and Montgomery), and volunteer monitoring that might be useful. She suggested using broad key words so that atypical journals be included.

Denise said we should address each parameter with a numeric WQ standard, such as temperature, DO, conductivity, and pH. She mentioned the impact of disturbing acidic soils.

The group discussed how multiple parameters might be combined in an indicator though weighting or expert opinion, but cautioned that users should be able to drill down to the individual parameters.

Denise asked if water depth and flow were included in this project and Mark indicated that these were (perhaps imperfectly) covered in the hydromorphology project, but could cross over in the final suite of stream health indicators. [Note that after discussion with USGS, Mark agreed to include some discussion of water depth, connectivity, and flow in this project.]

The group discussed that measurements might be rated even if below the regulatory standard (temperature is an example where the threshold is too high for some impacts). Sublethal, at risk, or of concern categories can be considered. Denise said we should ask Matt Stover of MDE how to deal with narrative criteria such as turbidity.

The group agreed that regionalization will be required to address geology (such as Karst and Fairfax Triassic) and other factors. Rory said that EPA has ecoregional thresholds, including for parameters without regulatory standards.

Denise said that the project data matrix should be usable beyond the project and include:
- Location and region
- Parameters

- Contact information

The group discussed what the assessment units might be, such as stream reaches and watersheds, which are both likely useful. Mark mentioned that statistical approach to 303d listing of watersheds and reach modeling done by Kelly Maloney of USGS for the Chessie BIBI. Additional work could be done to identify the length of stream that physicochemical (or biological) results are representative of.

Denise suggested that the project should also recommend best practices for presentation of the ultimate indicators.

Mark suggested that the project may result in options of composite/suites of indicators of different sizes, such as the basic parameters collected by sondes vs those requiring laboratory analysis vs those with more exotic toxics.

3. U.S. Geological Survey (USGS) Meeting

21March2025

Mark Southerland
Rory Coffey

Greg Noe, USGS Florence Bascom Geoscience Center, Research Ecologist
Matt Cashman, USGS MD-DE-DC Water Science Center, Geomorphologist
Marina Metes, USGS MD-DE-DC Water Science Center, Physical Scientist
Kelly Maloney, USGS Eastern Ecological Science Center in Kearneysville WV, Research Ecologist
Lindsay Boyle, USGS Eastern Ecological Science Center in Kearneysville WV, Fish Biologist
Rosemary Fanelli, USGS South Atlantic Water Science Center in Raleigh NC, Hydrologist
Peter Tango, USGS MD-DE-DC Water Science Center, Chesapeake Bay Monitoring Coordinator

Greg started by describing the three areas that USGS Stream Team is doing relevant work:

- Review of stressors led by Rosemary
- Regional assessments that are most relevant to this GIT project
- Focal studies on specific landscapes and questions along with Virginia Tech

Mark clarified that the project does not have specific goals or physicochemical attributes designated for inclusion, beyond adding these attributes to CBP program stream health indicator suite. He agreed with Kelly that discussing the different benefits of indicators beyond status and trends, to include early warnings and BMP targeting, should be included in the project. Greg emphasized that the SHWG should work toward a more specific definition of stream health to move us beyond "we'll know It when we see it." Rory said that determining which physicochemical attributes to include is a primary goal of the project and we will include discussion of both indicators that are important and that are feasible.

Kelly provided links to USGS work that began at AMAAB in 2017 covering status and trends modeling for the following, starting with Chessie BIBI, then fish, plus geomorphology, salinity, nutrients and sediment. For nutrients, not just TN and TP concentrations, but nitrate, ammonium, and soluble reactive P are more meaningful. Note that temperature and flow have been more challenging. They have not yet incorporated toxics except for some work on PFAS. The US Geological Survey (USGS) and Chesapeake

Bay Program partners are conducting multiple habitat assessment efforts to support restoration and protection efforts in Chesapeake Bay Watershed.

- Stream Health Conditions https://geonarrative.usgs.gov/chesapeakeassessments/
- Nutrients and suspended sediment https://www.sciencebase.gov/catalog/item/679cf1f7d34e89501cd2d66a
- Temperature https://www.sciencebase.gov/catalog/item/62fcf75ed34e3a4442867e38
- Salinity https://www.sciencebase.gov/catalog/item/631b80e7d34e71c6d67a2585
- Toxics (PCBs) https://www.sciencebase.gov/catalog/item/629f90a0d34ec53d276fd4d3
- Fish https://www.sciencebase.gov/catalog/item/606cdef4d34e670a7d5cfff1
- Habitat and Macroinvertebrates on CBP DataHub https://datahub.chesapeakebay.net/Home

The group noted that the Chessie BIBI has changed nearly +10% in about 20 years now, compared to 1-2% trends in WQ standards, SAV, and bay benthics over 40 years. Chessie BIBI may be the poster child illustrating the most significant changes since the Phosphorus-ban reduced P downstream of WWTPs.

Marina said they will be completing FACET with the 1-meter DEM to better describe physical habitat modification, including valley confinement and channel incision.

Rosemary said they are working on temperature metrics for status and trends that are ecologically meaningful for land use change and BMP effectiveness. There is an EPA-funded project by another organization to develop a Chesapeake basin-wide model for temperature on the 1:24,000 scale – ROAR project by Naomi Detenbeck and Kaylyn Gootman of EPA). There is also a Penn State PI - Kim Van Meter (e.g., Chesapeake Bay HydroML: Advanced Streamflow And Water Quality Predictions For The Chesapeake Bay Watershed)

Lindsay said that while there are a lot of discrete temperature data, it has only been useful for overall status and trends. It is hard to model for discrete areas, so they have been using continuous temperature data.

Peter provided background on the direction of the update to the CBP Agreement, noting that in addition to the TMDL parameters of nitrogen, phosphorus, and sediment, goals will include reduction in "pollutants," which might include plastics, microplastics, bacteria, and HABs. Matt commented that microbes are responsible for huge number of impaired waters listings in Virginia. Rosemary cautioned that we should be careful not to expand the scope of this project, but Mark said that these pollutants can be discussed in the project to provide completeness for SHWG, without including them in the recommendations for near-term indicators.

Rory said that we expect to prioritize buckets of parameters (within the 69 cites in some literature) based on both ecological importance and data availability.

Matt said that he is working on physicochemical indicators at the national scale to develop baseline conditions so that parameter values can be expressed as departure from natural/expected. This includes a plan to model thresholds nationally. Mark likened this to the critical use of reference condition for biological indicators. Matt also said that while the CBP and TMDL have focused on loads, concentrations of pollutants are more relevant to local conditions. He also recommended looking to surrogates where

baseline values are problematic, e.g., using loss of local riparian tree cover as a vulnerability proxy for temperature. He pointed to pH and acidity as parameters that are important but without a lot of data.

USGS is currently using functional components of the biota (as they are long-term indicators) to identify potential stressors—loss of coldwater taxa indicate thermal stress, etc. The jurisdictions have sampled oodles of biological data and Greg's USGS Stream Team work is also diving into this. Kelly agreed that range shifts can help highlight to the community that we increasingly need to manage for novel ecology (past ecology is not the future ecology with new species arriving and shifting).

Mark asked what the simplest physicochemical indicator would be and Rosemary said that conductivity is both a stressor itself and a useful proxy for metals and possibly pesticides, for which there are little data. Temperature is challenging because of the lack of standards and variation in local reference conditions, such as influence of groundwater inputs.

Kelly remarked that the challenges of using physicochemical indicators without thresholds of concern was the reason the field defaulted to biological indicators originally, so this project is returning to the challenge. He asked whether there are overlapping physicochemical and biological data that could be analyzed and Lindsay said there are effectively zero sites, since the large suites of physicochemical measurements are at gaged stations that are not wadeable for biological sampling. USGS is using gaged stations when flow is of interest, but Matt has flow predictions for smaller, ungagged streams with data. Matt also said that they have a postdoc looking at paired sites for conductivity and habitat. USGS may be able to provide a data "overlap" table of which abiotic variables are co-measured and which are not.

Greg emphasized that this work requires tradeoffs, so the USGS stream team has focused on testing hypotheses and evaluating BMPs for different stressors without flow information (though they are trying to interpret stage fluctuations).

Greg also highlighted the DELT (external deformities, erosion, lesions, and tumors) as pathogens and parasites on fish indicator that occurs in 2% of fish with 60% of DELTs being parasites. Sara Breitmeyer of USGS is the contact. Unfortunately, DELT data are not collected by every agency in the watershed and are not always collected in standardized way even within an agency, making the coverage of this data sparse and difficult to use watershed-wide.

Mark asked the group what they thought the best physicochemical indicators might be and Kelly suggested building off what we know and starting with the key stressors in the paper by Rosemary and Matt, such as specific conductance. We should use a table of what data are collected to identify the most promising parameters. Flow would be great but it is not generally available. Matt countered that flow and the ecological drought that results is very important to the physicochemical suite, so modeling done at NHD reaches should be considered.

Kelly suggested that for flow we could link to efforts getting such data for smaller streams: Flow Photo Explorer | USGS'. The Flow Photo Explorer is an integrated database and machine learning platform for predicting streamflow from timelapse imagery of rivers and streams. Flow disturbance (flashiness) is really important too, but difficult to compare to a reference/baseline. Kelly has a flow alteration paper with specific metrics - does get a bit at increased flashiness from a baseline: Linking Altered Flow Regimes to Biological Condition: an Example Using Benthic Macroinvertebrates in Small Streams of the Chesapeake Bay Watershed | Environmental Management

On the question of what is included in the hydromorphology vs physicochemical indicators buckets, Mark said that since this is the last bucket, the report should include any topics not already covered (or point out the intersection of variables like flow and physical connectivity). The hydromorphology project did not explicitly discuss longitudinal connectivity due to culverts and dams, but considering connectivity is an important part of the physical realm given habitat fragmentation strongly affects stream health if all else is equal.

Peter emphasized considering time scale of stressors/indicators, specifically to provide assessments of acute versus chronic impacts.

Mark asked if the group thought that composite indicators for physicochemical parameters, as some are doing internationally, was a useful approach. Lindsay said that it is tempting to combine metrics into composite indicators but would argue against it. Determining the relative impacts of different metrics is difficult at best. Mark agreed but said perhaps some scoring with number of "fatal" metrics would be useful. Matt stated that a composite indicator would be good if we only want to know whether a site is altered (like the Chessie BIBI does), but if want to know the cause and possible remedies we need the individual metrics, so providing both is ideal One option is an index that shows the number of stressors, as an indication of a less "easy" fix compared to an area with only one stressor? This is where he would like their geonarrative go, i.e., each reach would have an observed or modeled estimate of biological and abiotic endpoints, so that the user can then "see the entire ecosystem."

Rosemary described how one could roll up the metrics by HUC but would still need to drill down to individual metrics to interpret the results. Matt suggested flipping the concept from assessing stream health to quantifying overall risk from stressors (the physicochemical indicators).

Peter suggested that given there can be tens, hundreds, or thousands of stressors, success for management may be evidence of reducing ones we know are particularly widespread, heavy hitters (e.g., salt in freshwater to Peter). Having the individual indicators over a multimetric indicator then seems important. Multi-metrics can be tinkered with down the road.

Greg emphasized that we don't really know which stressors are acting as specific times and places, but that is what we are trying to get at.

4. EPA Region 3-Wheeling, Virginia DEQ, and Fairfax County Meeting

2April2025

Mark Southerland
Rory Coffey

Greg Pond, EPA Region 3-Wheeling
Brock Reggi, Virginia Department of Environmental Quality (DEQ)
Chris Ruck, Fairfax County

Prior to the meeting, Mark distributed a spreadsheet developed by Rory from background research that listed 17 data sources; 22 parameters as more commonly used, also used, and

less commonly used; and physicochemical parameters of water quality as physical (6), chemical (16), and biological (4). These lists were referred to throughout the discussion.

Greg recommended reviewing the PA water quality index (WQI) that used 21 physicochemical parameters from water quality samples and weighted each parameter by relationships with land use to across lotic environments (Wertz and Shank 2019). The group discussed the virtues of such a composite indicator for high level assessment and especially communication, but we should retain the ability to drill down to individual physicochemical indicators to identify driving stressors. Mark suggested using WQI as the model for a composite indicator with modifications for regionalization and our suite of indicators.

https://esajournals.onlinelibrary.wiley.com/doi/pdf/10.1002/ecs2.2947

Greg has worked with Kelly Maloney of USGS on the response of benthic macroinvertebrate metrics to physicochemical and habitat parameters that will be published in *Ecological Indicators*.

Greg believes that the biggest challenge will be spatial gaps in data on various physicochemical parameters. Pesticides are one example that might be addressed by using land use (e.g., percent row crop, percent pasture) as a surrogate. He recommends we develop a spatial map of the commonly used parameters to select those most likely to be useful watershed-wide.

Another issue is the different ways parameters are measured across the watershed, such as species of N versus total N, so lumping will be required. Specific conductivity is consistently recorded using sondes. DO is highly variable as points in time (depending on metabolism), so should be measured as DO saturation with temperature and elevation to be useful. Greg cited that PA uses dial swings as a measure of eutrophication, such as 40% over a 24hr period.

Use of reference conditions, such as O/E, is key so that deviation from expected can used as the threshold of concern. By calculating how the means/medians/range vary geographically will determine what regionalization will be needed. This will probably extend beyond ecoregions to geologic variation such as limestone versus freestone areas.

Brock said he is coming from a stormwater and stream restoration perspective and is interested in sediment transfer and stream stability. He specifically mentioned sediment protrusion height and pebble counts as metrics. Mark said that stream channel stability was a focus of the 2023 Hydromorphology Indicator recommendation and he sent that report to Brock on 3April2025. Depending on how this project evolves, Mark said that cross-topic issues like sediment will be addressed narratively if not in the physicochemical indicators. Broch recommended Elizabeth McKercher of VA DEQ elizabeth.mckercher@deq.virginia.gov) as a possible contact for Virginia DEQ water quality metrics.

Chris agreed with Greg that determining the spatial coverage of the data is key. He said that while municipal programs have more coverage, citizen science and non-profit efforts are now

using pretty reliable, low-cost kits for NOx (pass/fail) and salts/chloride. Isaac Walton League has extensive Salt Watch program for volunteers and Patapsco Heritage Greenway is a local non-profit that has adopted it.

Chris amplified Greg's comments that DO depends on temperature ranging from 7-8 to 14-15 in Fairfax County, so rarely below the standard of 5 which typically occurs with excessive algae or point source discharge. He suggested developing a DO profile at different temperatures.

He asked if periphyton/filamentous algae was being considered as a physicochemical or biological parameter, but noted it is less commonly measured. Mark said that he believed it might be considered as a biological indicator by ICPRB which has been looking at fish as possible addition to Chessie BIBI. Chris also said he doesn't like percent shredders because if varies with stream size. Greg said both algae and shredders can be seen as response to physicochemical parameters. Both Chris and Greg said that the Academy of Sciences in Philadelphia is the best source for diatom work as they received thousands of samples from VA, PA, and others. Greg also mentioned a touch test of 0-4 for diatom mats as a stressor identification procedure in WV.

Chris recommended using E. coli rather than traditional fecal coliform or obsolete total coliform. The shift to E. coli had occurred over last 15-20 years and is fast and easy now. He noted that health departments might be the source of E. coli data in many if not most jurisdictions.

Chris said that imidacloprid pesticide spraying for mosquitos was resulting in high levels in streams monitoring by Fairfax County. He noted that, while there is limited tracking of *Bacillus thuringiensis* (BT) that is commonly added as disks to ponds, Baltimore County has good estimates in Back River, where they spray with BT in solution.

Chris also finds that pH is typically in the normal range with rare c, ased below 6 or above 9. BOD and COD are also parameters with little value; Fairfax County only monitors for them in lakes which are rarely about the pass/fail of 10. The parameters obtained from sondes such as nitrate, chloride, and temperature are probably the most helpful. Greg said that Rosemary Fanelli of USGS has a good model of Cl from specific conductance with 0.99 R2. Regional differences are apparent, especially between the mountains and limestone middle Susquehanna.

Greg and Chris recommended selecting about 5 of commonly used parameters and applying them to training and testing areas. Options include nitrate, chloride, turbidity as measured by sondes and less sensitive kits for salinity and nitrate. This would entail identifying reference sites and running PCAs on the parameters. Greg suggested that we test our approach in geographically dense areas such as Maryland (MBSS) and Fairfax County and then apply predictions to data poor areas like York PA.

Greg suggested reviewing the Northeast stream classification from Stream Cat (Ryan Hill and Chuck Hawkins) that includes headwater cold, headwater warm, cool/cold, etc. to add

temperature classifications to geographic regionalization. Jen Stamp of Tetra Tech has been using the classification for work in Mid-Atlantic. This would probably work better than the simpler biological regions used by Chessie BIBI.

Brock asked whether the goal of the project was communication or scientific advancement. He suggested that ratios of results that pass or fail expectations. Mark said that both scientifically valid indicators and ultimate ability to show "stream health" across the Bay watershed were desired.

Prior to the meeting, Chris recommended revisiting the Biological Condition Gradient work of Tetra Tech (Ben Jessup, Jen Stamp, and Eric Leppo) in Virginia and Maryland.

https://www.deq.virginia.gov/home/showpublisheddocument/4303/637461491318800000

Jen Stamp noted that she is just finishing up a big effort to compile and harmonize lots of stream macroinvertebrate data for the Mid-Atlantic and run temperature tolerance analyses. We have the bug data prepared in a way that we can run additional tolerance analyses on other parameters (beyond temperature alone) in the future. Mark said that analyses of sites with both physicochemical and biological data would be very helpful for this project.

Mark Southerland
Tetra Tech
June 23, 2025
CBP GIT#1 Physicochemical Indicators

Minutes from Presentation of Draft Framework and Data Sources to Stream Health Work Group (SHWG) on 20June2025

Chesapeake Bay Program
Science. Restoration. Partnership.

STREAM HEALTH WORKGROUP FEBRUARY 2025 MEETING
Friday, June 20, 2025 from 10:00am - 12:00pm
Link to Meeting Materials

Microsoft Teams Need help?
Join the meeting now
Meeting ID: 239 163 249 666
Passcode: js3KF2F3

Dial in by phone
+1 202-991-0477,,710147031# United States, Washington
Find a local number
Phone conference ID: 710 147 031#

Join on a video conferencing device
Tenant key: sip:teams@video.epa.gov
Video ID: 118 003 394 4
More info
For organizers: Meeting options | Reset dial-in PIN
This meeting may be recorded. If the meeting is recorded, it will be announced via a banner showing "this meeting is being recorded." Participation in a recorded meeting will be deemed as consent to be recorded. Meeting recordings may be official agency records subject to appropriate policy, rules and regulations.

10:00 – Welcome, Roll Call, & Introductions (5 minutes)

- **Please put in the chat:** First and Last Name, Affiliation

10:05 – Housekeeping (5 minutes)

- **New Section of future agendas**
  - Request presentation topics
  - Helpful resources for partners: Funding Opportunities, Job openings.
- **Upcoming Meetings:**
  - The Next Stream Health Workgroup Meeting will be on **August 15th 10 AM - 12 PM**

10:10 – Update on Beyond 2025 (15 minutes)
Presenter: Alison Santoro, Workgroup Co-chair

- **Language Presented to PSC:**
  - Continually improve and protect local stream health and function, including their living resources and ecosystem services throughout the watershed using the best available science to inform land management, planning, and conservation.
    - Improve health and ecological integrity of at least 3% of non-tidal stream miles every 6 years.
- **Management Board and PSC are to continue to refine language during June**
- **Public feedback period in July**

10:25 – Presentation on Draft Framework for Phase 3B GIT Funded Project (30 minutes)
Presenter(s): Mark Southerland, Tetratech

- TetraTech has been awarded the GIT Funded Project:
  Phase 3B – Data Review and Development of Multi-Metric Stream Health Indicators – Physicochemical Metric Analysis

11:00 – MEETING ADJOURNED.

Attendees:

1. **Greg Zuknick**, EA
2. **Mark Southerland**, Tetra Tech
3. **Maggie Woodward**, Chesapeake Bay Commission
4. **Chris Spaur,** USACE
5. **Rikke Jepsen**, ICPRB
6. **Sandy Davis,** U.S. Fish and Wildlife Service Chesapeake Bay Field Office
7. **Denise Clearwater**, MD Dept. of the Environment
8. **Claire Buchanan,** ICPRB
9. **Greg Noe,** USGS
10. **John Lancaster,** PA DEP attending on behalf of Scott Heidel
11. **Rosemary Fanelli,** USGS
12. **Marina Metes,** USGS
13. **Brock Reggi,** Stream Restoration Specialist Virginia DEQ
14. **Gabriella Vailati,** DE DNREC
15. **Katie Brownson**, USFS
16. **Emily Young,** ICPRB
17. **Kelly Maloney,** USGS
18. **Nancy Roth,** Tetra Tech
19. **Alison Santoro,** MD DNR
20. **Cassie Davis,** NYS DEC
21. **Brittany Sturgis,** DE DNREC
22. **Carol Cain,** MD DNR
23. **Nick Staten,** CRC
24. **Matthew Meyers,** Fairfax County
25. **Ashley Huller,** PA
26. **Paige Hobaugh,** Tetra Tech
27. **Sadie Drescher,** CBT
28. **Megan McClaugherty,** ICPRB
29. **Matthew Cashman,** USGS
30. **Anne Hairston-Strang,** MD DNR
31. **Sara Weglein,** MD DNR

1. As CBP lead for the project, Santoro gave the project purpose and described this effort as multi-phase project to supplement the Chessie BIBI. This Physicochemical Indicators project is Phase 3B (following Phase 3A on Hydromorphological Indicators).

2. Southerland presented the Power Point

3. Southerland listed the next steps below and asked for additional comments by December 2. Santoro will post the presentation on the SHWG website.
   - Framework and Data Sources comments today (June 20, 2025)
   - Further comments due June 27
   - Data Inventory Matrix and Recommendations for Further Indicator Evaluation on August 6
   - Presentation to SHWG on August 15
   - Draft Report to SHWG on October 31
   - Final Report and Factsheet due January 31, 2026

4. Southerland responded to the following comments and questions live and via chat:

   <u>Questions from Audience:</u>

Rosemary Fanelli: Are you planning on quantifying a water quality index across the whole watershed as an input or are you proposing a framework for developing a water quality index?

Mark Southerland: No, we will not produce a final index, just recommendations for further indicator development.

Alison Santoro: Phase 3C will be the final index. The development of the index was presented as a project and was split up due to funding, Phase 3A and 3B are for identifying recommendations for what is available and good to use for an index. Perhaps Phase 3C will start in 2026 depending on funding, and it could take the form of a GIT funded project or a STAC workshop or something else.

From Chat:

Chat: **Claire Buchanan**: Re future interviews: can I suggest PADEP (Dustin Shull) and WVDEP (Ryan Pack). Each have some clever indexes to address aspects of WQ.

Chris Spaur: Major Disconnect between TN and bioavailable N!

Rosemary Fanelli: Perhaps your team can also look at the potential of some of these indicators to serve as proxies for other WQ parameters that are harder to monitor (for example, conductivity as a potential proxy for metals, or nutrients for pesticide loads).

-- Rosemary Fanelli: Good to see this later in your presentation.

Brock Reggi: Is there a data source or summary available on how the Bay drainage states differ on metrics for quantifying stream health. I know there are differences but not clear how far off each state are different and or similar...?

-- Mark Southerland: This is something we are going to dig into. One of the deliverables of this Project, in addition to the recommendations, is a data inventory. We have collected data sources but have not parsed through them yet.

Matthew Cashman: ^Great point by Reggi, Brock (DEQ). I would also add it's not just metrics, but also differences in the process for Stressor Identification, when identifying the likely cause of degraded ecological conditions
--Mark Southerland: Agreed. We all want to do more than produce a score of stream health; we want to be able to identify management actions to improve stream health.

5. Comments Received Outside SHWG meeting

Brock Reggi, VA DEQ

Mark,

Hope all is well with you and your family.

I have a call for the Stream Health Work group on Wednesday this week that will give opportunity to provide updates. I was wondering what the status was of the draft framework and data matrix mentioned below. The group decision from Virginia, all though not the opinion for everyone, was not to go with a multi metric sampling to show stream health in the next outcome update. I would like to see if there is anything to report on the status of your efforts and inform/ update that decision if possible. Feel free to email or call if you have availability ~ 757-345-8887

Chris Spaur, USACE-Baltimore

Mark

1 Attached. Please consider. Some big picture comments below on TN and TP (not in attached comments) which also mix in Bay impacts because relevant to stream decisions.

2 One of my biggest concerns is mis-use of TN as metric. Most spectacular example that I'm aware of: Conowingo Dam trapped sediments include staggering quantity of TN (particulate matter). However, vast majority of that is in refractory forms (not bioavailable), and impacts of that TN making it into Bay are minimal. Making Conowingo sediment management decisions based on TN essentially leads you down a path not helpful to environment (nor people)*.

It's my understanding that TN contained in typical stream bank sediments which are protected from erosion by stream geomorphic restoration projects are also in non-bioavailable forms. I suspect that Bay Program stream restoration protocols still over-credit N load reductions for certain stream geomorphic restoration projects (particularly NCD), although present protocols (~2020) are improved on this over initial protocols (~2010).

Conversely, dissolved forms of N are highly bioavailable and should be given priority consideration.

3 TP is also problematic, although less so. Bay-centric wise, P adsorbed to sediments/contained in particulate matter doesn't become bioavailable typically until bottom water conditions are hypoxic/anoxic, and also salinity > ~3 ppt. My understanding is that TP in sediment/particulate matter in freshwaters is poorly bioavailable unless hypoxic/anoxic also.

There's also substantial differences in TP content of saprolite vs floodplain sediments (and I think also historic vs modern floodplain sediments). Thus, requiring representative TP samples is important for proper crediting. I think this has been corrected in ~2020 protocols (vs ~2010 protocols).

Again, dissolved forms of P are highly bioavailable and should be given priority consideration.

Thanks,

Chris Spaur

Project Manager
Maryland South Section
Baltimore District, Regulatory Branch
443 759-0680 (m)
Regulatory Permitting 814-235-1763

*USACE and multiple agency partners - Lower Susquehanna River Watershed Assessment, 2015

Slide #/ 19, Title	Comment	Implication
3, Holistic Approach	To my knowledge we haven't yet developed a hydrology indicator that fairly represents altered flow impacts on aquatic life (?)	Clarify whether this effort dependent upon other future separate indicator development (?)
8 **Select Physicochemical Stream Assessment Literature**	The Chesapeake Bay Model and presumably TMDLs have categories/characterizations of water pollutants that are perhaps comparable to indexes or could be converted into them (?)	Consider if appropriate. One potential example. Chesapeake Bay Model subdivides N and P sources/species based on labile vs refractory
12, **Example Physicochemical Parameters**	Should this clarify streambed versus water column pollutants?	Could include both, clarify movement of pollutants between water column and streambed?
12, **Example Physicochemical Parameters**	TN, and perhaps other chemical, parameters poorly align with environmental impacts of concern	TN is a poor metric because it lumps labile and refractory forms of N. Stream bank sediments can have high TN, but most of that is refractory (not bioavailable). Need to select meaningful indicators that strongly associate with environmental effects of concern.
14, **Preliminary List of Potential Indicators**	Select forms of parameters that strongly align with stream biotic health or receiving water body health (down to Chesapeake Bay, as sensible)	Dissolved forms of N and P vastly different environmental impacts than those in particulate forms. Accordingly TN and TP that lump refractory and labile misrepresent stressors

Mark Southerland
Tetra Tech
September 29, 2025 with comments 6Oct2025
CBP GIT#1 Physicochemical Indicators

Minutes from Presentation of Draft Recommendations and Data Matrix to Stream Health Work Group (SHWG) on 26Sep2025

Attendees:

Staten, Nick, SHWG Coordinator
Alison Santoro, MD DNR and SHWG Co-chair
Southerland, Mark, Tetra Tech
Vailati, Gabriella, DE DNREC
Mckercher, Elizabeth, VDEQ
Reggi, Brock, DEQ
Zuknick, Gregory, EA
Noe, Gregory, USGS
Maggie Woodward, Ches Bay
Hobaugh, Paige, Tetra Tech
Davis, Cassandra M, NYS DEC
Roth, Nancy, Tetra Tech
Portner, Aerin, VDEQ
Sara Weglein, MD DNR and SHWG Co-Chair
Cashman, Matthew J, UGSG
Davis, Sandra, USFWS CBO
Maloney, Kelly O, USGS
Coffey, Rory, Tetra Tech
Metes, Marina J, USGS
Brownson, Katherine, USFS
Kyle Hodgson, MD DNR
Lydia Brinkley, Upper Susquehanna Coalition
Kristin Saunders, MD DNR
Fanelli, Rosemary M, USGS
Chris Spaur, USACE
Ahmed, Labeeb, USGS CBPO
Meeting Guest (Unverified)
Anne Hairston-Strang. MD DNR
Denise Clearwater, MDE

5. As CBP lead for the project, Santoro welcomed the group and turned it over to Southerland for presentation of Draft Recommendations and Data Matrix for Physicochemical Indicators project (Phase 3B).

6. Southerland presented the Power Point.

7. Southerland listed the next steps below and asked for additional comments by September 30. Staten send the presentation to the attendees and will post it on the SHWG website.
    - Data Matrix and Recommendations for Further Indicator Evaluation submitted on September 3
    - Presentation to SHWG on September 26
    - **Comments by September 30**
    - Draft Report to SHWG October 31
    - Final Report and Factsheet due January 31, 2026

8. Southerland responded to the following comments and questions live and via chat:

    - Fanelli – How representative are the sites with co-located data from all WQ indicators compared to the land use distribution/geological settings across the watershed?

Hobaugh said that we had not looked at that but would in next step.

    - Saunders – Is the Chesapeake Healthy Watersheds Assessment part of the existing frameworks you plan to use? I can't remember if it shows up on the DataHub yet or if you mentioned it in your slides. The HWA was used in the previous indicator assessment for hydromorphology metrics

Southerland said we had reviewed Healthy Watershed indicators but will reevaluate their utility.

    - Clearwater and Spaur – Is specific conductance adequate to characterize road salt loadings? vs individual ions (Cl, K, etc.). Thresholds vary within state borders based on ecoregion

Southerland agreed that conductivity tells a different story in different situations. Conductivity was chosen because it was the most commonly sampled parameter but we will look to see what individual ions are also sampled.

    - Cashman and Staten – Thresholds are probably the most challenging aspect of physicochemical indicators and will require discussion/debate within the community to come to consensus. EPA and other thresholds currently available vary considerably and can dramatically change stream health ratings. This variation in thresholds was seen in the

presentations by states in the last SHWG meeting on BSID. Big jurisdictional differences in potential thresholds is one of the issues for harmonization and making a single metric for the watershed. NYS has released draft guidance values for TP: https://dec.ny.gov/environmental-protection/water/water-quality/standards-classifications/nutrient-...

Coffey agreed that this is critical aspect of the project for which we can only provide citations and recommendations. Santoro described another grant-funded project with Breck Sullivan that will result in a multi-day workshop led by Matt Baker to help further this discussion.

- Noe – Does the spatial distribution table mean that only one site may occur in HUC to be recorded?

Coffey and Hobaugh confirmed that this may reflect only one site but all sites will have multiple samples.

- Fanelli and Cashman– Also related to road salt, I also wonder about how single measures of SC may/may not capture winter inputs. Do any of your datasets include routine/repeated sampling that can be used to generate summary metrics for these indicators? For example, mean annual SC, mean annual N? This would be especially important for temperature and characterizing WQ values relative to chronic vs. acute thresholds.

Southerland noted that Living Resources dataset included non-target timed sampling because it is conducted along with biological surveys; in contrast Nontidal WQ dataset is more likely to include multiple/targeted sampling. He agreed to compare the results of higher-frequency vs single samples to illustrate this effect.

- Hairston-Strang – How can this project be used by local jurisdictions to inform development decisions?

Southerland reflected on past use of stressor-biological correlations to inform land use and zoning but agreed that including land use in our Model Case would be informative. MBSS includes both biological and land use data for each sampling site. Santoro said that the 2026 workshop referenced earlier would also include discussion of how these indicator products can be useful for local jurisdictions.

- Saunders and Fanelli and Maloney– Also, during the August 28 STAR meeting at the Bay Program, there was a presentation: Tracking Status and Trends in Seven Key Indicators of River and Stream Condition in the Chesapeake Bay Watershed – Rosemary Fanelli (USGS), Lindsey Boyle (USGS) and Marissa Cassell (USGS). I think some folks are on this call in fact. It would be good to make sure this effort and that effort are connected to the extent people

are not aware of the USGS work. USGS is not looking at all of these indicators (DO, and pH for example) in the USGS effort, so the efforts are definitely complementary.
USGS has a slot on the Oct (or future) call to present some of these efforts and our modeling efforts to you all for input/feedback to see what we are doing/have and to help guide our future efforts.
https://www.chesapeakebay.net/files/documents/STAR_StatusandTrends_8.28.25.pdf

- Staten – What are the 12 total ecoregions? And are these based on Ecoregion Level III? I know there can be a little tiny overlap for some depending on watershed boundary definitions, but looking at a map I'm having trouble getting to 12.

Hobaugh confirmed that Ecoregion Level III was used and also that there are three that comprise a very small amount of area, which may explain why not all ecoregions had samples (58 Northeastern Highlands in a tiny area west of Reading PA but which drains to Susquehanna)

- Noe – Since TN and TP are catchalls for various nutrient constituents that have varying effects on biology, it would be more meaningful to use the constituents (e.g., nitrate and ammonium instead of TN and dissolved orthophosphate instead of TP).

Southerland agreed that constituents are preferable and will look at what is in the DataHub. Regardless, a recommendation will be included.

9. Comments Received Outside SHWG meeting

From: Spaur, Christopher C CIV USARMY CENAB (USA) <Christopher.C.Spaur@usace.army.mil>
Sent: Thursday, September 25, 2025 9:29 AM

I'm puzzled that there's no potential flow indicator metrics identified. Even if there's not indicator metrics, there's certainly flow recommendations that could perhaps be referenced at this time (?). For example, attached TNC 2010 report has flow recommendations USACE has utilized to plan water releases in PA projects. Presumably there are other such documents from USGS and others (?).

Side note. Although not sure that it fits current efforts (which seem to be just water quality and flow), I remain concerned over TN and TP metrics being used for sediments/soils. My understanding is that these combine bioavailable and non-bioavailable forms of N and P (don't discriminate between refractory and labile). We may be badly misrepresenting load reductions and thus incentivizing projects that might not otherwise be constructed. I think this is a national scale problem (USGS, USEPA, etc.).

Ecosystem Flow Recommendations for the Susquehanna River Basin
November 2010

Report prepared by The Nature Conservancy
Michele DePhilip
Tara Moberg

The Nature Conservancy
2101 N. Front St
Building #1, Suite 200
Harrisburg, PA 17110
Phone: (717) 232-6001
E-mail: Michele DePhilip, mdephilip@tnc.org

Southerland -- Good points Chris.

We have included “flow” in our recommended indicators for completeness but feel that it is an oddball that really falls between the hydromorphology project and this physicochemical project. Instream flow was the only metric with good geographic coverage in DataHub but, as you point out, there is a lot more to flow and stream health. We see it as a larger development project than addressing the other water quality metrics.

Similarly, you are right that TN and TP in sediment/soils is an important issue for restoration incentivization, but also something beyond our focus on in water parameters.
From: Heidel, Scott <scheidel@pa.gov>
Sent: Tuesday, September 30, 2025 2:36 PM
To: Staten, Nick <staten.nick@epa.gov>
Cc: Miller, Natahnee <natamiller@pa.gov>; dushull@pa.gov; Trostle, Tyler <tytrostle@pa.gov>; Hullinger, Ashley <ahullinger@pa.gov>; Lancaster, John <johlancast@pa.gov>
Subject: FW: [External] FW: Latest PP on Physicochemical Indicators

Hi Nick,

Here are PA DEP’s comments:

- PA DEP assessment data should be used as a part of this analysis as it is thorough and covers all parameter being investigated within a critically important part of the watershed.
- Why didn't they include anything from PA DEP in their interviews and literature search?
- PA DEP has already created a Water Quality Index (SRBC has too) and it was published in a scientific journal.
    - DEP WQI paper: https://esajournals.onlinelibrary.wiley.com/doi/10.1002/ecs2.2947
    - DEP WQI Resource: https://fweco.shinyapps.io/padep_wqi_UI/
    - SRBC WQI Resource: https://www.srbc.gov/portals/water-quality-projects/water-quality-index/
- This should be expanded to include PA's larger Water Quality Network (standard and reference stations) in the CB watershed.

Thank you very much,
Scott

Scott N Heidel | Environmental Group Manager | Chesapeake Bay Partnership Section
Pennsylvania Department of Environmental Protection
Bureau of Watershed Restoration and Nonpoint Source Management
Rachel Carson State Office Building
400 Market Street | Harrisburg, PA 17101-2301
From: Denise Clearwater -MDE- <denise.clearwater@maryland.gov>
Sent: Monday, October 6, 2025 10:21 AM

Hi Mark,

I received a belated correction to a statement in the document about MD not having turbidity criteria. In fact, MD does have turbidity criteria (COMAR 26.08.02.03-3) but it is relatively high and arguable not the most protective for nontidal streams.

Denise

Mark Southerland
Tetra Tech
January 14, 2026
CBP GIT#1 Physicochemical Indicators

Minutes from Presentation of Draft Report to Stream Health Work Group (SHWG) on 19Dec2025 with Additional Comments post-meeting and from MWMC on 20Nov2025

Attendees:

Staten, Nick, SHWG Coordinator
Santoro, Alison, MD DNR and SHWG Co-chair
Weglein, Sara, MD DNR and SHWG Co-Chair
Southerland, Mark, Tetra Tech
McKercher, Elizabeth, VDEQ
Noe, Gregory, USGS
Woodward, Maggie, Ches Bay
Davis, Cassandra M, NYS DEC
Roth, Nancy, Tetra Tech
Cashman, Matthew J, UGSG
Maloney, Kelly O, USGS
Coffey, Rory, Tetra Tech
Metes, Marina J, USGS
Hodgson, Kyle, MD DNR
Fanelli, Rosemary M, USGS
Spaur, Chris, USACE
Ahmed, Labeeb, USGS CBPO
Hairston-Strang, Anne, MD DNR
Clearwater, Denise, MDE
Buchanan, Claire, ICPRB
Young, Emily, ICPRB
Jepsen, Rikke, ICPRB
Boyle, Lindsey, USGS
Kiser, Alexander H
Claggett, Peter, USGS CBPO
Meyers, Matthew, Fairfax County
Cassell, Marissa
Bourassa, Renee
Robinson, Matthew, CBP
Vailati, Gabriella, DNREC
Sturgis, Brittany, DNREC
Clifton, Zachary
McCauley, Martha
Drescher, Sadie, CBT
Moncion, Serena
McClaugherty, Megan
Guy, Chris
Heidel, Scott
Heyer, Kristen
Lookenbill, Michael (Josh)
Abdu, Mimi
Carol Cain, Carol, DNR
Brownson, Katherine, USFS

10. After SHWG updates and presentations by USGS and ICPRB, Santoro turned the meeting over to Southerland for presentation of Draft Report for Physicochemical Indicators project (Phase 3B).

11. Southerland presented the Power Point. The Power Point and Draft Report were provided to SHWG by Staten.

12. Southerland thanked all the participants that helped with the project and requested comments by December 26, 2025. Final Report and Factsheet are due to SHWG and CBT by January 31, 2026

13. Chris Spaur, USACE, asked if water quality procedures fairly exclude forms of N and P that are non-bioavailable in streams? Such as N in leaf litter or P strongly adsorbed to sediments. (From Bay-centric perspective, P adsorbed to sediments becomes bioavailable in hypoxic settings >~2 or 3 ppt salinity. Not the same for streams!)

Southerland and Coffey said that they recognized that dissolved forms are more appropriate, but the total forms were more consistently available in Chesapeake Bay DataHub and were used in the Model Case. Narrative in the final report will note that while most regulatory programs rely on total nutrient measurements, bioavailable forms are more ecologically relevant.

14. Anne Hairston-Strang, MD Forest Service, asked for any insights on which BMPs could bridge the gap in response seen between WQI and BIBI, i.e., reduce those additional stressors.

Southerland said that it would take additional research on stressor identification and BMP performance to answer that question. He noted that the latest evidence on salt in BMPs indicates salt may release contaminants that the BMPs are designed to retain.

15. Previous comments received when presentation was given at MWMC on 20Nov2025 are below:

- Steve Nelson, WSSC, was interested in the dashboard approach to get physicochemical information out
- Renee Thompson, ICPRB, asked that we don't forget the lessons of healthy watersheds, especially the importance of addressing sediment transfer
- Unknown person from PA gave an example of moving beyond simple measurement of a parameter to values that better reflect ecological effects
- Unknown person agreed that temperature and flow are tricky parameters unless transformed for when measurements taken
- Matt Hedin, Coastal Resources, really likes WQI to communicate rather than individual parameters. He was also curious to see what parameters are responsible for the differences between WQI and Chessie BIBI.

These comments will be incorporated into the final report where appropriate.

16. Subsequent comments received from SHWG participants after 19Dec2025 presentation:

- ICPRB provided comments on the draft report and recommended expanding discussion of state BSID approaches and data
- USGS provided comments on the draft report and several additional references
- Chris Spaur of USACE elaborated on his concern that "water quality procedures fairly exclude forms of N and P that are non-bioavailable in streams" in his email below:

Big picture. While report is focused on water quality, taking a tangent to interlink this with sediments/soils to seek to ensure management decisions adequately consider bioavailability.

*With respect to riverine sediments/soils, use of TN and TP metrics is problematic for managing eutrophication in that sediments/soils include substantial poorly-bioavailable (recalcitrant) forms. In rivers themselves, TP bound to fine sediment/soils can become bioavailable in hyporheic zone or hypoxic waters. Otherwise, on coarser particles in oxygenated waters, TP poorly bioavailable (?). My understanding is that TN contained in particulate matter of sediments/soils is poorly-bioavailable generally. This poorly-bioavailable situation was to my understanding not adequately captured in initial Bay Program stream restoration BMP protocols, and unfortunately probably induced/incentivized stream restoration BMPs because of over-crediting based on erroneous equivalency of recalcitrant and labile nutrient forms. Hopefully the ~2020 reworked protocols have corrected this (?) and society is now getting fair benefits consideration.**

It's important that our N and P metrics fairly capture bioavailability, whether of water or sediment/soil, to help society make the best BMP decisions. Perhaps the TN and TP water quality assessment methods already do this fairly (?). However, based on above concerns, it's worth scrutinizing this and as appropriate adjusting metrics to fairly credit.

*Of great importance for public communication, we should clarify how water quality TN and TP methods differ from soils/sediment TN and TP. Otherwise, members of public hearing about TN, TP load reductions from sediment/soil stabilization equate that with efforts to reduce TN, TP loads in waters.** Simplistic conclusion unfortunately drawn is that stream bank/channel stabilization is inherently good because of reduced TN and TP loads that result. Why worry about reducing loads from stormwater or agriculture when you can produce that result more feasibly by just stabilizing channels and banks?*

Chris Spaur

These comments will be incorporated into the final report where appropriate.