# CLIMATE CHANGE AND THE CWA 303(d) PROGRAM

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**PRACTICES AND IDEAS FROM**
**CONVERSATIONS AMONG STATE, TERRITORIAL, AND TRIBAL STAFF**

ENVIRONMENTAL LAW • INSTITUTE®

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# I. Introduction

In 2021 and 2022, the Environmental Law Institute (ELI) hosted three workshops that, at least in part, addressed how States, Territories, and Tribes have considered and could consider climate change in CWA 303(d) listing, TMDL development, TMDL implementation, and related activities and products. This document is a brief summary of the practices and ideas conveyed in those forums. Most of the information included here originated from registration responses and in-session discussions of State, Territorial, and Tribal staff [hereinafter "staff"] as part of the *2021 National CWA 303(d) and Data Management Training Workshop*, as well as presentations and discussions in the *Climate Change and the CWA 303(d) Program: Opportunities for Progress* workshop and *2022 National Training Workshop on Water Quality Data, Assessment, and Plans*, each of which was convened by ELI through a cooperative agreement with the U.S. Environmental Protection Agency (EPA). Follow-up conversations and independent literature reviews by ELI staff supplement that material.

The information provided here is not intended to be comprehensive. It is intended to facilitate communication among water quality programs, especially CWA 303(d) programs, and help generate new ideas in this evolving area. With the 2022 CWA 303(d) Program Vision's focus on climate change,[1] this is an opportune time to consider more thoroughly how to account for the impacts of climate change in CWA 303(d) Program activities and products as well as include it in communications and collaborations with other programs and stakeholders.

# II. TMDL Development

Climate change introduces additional uncertainties to the data-based assumptions in TMDLs concerning hydrologic scenarios and influences on the pollutant being addressed. Staff suggested that TMDLs and implementation approaches be revisited and evaluated more often, specifically to account for any short- to medium-term climate change impacts. They recommended proactively evaluating how baseline and critical conditions change, and then revising the TMDLs as needed.

Staff also identified ways in which TMDLs can be developed to be more accurate and effective in the face of climate change. Some of them noted the value of expressly acknowledging the effects that climate change has had, and likely will continue to have, on various factors influencing the impairment. For example, Michigan's Statewide *E. coli* TMDL, in a section titled "Planning for Future Change," outlines potential impacts of climate change on *E. coli* concentrations through warmer water temperatures, lower base flows during the summer, extremely high flows following storm events, and a longer agricultural season.[2] Identifying these variables influenced the approaches for sustainable restoration recommended in the TMDL document, such as increasing capacity to infiltrate storm water and preserving the integrity of vegetated riparian buffers as agriculture moves further north.

[1] *See,* www.epa.gov/tmdl/vision.

[2] MICH. DEP'T OF ENV'T, GREAT LAKES, AND ENERGY, MICHIGAN'S STATEWIDE *E. COLI* TOTAL MAXIMUM DAILY LOAD, 84 (July 2019) https://www.michigan.gov/egle/about/organization/water-resources/tmdls/statewide-e-coli-tmdl.

Some staff referenced the use of models to better understand and consider climate change factors. For example, the Minnesota Pollution Control Agency has incorporated datasets on climate trends and future projections into Hydrological Simulation Program – FORTRAN (HSPF) model applications. HSPF was used in developing the Cloquet River Watershed Restoration and Protection Strategy Report (specifically Section 2.4.4), to assess potential changes in flow, sediment and nutrient loading, and water temperature under four different climate change simulations. On the HUC8 watershed level, the simulations showed increases to nutrient loading and water temperature in streams and variable changes to flow and sediment loading. The Chesapeake Bay Program developed precipitation projections that can be viewed at a local scale and extend out, in ten-year intervals, to 2055. The objective of the projections is to produce more accurate allocation determinations going forward, first for the assessment of 2025 climate change impacts on the Chesapeake Bay TMDL and then to look beyond 2025 to see where the Chesapeake Bay Program is heading w/ respect to climate change challenges. The Chesapeake Bay Program views better precipitation volume projections, combined with precipitation intensity, temperature, and sea level rise projections, as helping to better guide decision-making to ensure that the Chesapeake Bay meets, and continues to meet, its water quality standards. Models also have been used to more accurately forecast the effects of climate change on specific resources. For example, the Fond du Lac Band of Lake Superior Chippewa has partnered with the University of Minnesota to develop climate change models, at the watershed level, that can be used to predict impacts to wild rice waters in the Upper Great Lakes region.

With climate change affecting flow conditions and increasing the frequency of extreme events, both dry and wet, estimates of representative flows used in wasteload allocation (WLA) and load allocation (LA) calculations can be challenging. In some cases, historic climate data may not accurately represent current or near future climate conditions. Staff from Wisconsin suggested using the most recent and representative data that matches potential climate projections for the region. They also recommended, for TMDL development that relies on continuous simulation models, selecting the most current available climate data with considerations for critical flow conditions, including wet, dry, and average years. In addition, Wisconsin staff proposed considering specific rainfall events within the selected climate record and how those events impact the overall predictions. They also noted that other methods, such as synthetic climate files, can be difficult to create, and that watershed and water quality models can only be calibrated and validated using actual climate data and not synthetic datasets. They emphasized the importance of ensuring that the model is accurately predicting results at the extremes, wet and dry. They added that, if the model calibration and validation process reveals that the model is unable to simulate the "extreme" dry or wet conditions, then the model will be unlikely to provide accurate representations under future climates projections.

Some staff have accounted for climate-induced flow variations when calculating WLAs and LAs by using flow duration curves with wider flow ranges. Flow duration curves portray the cumulative frequency of historic flow data over a particular period of time, relating flow values to the percent of time that those values have been met or exceeded.[3] Flow duration curves can help visualize the frequency and severity of disruptions, such as droughts and big storms, as well as the timing and size of stream flow, enabling improved assessments of a stream's full range of possible flow conditions. A few staff suggested that using these expanded flow ranges for load duration curves, which are visual representations of the relationship between streamflow and loading capacity, can aid load reduction decision-making.

Even in circumstances informed by the best data, models, and other analytical tools, uncertainty remains an inherent element of the TMDL development process. The key pieces of a TMDL may be able to evaluate and express uncertainty associated with climate change. For example, Tetra Tech staff suggested using climate change scenarios to create upper and lower LA and WLA bounds, and to calculate a TMDL's Margin of Safety (MOS).[4] Staff from a few jurisdictions expressed curiosity as to the role that MOS could play in reflecting variability and uncertainty due to climate change, and similar questions were asked about reserve capacity, the amount of allowed load set aside for future growth and development.[5] Focusing specifically on LAs, a few staff highlighted the value that climate models can play in reasonable assurance demonstrations, including justifications for the allocation and demonstrating that the best management practices (BMPs) are expected to be sufficient under current and future conditions.

# III. CWA 303(d) Listing and IR Categorization

Practices and ideas regarding the inclusion of climate change considerations into CWA 303(d) listing and Integrated Report (IR) categorization decisions have been more limited than in other aspects of the CWA process. Some staff referred to climate change projections and modeling scenarios as potentially having a role in IR categorization and offering insights into where impairments are likely to emerge; for example, how changes in precipitation will impact flow and potentially lead to future impairments. Also, staff recommended that the EPA offer more guidance and resources, where possible, especially more direction on and examples of listing methods and strategies for waters for which changes in climate are the sole or primary source of impairment.

# IV. Monitoring, Data Collection, and Data Analysis

In addition to the information challenges identified above, staff noted various obstacles to the monitoring, data collection, and data analysis necessary to connect climate change and water quality. Identified obstacles included a lack of watershed-level data, limited access to long-term monitoring resources, limited access to and experience with climate modeling tools, and uncertainties about pollutant interactions and the cumulative impacts of climate change.

[3] U.S. Envtl. Prot. Agency, An Approach for Using Load Duration Curves in the Development of TMDLs, 1 (Aug. 2007) https://www.epa.gov/sites/default/files/2015-07/documents/2007_08_23_tmdl_duration_curve_guide_aug2007.pdf.
[4] Hope Herron, Climate Change and TMDLs, slide 25 (July 31, 2017) https://www.chesapeakebay.net/channel_files/25339/herron_presentation_revised.pdf.
[5] U.S. Envtl. Prot. Agency, Watershed Academy Web: Introduction to the Clean Water Act, https://cfpub.epa.gov/watertrain/moduleFrame.cfm?parent_object_id=2717.

Staff noted that more inter- and intra-jurisdictional collaboration in data collection and assessment could improve understanding of how climate change is affecting water quality. The Treaty Tribes in Western Washington specifically highlighted the effect on modeling, noting that expanded networks that directly measure key climate variables, such as precipitation and air temperature, are important for calibrating regionally downscaled models.[6]

One successful approach that staff noted is participation in Regional Monitoring Networks, which aggregate and supplement current data collection efforts. Through such a collaboration, the Fond du Lac Band of Lake Superior Chippewa deployed a phenocam at Joe Martin Lake, chosen as a reference for climate change and National Aquatic Resource Surveys, to record the lake's ice-on and ice-off dates each year.[7] Staff from the Red Lake Band of Chippewa noted that they have been using Regional Monitoring Network protocols for two lake and two stream sites, collecting lake evaporation measurements during ice-free periods and measuring indicators like net solar radiation, temperature, humidity, wind speed, and wind direction. Pooling these data improves the ability to detect trends over shorter time periods and provides a better understanding of the effects of changing climate and how to respond to it.[8]

Staff from a few Western States suggested better collaboration with colleagues working on water quantity issues to improve their understanding of and responses to variations in flow volume and timing. Staff from Pennsylvania highlighted the promise of citizen science for expanding the pool of sources from which water quality programs can pull data, building trust, and engaging communities, ultimately facilitating more effective and flexible governance of shared resources that often are difficult to regulate. Also, staff from numerous jurisdictions called on the EPA and the Association of Clean Water Administrators to facilitate easier exchanges of data so that staff can learn from the efforts of other States, Territories, and Tribes with whom they are not in regular contact.

In addition to the importance of recent data for things like more accurately projecting loading capacity into the future, staff highlighted the value of datasets with longer timespans for better understanding the changes attributable to climate. For example, Maine lakes are managed for trophic state, and those monitoring data, collected over the last 50 years, have been used to evaluate the effects of climate change on the lakes. Minnesota's long-term stream flow and water quality monitoring programs produce data that help determine what and how much adaptation is needed. This includes its Sentinel Lakes Program, which uses temperature, water chemistry, water level, and water biology data from 25 lakes around the State to gain a better understanding of the biological, chemical, and physical processes occurring in all of the State's lakes. Minnesota staff also engage in long-term monitoring of biology in rivers and streams to distinguish between changes due to climate change as opposed to other local watershed

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[6] NORTHWEST INDIAN FISHERIES COMMISSION, CLIMATE CHANGE AND OUR NATURAL RESOURCES: A REPORT FROM THE TREATY TRIBES IN WESTERN WASHINGTON, 56 (Nov. 2016) https://nwifc.org/w/wp-content/uploads/downloads/2017/01/CC_and_Our_NR_Report_2016-1.pdf.

[7] FOND DU LAC ENVTL. PROGRAM, FOND DU LAC RESERVATION NONPOINT SOURCE ASSESSMENT REPORT, 78 (Feb. 2021) https://www.fdlrez.com/RM/downloads/NPSAssessmentReport2021.pdf.

[8] U.S. Envtl. Prot. Agency, Regional Monitoring Networks (RMNs) to Detect Changing Baselines in Freshwater Wadeable Streams, https://www.epa.gov/sites/default/files/2018-01/documents/rmn_science_in_action_factsheet_02_25_16-update-29jan18.pdf.

disturbances. Staff from several jurisdictions indicated that they look to the U.S. Geological Survey (USGS) for more long-term monitoring resources. Staff from one State added that, in States that lack support for climate change adaptation, USGS data are all the more vital, and are even favored over State data by many stakeholder groups involved in water quality management efforts.

These advances in data collection and sharing could help with another area of staff interest: learning more about the interactions and cumulative impacts of different pollutants as a result of climate change. Staff referencing this under-explored area were primarily focused on the relationships between temperature, dissolved oxygen, and nutrients, like warmer water temperatures reducing dissolved oxygen concentrations while exacerbating algal blooms, further reducing dissolved oxygen concentrations. Staff also noted a need to develop better methods of distinguishing causes of impairment that are significantly influenced by climate change, such as water temperature, and those that are less influenced by climate change.

Because of the positive correlation between warmer water and more prevalent harmful algal blooms (HABs), some staff recommended that lake assessment methods include more climate change parameters and HABs surveys. The Skokomish Tribe monitored and assessed the influence of weather impacts on HABs as part of a 2020 study of warming waters as a component of complex environmental factors driving HABs and the associated impacts that HABs have on Tribal Nations. Relatedly, the Colorado Department of Public Health and Environment is prepared to support local entities and State Parks and Wildlife counterparts with HABs testing in May now instead of July, having noticed blooms occurring earlier in the summer.

# V. Restoration, Protection, and Adaptation Strategies

The examples below highlight how some jurisdictions are addressing impacts of climate change through TMDL implementation, nonpoint source management plans, and BMPs.

### *Flow Volumes*

Climate change can contribute to alterations in the usual timing and quantity of flows, including disruptions in precipitation patterns, earlier and faster snowmelt, and more intense storm events. Staff from Minnesota referenced increased baseflow, heavier rainfall, and more intense storm events that cause stream bank erosion, increase flooding, and increase pollutant runoff. Staff from New Mexico spoke of drought and decreased stream flow that increases pollutant concentration as dilution capacity drops. Staff from Maine noted that, during drought years, some perennial waters have become intermittent. These are just some of the changes mentioned.

The consequences of these flow changes for water quality criteria and designated uses vary. For example, greater rainfall and surface water flows have threatened Manoomin, a wild rice species with cultural, spiritual, medicinal, and culinary significance to the Chippewa people. In response, the Fond du Lac Band of Lake Superior Chippewa have been collaborating with the Minnesota Department of Natural Resources to implement winter drawdowns that maintain shallow water depths and protect the plants from flooding.

To counteract the effects of more frequent and intense storm events in Wisconsin, dispersed infiltration and green infrastructure are being encouraged in urban areas. To promote more resilient infrastructure, recommendations are also being developed on how to augment NOAA Atlas 14 to account for changes in frequency and intensity of rainfall events until the updated NOAA Atlas 15 becomes available. For agricultural areas, the State is heavily promoting the use of cover crops, reduced tillage, and other management practices that promote infiltration and reduce soil and nutrient losses. Wisconsin staff noted that increasing the use of continuous vegetative cover can reduce runoff while also reducing agriculture's carbon footprint through reduced need for fertilizer applications and associated nitrous oxide emissions, while also increasing carbon storage in the soil.

Relatedly, Minnesota staff highlighted a few BMP recommendations for the implementation of Total Suspended Solids TMDLs, seeking to reduce sediment loading into the Minnesota River. These BMPs included crop residue management, buffer installment, water and sediment control basins, sediment traps, and the use of a two-stage ditch. The agency also suggested greater use of cover crops and perennial vegetation.

Michigan staff have contemplated periodic re-evaluation of BMP design criteria for storm events, given documented increases in storm intensity.

***Temperature***

Higher air temperatures can raise water temperatures, which can lead to algal blooms, lower levels of dissolved oxygen, loss of thermally sensitive aquatic species, waterbody shrinkage, and other impacts.[9]

To address temperature impairments, multiple States have used riparian buffers to shade the water. Conscientious of the impacts of climate change on the sources of shade being used, Michigan's 2015 Nonpoint Source Program Plan recommends that the composition of plants in vegetated BMPs be adapted as the climate warms to include more heat-tolerant species, like red maple, and fewer cold-adapted species, like sugar maple.[10]

In the Columbia River, efforts to protect and restore cold-water refuges (locations that migrating adult steelhead and salmon use to temporarily escape warm summer river temperatures) have included the restoration of stream vegetation, channel complexity, and floodplain function as well as source water exchanges and strategic dam releases to cool summer flows. The EPA's Columbia River Cold Water Refuges Plan suggests that this protection and restoration can be accomplished through State forest practices, Federal forest plans, TMDL implementation plans, watershed resource plans, salmon recovery plans, and regulatory plans for development to limit withdraws of water from and deforestation near these streams.[11]

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[9] U.S. Envtl. Prot. Agency, Watershed Academy Web: The Effect of Climate Change on Water Resources and Programs, https://cfpub.epa.gov/watertrain/moduleFrame.cfm?parent_object_id=2456&object_id=2459.
[10] MICH. DEP'T OF ENVTL. QUALITY, 2015 NONPOINT SOURCE PROGRAM PLAN (2015).
[11] U.S. ENVTL. PROT. AGENCY REGION 10, COLUMBIA RIVER COLD WATER REFUGES PLAN, 183-185 (Jan. 2021) https://www.epa.gov/sites/default/files/2021-01/documents/columbia-river-cwr-plan-final-2021.pdf.

The Treaty Tribes in Western Washington are considering a range of strategies to mitigate rising temperatures in their respective waterbodies, including reductions in water withdrawals during high temperature and low flow periods; modifying reservoir operations to control downstream flow and temperature; planting riparian vegetation and fencing to control grazing; and identifying and protecting thermal refuges, such as cold-water tributary confluences, groundwater inputs, and deep pools.[12]

To address stream vulnerability to climate change, Minnesota developed protection strategies starting with the Hydrological Simulation Program – FORTRAN (HSPF), projecting future climate conditions with a specific focus on maximum water temperatures in July. The State considered the stress and lethal temperatures for the native brook trout inhabiting their streams of concern. When comparing historical scenarios with a 2040 scenario, they saw that the projected increases in temperatures were causing more streams to approach the brook trout's lethal threshold. The state identified three streams that are projected to maintain the lowest in-stream temperatures and prioritized these streams for protection. To improve the microclimate and effective stream shade and to prepare for future climate change impacts, the state recommends protecting the floodplain and riparian corridor canopy and understory of these three streams.[13]

***Habitat Degradation***

Climate change can contribute to various types of habitat degradation. In addition to the impacts noted above, like low dissolved oxygen levels and dry streams, the effects of climate change on habitat also can include blown out stream channels and altered uplands.

Montana is restoring natural stream processes to improve water quality while providing additional co-benefits that mitigate floods, increase water storage, and bolster aquatic habitat resilience to climate change. For example, Ninemile Creek was channelized and disconnected from its flood plain due to historical mining practices. As a result, streambank erosion was accelerated, reducing habitat and increasing sedimentation. By reconnecting streamflows to the floodplain during spring runoff, groundwater contributions to the stream at baseflow have increased.[14] This information led to new partnerships with disaster mitigation agencies and leveraged funds from the CWA 319 Program as well as grants and other support from private, State, and Federal entities to fully reconstruct highly impacted reaches of the stream and increase cold water refuge/refugia for aquatic life.[15] Also, Montana's Nonpoint Source Management Plan identifies various impacts from climate change on water quality and recommends actions to address them, including projects that reconnect streams with their floodplains, increase drought

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[12] NORTHWEST INDIAN FISHERIES COMMISSION, *supra* note 6, at 48.

[13] *See*, MINN. POLLUTION CONTROL AGENCY & TETRA TECH, FINAL DULUTH URBAN AREA WATERSHED RESTORATION AND PROTECTION (2020) Final Duluth Urban Area Watershed Restoration and Protection Strategy Report (state.mn.us).

[14] *See, e.g.,* Christine M. Brissette, *Stream Restoration Effects on Hydraulic Exchange, Storage and Alluvial Aquifer Discharge*, Graduate Student Theses, Dissertations, & Professional Papers 10992 (2017).

[15] Entities that have supported the Ninemile Creek restoration include: the Federal Emergency Management Agency; Lolo National Forest; Montana Department of Natural Resources and Conservation; Montana Fish, Wildlife, and Parks; Ninemile Landowners; Missoula County; University of Montana; Big Sky Brewing; Turner Foundation; National Wildlife Federation; Northwestern Energy; Tiffany & Co.; River Design Group; and Geum Environmental.

resiliency, protect and restore wetland areas and cold-water refuges, and increase public awareness of water quality issues related to climate change.[16]

The Treaty Tribes in Western Washington are responding to a loss of connectivity by considering the removal of levees and bank armoring to reconnect floodplains. This process also might require the relocation of infrastructure, buildings, and/or agriculture out of the floodplain. While the Treaty Tribes recognize the possible financial and political challenges of these strategies, they assert that "the benefits of recreating functional floodplains often outweigh the heavy long-term costs of chronic flooding, levee repair, and loss of fish and wildlife."[17]

# VI. Conclusion

The effects of climate change are different in different parts of the country, and State, Territorial, and Tribal programs are different, from organization, to staff capacity, to access to information, to procedures, to challenges and priorities. Thus, approaches to incorporating climate change considerations into the work of the CWA 303(d) Program and related water quality efforts have been and will continue to be different. While universal answers will be rare, the upshot to this reality is that there will be much to learn from one another, including:

- How to expand data networks that directly measure key climate variables;
- Ways of selecting, using, and downscaling various models to incorporate climate projections in plans and decisions;
- Approaches to using IR subcategories to communicate water quality problems and the strategies being implemented to address them;
- How to reflect variability and uncertainty in a TMDL's margin of safety, load allocation, and wasteload allocation;
- Procedures for revisiting and evaluating TMDLs, implementation approaches, and BMP design criteria; and
- How implementation actions can mitigate and adapt to the impacts of climate change.

In addition, there are various ways in which the EPA can inform and otherwise aid these approaches, including resources, guidance, and facilitating communication about the approaches and their results among programs across the country. There is much work to be done at all levels, but it has begun.

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[16] MONT. DEP'T OF ENVTL. QUALITY, 2017 MONTANA NONPOINT SOURCE MANAGEMENT PLAN, 3-21 to 3-22 (2017) https://deq.mt.gov/files/Water/WPB/Nonpoint/Publications/Annual%20Reports/2017NPSManagementPlanFinal.pdf

[17] NORTHWEST INDIAN FISHERIES COMMISSION, *supra* note 6, at 49.