NC Division of Water Resources

1,4-Dioxane and Bromide Monitoring Plan

In Support of NFWF-Funded Project ID #8020.16.054182

Water Sciences Section
3-28-2017

Background

1,4-Dioxane

1,4-dioxane is an organic compound that readily dissolves in water at all concentrations, is persistent in the environment, and is difficult to remove through standard water and wastewater treatment processes. It is used as an industrial solvent and formed as a byproduct of some industrial processes. The compound has been characterized as "likely to be carcinogenic to humans" and identified as a potential contaminant of concern in public drinking water by the United States Environmental Protection Agency (USEPA).

1,4-dioxane was recently monitored in selected finished drinking water supplies nationwide under the USEPA's Third Unregulated Contaminant Monitoring Rule (UCMR3). The USEPA uses UCMR studies to determine the extent of contamination and provide data for the consideration of new drinking water regulations. UCMR3 data indicated that finished drinking water from at least 23 large (serving > 10,000 people) utilities in North Carolina contained levels of 1,4-dioxane in excess of the NC calculated surface water criterion (0.35 µg/L) to protect human health. Nearly all of these utilities used surface water as their primary water source, and they were located in the Cape Fear, Neuse, and Yadkin River basins. Due to wide-spread presence of this constituent throughout the United States as identified through the UCMR3 study, it is possible that the USEPA will develop health-based standards for 1,4-dioxane in the future.

A North Carolina Division of Water Resources (NC DWR) study was conducted from 2014-2016 to monitor ambient concentrations of 1,4-dioxane in the Cape Fear River and its tributaries, and to identify potential sources of the contaminant. This study garnered media attention and was the focus of several news articles. In order to fully understand and identify the sources of 1,4-dioxane in NC, this study will be continued in the Cape Fear River basin and expanded into the other two river basins (Yadkin and Neuse) with UCMR3 1,4-dioxane results ≥ 0.35 µg/L in public drinking water.

Bromide

Bromide in surface water has been associated with industrial and agricultural chemicals and coal ash facilities. It is a health concern due to its contribution to the formation of trihalomethanes (THMs). THMs are disinfection byproducts (DBPs) resulting from chlorine disinfection treatment of drinking water. Several THMs are characterized by the USEPA as "likely to be carcinogenic to humans" or as having "suggestive evidence of carcinogenic potential" and are regulated under the federal Safe Drinking Water Act with Maximum Contaminant Levels (MCLs).

Based on quarterly DBP monitoring, the NC DWR Public Water Supply Section (PWS) has determined that approximately 20% (27 of 138) of NC drinking water systems that utilize surface water sources have elevated DBPs containing significant amounts of brominated trihalomethane compounds. Results from these facilities included at least one sample point at which ≥ 30% of DBPs were made up of brominated compounds and the amount of DBPs was ≥ 50% of the MCL.

Bromide samples have been collected by the NC DWR in conjunction with 1,4-dioxane sampling in the Cape Fear River basin. Expansion and continuation of this study will involve an additional 18 months of ambient and source identification monitoring throughout the state. Initially, this will be targeted

upstream of the NC public drinking water treatment facilities identified by PWS monitoring as experiencing elevated levels of brominated DBPs. Some of these facilities utilize multiple surface water sources and/or supply water to multiple municipalities.

Objective

The NC DWR Public Water Supply Section protects nearly 6000 public water systems within NC, serving the homes of approximately three-fourths of the state's population, as well as workplaces, schools, restaurants, and other public facilities. The NC DWR Water Sciences Section (WSS) will monitor bromide and 1,4-dioxane in selected surface waters used as public drinking water supply sources in order to provide data to assist the NC Department of Environmental Quality with proactively addressing areas of contamination. The long-term conservation outcome supported by these projects will be increased protection of surface water as a water supply resource and increased safety of North Carolina's drinking water.

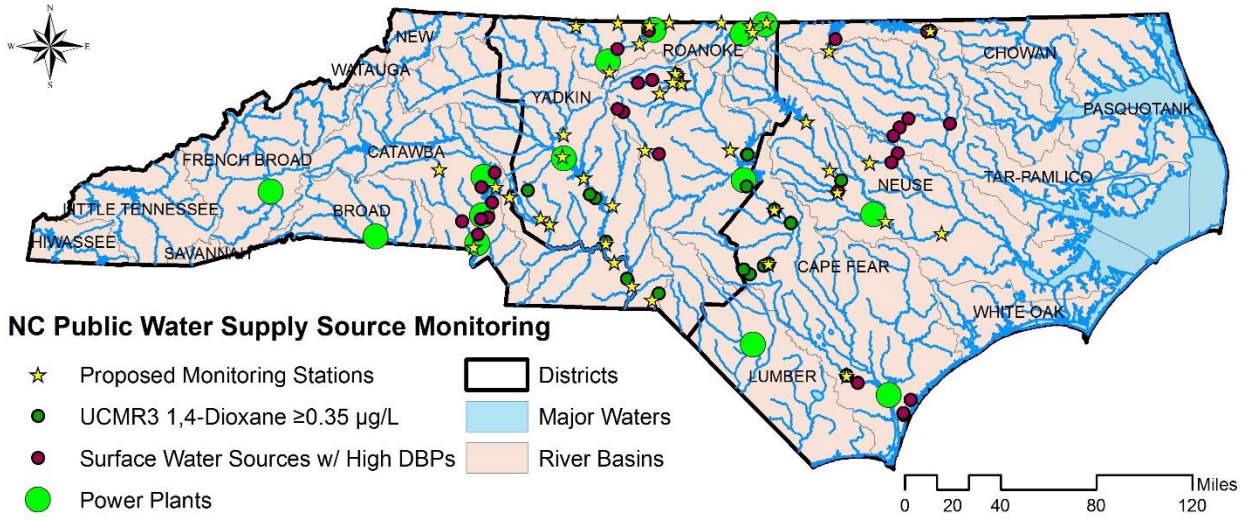
Activities

Samples will be collected in the same stream networks as public drinking water with elevated THM and/or 1,4-dioxane concentrations. Monitoring sites will be established at current ambient stations when possible, and additional stations will be established as needed to track sources. All samples will be collected as near-surface (i.e. 0.1-meter depth) grab samples, and will be analyzed for bromide and field parameters (pH, specific conductance, water temperature, and dissolved oxygen). Samples from stations in close proximity to power plants and/or public water treatment plants with elevated UCMR3 results will also be analyzed for 1,4-dioxane.

Sampling will occur monthly for 18 months during 2017-2018 at the stream stations indicated in the map and table below, in accordance with methods described in North Carolina's Ambient Monitoring System (AMS) Quality Assurance Project Plan (QAPP) (NCDENR, 2014). Bromide sampling will also occur once during the project period at the two lake stations in the table, in accordance with the Ambient Lakes Monitoring Program (ALMP) QAPP (NCDENR, 2012). All samples will adhere to the NC DWR Laboratories' Sample Submittal Guidelines (DWR, 2016) and further instructions provided by the NC DWR Central Laboratory for bromide and 1,4-dioxane sample collection, processing, and preservation. Quality assurance (QA) samples, including duplicates, matrix spikes, and matrix spike duplicates will be collected per the QAPPs and laboratory guidance.

Station	Location	Basin	District	Parameter(s)	Issue(s)
B0210000	Haw River at SR 1561 Hub Mill Rd.	Cape Fear	Central	Both	2, 3
B0750000	South Buffalo Creek at SR 2821 at McLeansville	Cape Fear	Central	Both	2, 3
B0840000	Reedy Fork at NC-87 at Ossipee	Cape Fear	Central	Both	2, 3
B1	Haw River at SR 1712 (Brooks Bridge Rd)	Cape Fear	Central	Both	2, 3
B2100000	Haw River at SR 1713 near Bynum	Cape Fear	Central	Both	1, 2, 3
B4	Haw River at Troxler Mill Rd near Reidsville	Cape Fear	Central	Both	2, 3
B6	Reedy Fork at NC-61 near Ossipee	Cape Fear	Central	Both	2, 3
DAQBELEWS08	Belews Lake at NC 65	Roanoke	Central	Bromide	1, 3
N0150000	Dan River at NC 704 near Francisco	Roanoke	Central	Bromide	1, 3
N1400000	Mayo River at SR 1358 near Price	Roanoke	Central	Bromide	1, 3
N2300000	Dan River at SR 2150 near Wentworth	Roanoke	Central	Bromide	1, 3
N2430000	Smith River at SR 1714 near Eden	Roanoke	Central	Bromide	1, 3
N3000000	Dan River at SR 1761 near Mayfield	Roanoke	Central	Bromide	1
N3500000	Dan River at NC 57 at VA line at Milton	Roanoke	Central	Bromide	1
N4250000	Hyco River below dam near McGhees Mill	Roanoke	Central	Bromide	1
N4406000	Marlowe Creek at SR 1322 near Woodsdale	Roanoke	Central	Bromide	1
N4590000	Mayo Creek at SR 1501 near Bethel Hill	Roanoke	Central	Bromide	1
NCSU24	Hasketts Creek at WOW Road near Asheboro	Cape Fear	Central	Both	1, 2, 3
Q2810000	Yadkin River at US 64 at Yadkin College	Yadkin	Central	Both	1
Q4660000	Yadkin River at NC 150 near Spencer	Yadkin	Central	Both	1
Q6120000	Yadkin River at SR 1002 at High Rock	Yadkin	Central	Both	1, 2
Q6810000	Uwharrie River at NC 109 near Uwharrie	Yadkin	Central	Both	2
Q7150000	Pee Dee River at NC 731 near Shankle	Yadkin	Central	Both	1, 2
Q7330000	Rocky River at SR 2420 near Davidson	Yadkin	Central	Both	2
Q8090000	Irish Buffalo Creek at SR 1132 near Faggarts	Yadkin	Central	Both	2
Q8220000	Rocky River at SR 1006 near Concord	Yadkin	Central	Both	2
Q9400000	Pee Dee River at US 74 near Rockingham	Yadkin	Central	Both	2
Q9916000	Pee Dee River at NC 109 near Mangum	Yadkin	Central	Both	2
Q9940000	Marks Creek at SR 1812 near Hamlet	Yadkin	Central	Both	2
B6370000	Cape Fear River at US-401 at Lillington	Cape Fear	Eastern	Both	1, 2, 3
B7480000	Cape Fear River at Hoffer WTP intake at Fayetteville	Cape Fear	Eastern	Both	2, 3
B8	Cape Fear River at Harnett Cty Public Utilities intake	Cape Fear	Eastern	Both	1, 2, 3
B8350000	Cape Fear River at Lock 1 near Kelly	Cape Fear	Eastern	Both	2, 3
J1890000	Neuse River at SR 2000	Neuse	Eastern	Both	2, 3
J4370000	Neuse River at US 70 Business at Smithfield	Neuse	Eastern	Both	1, 2, 3
J4510000	Neuse River at NC 42 near Clayton	Neuse	Eastern	Both	2, 3
J5970000	Neuse River at SR 1915 near Goldsboro	Neuse	Eastern	Both	1, 2, 3
J6150000	Neuse River at NC 11 at Kinston	Neuse	Eastern	Both	1, 2, 3
J6740000	Contentnea Creek at NC 581 near Lucama	Neuse	Eastern	Bromide	3
N5000000	Nutbush Creek at SR 1317 near Henderson	Roanoke	Eastern	Bromide	3
N7300000	Roanoke River at NC 48 at Roanoke Rapids	Roanoke	Eastern	Bromide	3
C4380000	S. Fork Catawba River at NC 10 near Startown	Catawba	Western	Bromide	3
C7000000	S. Fork Catawba River at SR 2524 near S. Belmont	Catawba	Western	Bromide	1
DAQNORMAN08	Lake Norman at Reeds Creek	Catawba	Western	Bromide	1, 3

Note: Issue Types: 1 - Power Plant; 2 - WTP with 1,4-Dioxane; 3 - WTP with DBPs



During past 1,4-dioxane monitoring, a contract laboratory was utilized for analysis because the NC DWR Central Laboratory did not have the analytical testing capacity to measure this compound. Instrumentation improvements will enable the NC DWR to develop enhanced long-term data analysis and tracking capabilities for 1,4-dioxane, as well as other volatile contaminants that may be identified in the future. Through the acquisition of a gas chromatography mass spectrometer (GC-MS) with an automated purge-and-trap sample preparation system, the project will build the capacity of the WSS Organic Chemistry Branch to measure concentrations of 1,4-dioxane and other organic compounds in NC's waters. Additional funds will be utilized for the supplies and materials necessary to collect and analyze the samples described above.

Outcomes and Indicators

Laboratory instrumentation will be acquired, installed, and calibrated by June 2017. A sampling and analysis schedule for the 2017 sampling season will be established by June 2017, and sampling will begin by July 2017. Data will be compiled, subjected to a quality assurance process, and uploaded to the NC DWR water quality data management system on a quarterly basis during the period of sample collection and analysis.

All project-related sampling and analysis activities are expected to be completed within the project timeline below. The project schedule will be monitored by the project manager, and regular reports will be made to NFWF to confirm project progress.

Timeframe	Activities	Outcome(s)
September 2016 - June 2017	Acquisition of laboratory and field equipment and supplies; Installation and calibration of laboratory instrumentation	Instrumentation ready to analyze surface water samples; Sampling staff fully equipped for field collection
July 2017 - December 2018	Field sampling and preservation of selected NC surface waters (monthly; sampling may begin earlier depending upon staffing and analytical resources)	Surface water samples submitted to the NC DWR Central Laboratory for analysis in a timely manner
July 2017 - March 2019	Laboratory analysis and reporting of bromide (mg/L) and 1,4-dioxane (µg/L) concentrations	Quality-assured laboratory results for bromide and 1,4-dioxane in surface water are finalized
July 2017 - June 2019	Final data quality control steps and entry into WSS data management system conducted quarterly (or more frequently)	Quality-assured results for bromide and 1,4-dioxane are made available to NC DWR staff via the data management system
By June 30, 2019	Data formatted, summarized and provided to the NC Public Water Supply Section, and to other interested parties via summary report available on NC DWR website	The NC DWR Public Water Supply Section has the data necessary to make informed decisions about NC's drinking water in regard to bromide and 1,4-dioxane

Project Team

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References

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(NCDEQ) N.C. Department of Environmental Quality, Division of Water Resources, Water Sciences Section. 2016. Sample Submittal Guidelines – DWR Water Sciences Section Chemistry Laboratories. *Available as a link from* http://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/microbiology-inorganics-branch/sample-submission.