DELAWARE WATER RESOURCES CENTER
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UDWRC Director's Message

Drought is Drought and Flood is Flood, And Never the Twain Shall Meet

Dr. Gerald Joseph McAdams Kauffman, Jr.
Director
University of Delaware
Water Resources Center

"Oh, East is East, and West is West, and never the twain shall meet." Rudyard Kipling wrote this about colonialism and the state of world affairs in 1889, and one could apply it to the Russian invasion of Ukraine now. But in this case, we may apply it to the affairs of climate and water. While the West bakes in the worst drought in a millennium, the East has been deluged by the floods of Ida, the worst in two centuries along the Brandywine in Delaware and Pennsylvania. While drought and flood are at opposite extremes of the hydrologic cycle, they share the common causes of atmospheric warming and climate change. With Joe Biden (UD '65) now in the White House as the 46th President of the United States of America, I want to share with you my views on a national approach to these global challenges because at the UDWRC we employ the "Delaware Way" to address climate and water problems.

In Barcelona during the November 2009 negotiations for the Copenhagen climate conference, the executive director of the Stockholm International Water Institute precisely said that "climate change is

water change." This is explained in thermodynamics by the Clausius-Clapeyron relationship that for every 2 degrees Fahrenheit rise in temperature the atmosphere can hold 7 percent more water vapor. That is, global warming causes more evaporation, higher humidity, and increased water saturation in the atmosphere resulting in more wildfires, damaging storms and floods, searing drought, burying blizzards, and melting of the glaciers leading to dwindling water supplies and sea-level rise. With the inauguration of President Joe Biden on January 20, 2021, and the 117th Congress, climate change is once again a top priority of the federal government, and we are seeing a brand new age—the 4th era of environmentalism—in the United States. The actions and deliberations on climate change ought to be apolitical and nonpartisan because after all to adapt an adage from my colleague at the University of Minnesota Water Resources Center, "clean water (and air) is neither red or blue, it is clear."

In these new "Roaring Twenties" the four great challenges of the day are: (1) fight the pandemic, (2) revive the economy, (3) combat climate change, (4) and achieve racial justice. All four of these issues are intertwined in the disciplines of sustainable water and environmental policy. Clean water provides necessary hygiene to control the spread of the coronavirus. Clean water programs stimulate the economy and support high-paying green jobs. Finance of clean low-carbon energy combats climate change. Investment in polluted neighborhoods provides environmental justice to fight racism and provides good jobs for people of all races, creeds, and colors.

On March 22, 2016, President Obama invited 200 scientists to the White House Water Summit in Washington, D.C. On UN World Water Day, the White House hosted this first-ever national water summit to shine a spotlight on cross-cutting, creative solutions to solving the water problems of the day. Six years later, we're looking forward to the next White House summit that could be a "Bretton Woods" of water and climate modeled on the 1944 economic summit where the 75 allied nations assembled in the White Mountains of New Hampshire to plan a new world order.

Constitutionally, Delaware is the First State, and so it is in water. Sitting on the Delmarva Peninsula and surrounded on three sides by water, it is one of just three peninsular states, and with the C&D Canal, many consider it technically to be an island. At a mean elevation of only sixty feet above sea level, Delaware is also the lowest state in the United States with one-fifth of its landmass in the floodplain and a beautiful and bounteous 130-mile coastline with the cleanest ocean beaches in the nation. But this profile leaves the state vulnerable to worsening coastal storms and accelerating sea-level rise, perhaps more than other states. The Diamond State is fortuitously situated by geography and hydrology between two great estuary systems in America, the Chesapeake and the Delaware, that support abundant ecology and a $16 billion water economy.

Twenty years ago, at the turn of the century, Delaware took action to address the critical water issues of the day in a collaborative manner of getting along known as the "Delaware Way." In 2000, the Governor and General Assembly appointed the Water Supply Coordinating Council and a State Water Master that transformed water supply management in Delaware after the crippling drought of 1995–2002. The same year a state law was passed creating the Delaware Nutrient Management Commission a voluntary program that allows farmers to modernize farms and reduce nutrient loads to the Delaware, Chesapeake, and Inland bays without overbearing regulation. Also in 2000, Bill Clinton signed the White Clay Creek National Wild and Scenic River Act advanced by Senator Joe Biden (D-DE) and Congressman Joe Pitts (R-PA) as a bipartisan interstate approach to preserve the watershed in Delaware and Pennsylvania that supplies drinking water to 200,000 people or a full one-fifth of the population of the First State. Since then, Delaware has created a Division of Climate Change and Energy in the Department of Natural Resources and Environmental Control (one of the first in the nation) with a focus on climate change, sea-level rise, and clean energy. Delaware enacted these water and climate programs a generation ago and this cooperative way of cleaning up the environment is a model available to the greater United States.

About the UDWRC

Mission: Established in 1965 as one of the 54 National Institutes for Water Resources (NIWR) at land grant universities in the 50 states, the District of Columbia, and three island territories of Guam, Puerto

Rico, and the U.S. Virgin Islands. The UDWRC is Congressionally-mandated by Section 104 of the Water Resources Research Act of 1984 and 1964 administered by the U.S. Department of the Interior and U.S. Geological Survey. As part of the NIWR network, the mission of the UDWRC is to: (1) support research, education, and public outreach programs that focus on water supply, water management, and water quality—issues important to Delaware citizens and (2) foster/support training and education programs for future water scientists, engineers, managers, and policy-makers who will lead the water resources research, planning, and management efforts in our state.

Staffing: The UDWRC hosts the following faculty, scientists, and students to fulfill our mission:

Gerald J. Kauffman - Director/Associate Professor
Martha C. Narvaez - Policy Scientist/Associate Director
Nicole M. Minni - Associate Policy Scientist/GIS Laboratory, Lewes Campus
Andrew R. Homsey - Policy Scientist/GIS Manager
Sherri Martinez - Sponsored Programs Coordinator
Sophie Philips - Graduate Research Fellow (M.S. Energy & Environmental Policy)
Hayley Rost - Graduate Research Fellow (Master of Public Administration)
Liz Shields - Graduate Research Fellow (Master of Public Policy)

Public Health: In accordance with the Governor's and UD administration's directives concerning the pandemic, the UDWRC moved toward a phased reopening of the office during the Fall semester of 2021 with more extensive reopening in the Spring 2022 semester. The ongoing pandemic has borne out the fact that the UDWRC is able to maintain a high degree of efficiency and efficacy through the recent disruptions to the physical parameters of the work environment. Much of the work undertaken has been and can continue to be effectively achieved from remote locations, using technology to remain in contact with co-workers, funders, colleagues, and students.

Diversity: Diversity is essential in civil society and in our scientific mission at the University of Delaware. The UDWRC will redouble efforts to reach out and recruit talented minority and economically disadvantaged students and researchers. In the scientific world, diversity is necessary for the evolution of knowledge and thus protection of the environment on which everyone's well-being depends. The UDWRC has long been dedicated to this ideal taking a leadership role with youth in Wilmington through the Green Jobs program to develop the skills of tomorrow's leaders. Certainly more can and needs to be done. Through the recruitment of an increasingly diverse population of faculty, policy scientists, and undergraduate and graduate research students, this diversity can be strengthened. In accordance with our mission as designated by Congress under the Water Resources Research Act of 1984, the UDWRC will reach beyond the University of Delaware to strengthen partnerships across the state at research institutions of higher learning at Delaware State University and Delaware Technical Community College. In this way, UDWRC will strengthen and broaden its research and scientific reach and enhance its ability to serve the needs of Delaware and all Delawareans, to whom water is a crucial resource and a prerequisite to health and happiness. We will focus on:

- Correspond with the leadership of the University of Delaware, Delaware State University, and Delaware Technical and Community College requesting nominations of diverse students for UDWRC undergraduate water research internships.
- Re-examine UDWRC Advisory Panel for diversity and request feedback from the UDWRC Advisory Panel on ways UDWRC may increase inclusiveness among its students, board, and project work.
- Revisit with the UDWRC student alumni and celebrate their stories and their background.
- Incorporate demographics of race, ethnicity, gender, and income of the study area into our research reports. Assess how existing and future projects may be enhanced to improve diversity and inclusiveness through the University of Delaware Office of Equity and Inclusion and Coalition for the Delaware River Watershed (CDRW). UDWRC has two Delaware offices, its main office on the University of Delaware Newark campus, between Penny Hall and the Perkins Student Center, and on the Hugh R. Sharp campus of the University of Delaware in Lewes. Detailed directions for both locations are here.

UDWRC Research Interns

FY22 Student Support
Beginning in June 2021, the UDWRC supported 14 undergraduate and graduate water research internships during FY22 through the annual base (104b) grants. The UDWRC research students presented their research findings at the 57th annual meeting of the UDWRC Advisory Panel on May 5, 2022, at the University of Delaware:

FY22 Delaware Water Resources Center Water Research Internships

Student	Major	Research
Hayley Rost	Master of Public Administration, Biden School	Water Quality Monitoring in the White Clay Creek National Wild & Scenic River
Sophie Phillips	Master of Energy & Environmental Policy, Biden School	Diversity in National Parks: How Understanding our Past Can Help Us Create an Inclusive Experience
Liz Shields	Master of Public Policy, Biden School	Indigenous and European Place Names of Along Streams and Waterways in Delaware (Lenapehocking)
Andrew Blackburn	Chemical Engineering	Phyical and Chemical Effects of Biochar on Soil
Nicole Gutkowski	Marine Science - Oceanography	Investigating the Utility of Bivalves As Biomonitors of Heavy Metal Contamination in the Delaware Bay
Megan Jarocki	Environmental Engineering	Water Quality Sampling and Analysis Along the White Clay Creek National Wild & Scenic River in Delaware and Pennsylvania
Brian Kennedy	Energy and Environmental Policy	Water Quality Analysis of the Water Supply System in and Around Newark, Delaware
Nathaniel Levia	Insect Ecology and Conservation	How Mill Dams Affect Insects and Spiders in Aquatic and Riparian Ecosystems
Erik Rodriguez	Environmental Engineering	Water Quality Analysis of the Water Supply System in and Around Newark, Delaware
Andreanna Roros	Geological Sciences	Impact of Stormwater Infiltration on Groundwater Radium Levels in Delaware
Sophia Talley	Environmental Engineering	PFAS Analysis Along the Four Drinking Water Streams in New Castle County, Delaware
Megan Wassil	Environmental Engineering	Water Quality Sampling and Analysis Along the White Clay Creek National Wild & Scenic River in Delaware and Pennsylvania

FY23 Student Support
Beginning in June 2022, the UDWRC is supporting 14 undergraduate and graduate water research internships during FY23 through the annual base (104b) grants. The UDWRC research students are scheduled to present their research findings at the 58th annual meeting of the UDWRC Advisory Panel next May at the University of Delaware:

Water Research Student	Major	Research
Theodora Bertneski	Food Science	AMR Detection and Analysis of Spread Through Delaware Watersheds
Andrew Blackburn	Chemical Engineering	Use of Precipitation and Evaporative Flux on

		Treating Soils with High Salt Concentrations
Francesca Discenza	Environmental Engineering	Water Quality Trends Along the White Clay Creek National Wild & Scenic River in Delaware and Pennsylvania
Owen Donnelly	Biology	COVID19 Detection and Surveillance in Wastewater in the White Clay Creek Watershed in New Castle County, Delaware
Cooper Feeny	Economics and Public Policy	Plastic Pollution TMDL and Pollution Control Strategy for the Brandywine River Watershed in Wilmington, Delaware
Lydia Franks	MS Water Science & Policy, Biden School	Comparative Analysis of Interstate Governance and Policy Initiatives in the Chesapeake & Delaware Bay Basins
Sydney Iredell	Biology	COVID19 Detection and Surveillance in Wastewater in the White Clay Creek Watershed in New Castle County, Delaware
Brian Kennedy	Environmental Engineering	Water Quality Monitoring of the Newark Surface Water Supply System Along the White Clay Creek in Delaware
Nathaniel Levia	Insect Ecology and Conservation	The Effects Mill Dams Have on Insects and Spiders in Aquatic and Riparian Ecosystems
Elizabeth Manning	Environmental Engineering	Watershed Characterization of the Tributaries Along the Red Clay Creek
Kylee McGinness	Biology	COVID19 Detection and Surveillance in Wastewater in the White Clay Creek Watershed in New Castle County, Delaware
Elizabeth Shields	MS Public Policy, Biden School	Alosine Survey and Return of Fishable Water Quality Standards to the Red Clay Creek Watershed in Delaware
Adam Smith	Political Science and Criminal Justice	Climate Policies
Sophia Talley	Environmental Engineering	Watershed Characterization of the Tidal Christina River in Wilmington, Delaware
Alyssa Wentzel	Energy and Environmental Policy	Water Quality Monitoring and Evaluating Microplastics and Delaware's Waterways

UDWRC Undergraduate Intern Research

Physical and Chemical Effects of Biochar on Soil
Andrew Blackburn
Major: Chemical Engineering

The addition of biochar to roadway soils has shown promising results in its ability to filtrate water more efficiently and reduce the pollutants found in runoff. In order to understand both the physical and chemical effects of adding biochar, two experiments were performed. The first experiment analyzed the effects of biochar on water-stable aggregation and other physical structures, while the second experiment looked at the ability of biochar to leach phosphorus from the soil. In the aggregation study, a wet-sieving device was used to delicately sift through soil cores in order to establish a distribution of

aggregate sizes for a variety of soils, half of which contained biochar. When properly analyzed, the laboratory soils showed a decrease in aggregation, most of which was due to the disappearance of large cemented soil particles when biochar was applied. These laboratory produced results were contradictory to those yielded by the field sites that showed an overall increase in aggregation when biochar was applied. Thus, the current laboratory practices must be revised in order to properly mimic field site conditions. In the second experiment, batch reactors were made with a pseudo-soil complete with a storm event and centrifuge to simulate and separate a leachate. Biochar is known to affect the pH of soil, and as a result, the storm water pH varied between 7 and 8.5. When phosphate concentrations were measured in the leachate, increasing the pH and biochar content both decreased the phosphorus leaching ability. These findings indicate that applying biochar to roadway soils can decrease the amount of phosphorus that is brought into watersheds and limit the eutrophication of natural water resources.

Investigating the Utility of Bivalves as Biomonitors for Heavy Metal Contamination in the Delaware Bay

Nicole Gutkowski

Major: Marine Science - Oceanography

Due to the expansion of industry and urbanization, there are expected to be high contamination levels in the Delaware Bay. While concentrations of contaminants in water are generally too low to measure, bivalve's filtration of water and sediment allows contaminants to bioaccumulate within their tissues. This project aims to investigate the utility of bivalves as biomonitors for heavy metal contamination in the Delaware Bay. Field samples of bivalves, water, and sediment were collected from selected sites spaced along the Delaware Bay to perform this investigation. The Direct Mercury Analyzer was used to measure mercury concentrations in the field samples. Measured concentrations were utilized to assess the spatial distribution of contaminants in the Delaware Bay. Bioaccumulation of heavy metals in bivalve tissues and the spatial distribution of contaminants within the Delaware Bay presents important applications for the aquaculture industry.

Water Quality Sampling and Analysis Along the White Clay Creek National Wild & Scenic River in Delaware and Pennsylvania

Megan Jarocki

Major: Environmental Engineering

The first of two projects conducted water quality sampling and analysis of the White Clay Creek Wild & Scenic River Watershed in Delaware and Pennsylvania with the goal of determining the quality of the drinking water in the White Clay. High-quality drinking water is essential for the health and safety of those who inhabit the watershed and potentially consume the water. Within this project, there were three central aims: to test drinking water for common contaminants, to determine what branch of the White Clay Creek was getting heavy nitrogen runoff, and to look for long- and short-term trends in the water quality of the White Clay. The second project relates to PFAS analysis along the four drinking water streams in New Castle County, Delaware. The purpose of this project was to determine if there is significant PFAS contamination in northern Delaware's drinking water. Two samples were taken from each of the five drinking water sources examined in this study, sent to the lab, and analyzed. Delaware

did not yet have regulations regarding PFAS concentrations in drinking water, therefore we compared our findings to the regulations of Vermont and Massachusetts (both states have PFAS regulations). The analysis determined that the concentration of PFAS in the Red Clay Creek site is greater than expected and is at a level higher than the advised amount.

Water Quality Analysis of the Water Supply System Along the White Clay Creek in and Around Newark Delaware

Brian Kennedy & Erik Rodriguez
Major: Energy and Environmental Policy *Major: Environmental Engineering*

This research aimed to determine whether the White Clay Creek forest is adequately filtering water that becomes the City of Newark's drinking water by tracking the levels of various nutrients within the Creek. The researchers took probe measurements in the field with portable testing equipment and grab samples to be analyzed at the agricultural campus lab. Data were collected on nutrients such as nitrates, chlorine, and phosphorus. After analyzing the nutrient data by site and over time, no trend of reduction was identified through the sites moving down along the White Clay Creek. The results suggest that while the overall nutrient levels in the White Clay Creek were significantly below the health standard since there was not a reduction in nutrient levels between samples taken upstream and downstream, the forest is not adequately filtering nutrients from the water.

How Mill Dams Affect Insects and Spiders In Aquatic and Riparian Ecosystems

Nathaniel Levia
Major: Insect Ecology and Conservation

Mill Dams have dotted the landscape of Delaware since the colonial era; however, they are now starting to be removed from waterways. The mill dam located at the end of Paper Mill Road in Newark, Delaware, was once part of the Curtis Paper Mill, which has since been demolished, and turned into a public park. The final standing remnant of the Curtis Paper Mill is the mill dam, which was scheduled to be removed in 2021. While the dam removal has yet to occur, data collected on both sides of the mill dam show how the dam is affecting the stream. In this study, the stream was split into six search zones, three zones located downstream of the dam and three zones located upstream of the dam. Insects and spiders were collected from the riparian and aquatic ecosystems in each zone utilizing pitfall traps and hand sampling. Isotopic analysis was performed on specimens from the suborder Ensifera, due to them being opportunistic feeders. The aquatic macroinvertebrates collected were also analyzed and used as bioindicators. The Hilsenhoff Biotic Index, a method that uses the presence and abundance of

invertebrates and their pollution tolerance to estimate water quality, was used to calculate biotic index values for each of the six zones, as well as for above and below the dam. The results of this project indicate that there is a difference in aquatic fauna above and below the dam, and no major difference in fauna in the riparian zones above and below the mill dams.

Impact of Stormwater Infiltration on Groundwater Radium Levels in Delaware
Andreanna Roros
Major: Geological Sciences

This study investigated the impacts of stormwater infiltration on groundwater by measuring radium isotopes in samples collected periodically from monitoring wells at the BMP-663 infiltration basin at Route 301 and Bunker Hill Road. The intent of this investigation was to characterize potential risks to groundwater quality from de-icing practices at the Delaware Department of Transportation (DelDOT), which include the spreading of brines and rock salt during the winter months. The gradual increases in chloride concentrations and the movement of salty water within the Rancocas Aquifer beneath these sites have a significant probability of exacerbating radionuclide release in groundwater—with radium isotopes being the most likely to be mobilized in the aquifer by an increase in groundwater salinity. This study is imperative not only because of the geologically derived radionuclides coming from the aquifer but also because it is a source of drinking water for thousands of people in southern New Castle and northern Kent Counties. For that reason, it was also important to ensure that the wells did not exceed the EPA maximum contaminant level (MCL) for radium in drinking water, as high and chronic levels of ingestion can be carcinogenic.

PFAS Analysis Along the Four Drinking Water Streams in New Castle County, Delaware
Sophia Talley
Major: Environmental Engineering

The first project sought to determine if there are significant levels of PFAS contamination within Northern Delaware's drinking water supply. Per-and polyfluoroalkyl substances, better known as PFAS, are "forever chemicals" that remain within the environment. Samples from five different drinking water sources throughout Northern Delaware found that there was only one site with PFAS levels greater than the recommended threshold; however, further testing is needed to draw concrete conclusions. The second project involved testing the Pennsylvania portion of the White Clay Creek for nitrogen contamination to determine where the source of nitrogen contamination is located. Tests were conducted in the Eastern, Western, Middle, and Main branches of the White Clay to hone in on the potential source, or sources, of the nitrogen contamination.

Water Quality Sampling and Analysis Along the White Clay Creek National Wild & Scenic River in Delaware and Pennsylvania
Megan Wassil
Major: Environmental Engineering

This project focused on the nitrogen levels in the White Clay Creek. The goal of this research was to determine the source of high concentrations of nitrogen in the City of Newark's drinking water. Field samples were collected along White Clay Creek and assessed utilizing variables such as turbidity, conductivity, and nitrogen concentration. The research team analyzed the data yielded by these samples to determine which branch of the White Clay Creek has the highest levels of nitrogen present and is potentially the source of nitrogen contamination.

Water Resources Graduate Research Assistant Research

Diversity in National Parks: How Understanding our Past Can Help Us Create an Inclusive Experience
Sophie Phillips
Master of Energy & Environmental Policy, Biden School

Throughout the year, National Parks are busy with activity. From hiking and camping to museum visits and ranger-led tours, there are options for everyone to enjoy. In 2019 alone there were 327,516,619 visitors to the National Parks (NPS, 2020). On the surface, it appears the National Parks are doing very well, but looking deeper, there are concerns about the demographics of visitors and employees. A survey by the National Park Service in 2016 showed only 7 percent of park visitors are African American, and only 20 percent of visitors are minorities, even though African Americans make up 13 percent of the U.S. population and minorities make up 40% (Rott, 2016). The history of African American experiences with nature, forests, and national lands provides some insight as to why National Park engagement

within this population is so low.

The history of segregation in the United States national lands, the lack of representation of African Americans in the National Parks workforce, and a system that pushes kids out of environmental fields leave us with a lot of work to do. Creating programs within the park system that invite youth to become part of that space is an important first step. The creation of an app and podcast series about black history can build understanding and help address the knowledge gap around the history of this nation, while the hiring of more African American employees in leadership positions will allow for the increase of that vital representation. We are far from solving this problem, but those in leadership positions of our national lands are ready to make the changes needed to truly show that we all have ownership in this land.

Water Quality Monitoring in the White Clay Creek National Wild & Scenic River
Hayley Rost
Master of Public Administration, Biden School

In partnership with the White Clay Watershed Association Wild and Scenic Program (WCWA), UDWRC graduate students conducted biweekly fieldwork in the White Clay Creek to assist with the WCWA ongoing water quality monitoring program. The White Clay Creek is a designated National Wild & Scenic River and was the first Wild & Scenic River to be protected on a watershed basis. Approximately 124,000 people live in the watershed basin, according to the 2010 census, which is nearly double from the 1970 basin population. One of the central purposes of the water quality monitoring program was to improve science-based knowledge of stream conditions within the watershed. By assessing the streams, how the surrounding land use affects the streams, and how the streams are impacted by weather events over time, the WCWA will be able to develop a more effective plan for restoration, preservation, and management efforts in the White Clay Creek watershed. Ultimately, the goal of the program is to successfully manage the streams so the waterways are able to fulfill their designated uses and be delisted as impaired. Data collected through the program will be shared with elected officials, who make decisions that can potentially affect water quality and stream habitat, as well as watershed residents, so they are able to make informed decisions concerning their own properties.

Indigenous and European Place Names Along Streams and Waterways in Delaware (Lenapehocking)
Liz Shields
Master of Public Policy, Biden School

Beginning in Summer 2021, this project was created to initiate important research, conversation, and recognition around the names of waterways and places in our state. There is a rich and long history of the relationships between the Lenape Haki-nk, Susquehannock, Choptank, Nentego/Nanticoke, and Pokomoke peoples and this land we now know as Delaware. We acknowledge both the history and the maintained presence of these Indigenous peoples, as well as the existence of their original connections and name associations to the land and water. The goal of this living project is to begin to uncover what available records show and tell of the lineage and possible meanings behind the Indigenous, early European settlers, and commonly known names. Through an analysis of the 1966 United States Geological Survey "Delaware Place Names" Report, a current total of 107 waterways and key land points have been organized, interpreted, and placed, producing a new alternative visual for mapping in Delaware. The next steps of the project will play out in the evolution of the printed sample into a living online map with additional content and context. Given the limitations of the 1966 USGS report, we plan to collaborate with other sources and initiate communication with Indigenous tribal leadership and members around the state for their input on variants, translations, locations, and other vital elements to this process.

UDWRC Advisory Panel

Jayme Arthurs
Natural Resources Conservation Service
USDA
Dover, DE

Ethan Robinson
Department of Public Works
City of Newark
Newark, DE

Jeff Downing
Mt. Cuba Center
Wilmington, DE

Asia Dowtin
Department of Forestry
Michigan State University
East Lansing, MI

Mingxin Guo
Department of Agriculture and Natural Resources
Delaware State University
Dover, DE

Kate Hutelmyer
Partnership for the Delaware Estuary
Wilmington, DE

Position Vacant
Center for Inland Bays
Lewes, DE

Thomas McKenna
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Newark, DE

Kristen Travers
Delaware Nature Society
Hockessin, DE

Chris Oh
Department of Public Works
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Wilmington, DE

Betzaida (Betzy) Reyes
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Kash Srinivasan
Kash Srinivasan Group
Wilmington, DE

Jim Jordan
Brandywine Red Clay Alliance
West Chester, PA

Stacy McNatt
Department of Special Services
New Castle County
New Castle, DE

Shreeram Inamdar
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Paul Imhoff
Department of Civil and Environmental Engineering
University of Delaware
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Jennifer Volk
Kent County Cooperative Extension
University of Delaware
Dover, DE

Steve Williams/Jennifer Walls
DE DNREC
Division of Watershed Stewardship
Dover, DE

Christian Hauser
Delaware Sea Grant
Newark, DE

UD MPA Grad Hayley Rost Awarded 2022 Biden School of Public Policy & Administration Excellence in Water Resources Scholarship Medal

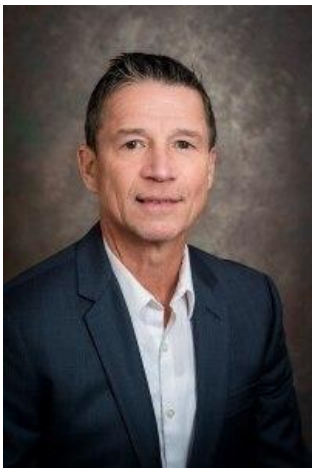
Martha Narvaez

This spring, Hayley Rost received the 2022 Biden School of Public Policy and Administration Excellence in Water Resources Scholarship Award. On May 28, 2022, Hayley graduated from the University of Delaware with a Master of Public Administration degree. Hayley graduated with an outstanding academic record. Since starting her fellowship with the Water Resources Center in August 2020, Hayley has been an asset to the center. Hayley is a mature and responsible individual and demonstrates key characteristics of the Excellence in Water Resources award. Hayley was an integral member of several projects undertaken at the Water Resource Center over the past two years. Hayley provided new ideas to the projects she worked on and worked well independently and as part of a team. Hayley's most notable project research was (1) with the National Park Service on a Reconnaissance Study of Potentially Eligible National Wild & Scenic Rivers in Delaware and (2) Indigenous and European Place Names of Rivers and Streams in Delaware. Hayley also showed interest in learning more about several projects at the Water Resources Center and took on extra work to have the opportunity to learn more. Hayley showed initiative and did not retreat from tasks that seem difficult or challenging. Hayley was also recognized by her peers for her leadership at the Water Resources Center. Liz Shields, MPP '23

remarked, "Hayley taught me so much about what she had learned and picked up on in her first year before my start this past fall and she helped me with all the projects we worked on together. She has been a patient and knowledgeable mentor and teammate!" Through her work with the Water Resources Center, Hayley has been an asset to the Water Resources Center staff and students. Congratulations and best wishes to Hayley in all her future endeavors!

Ratledge Family Award for Delaware Public Service

Gerald Kauffman



The 2021 recipient of the Ratledge Family Award for Delaware Public Service included Gerald Joseph McAdams Kauffman, Jr., director of the UD Water Resources Center (UDWRC) in the Institute for Public Administration (IPA) and associate professor in the Biden School of Public Policy and Administration. "It gives me great pleasure to recognize the outstanding recipients of the 2021 and 2020 Ratledge Family Award," said Maria Aristigueta, dean of the Biden School and the Charles P. Messick Chair in Public Administration. As director of the UDWRC, Kauffman oversees the Water Resource Center, one of the 54 Congressionally designated National Institutes for Water Resources supported by the U.S. Department of Interior and U.S. Geological Survey at land grant universities in the 50 states, District of Columbia, and island territories. "As the director of the UDWRC, Jerry defined two key missions related to Delaware's water resources—our precious groundwater aquifers and our streams, ponds, lakes, and coastal waters," said Jerome R. Lewis, director of IPA in the Biden School. "The first is to support research, education, and public outreach programs that focus on water supply, water management, and water quality—issues of considerable importance to Delaware citizens who are concerned about the future of our water resources. The second mission is to foster and support training and education programs for the future water scientists, engineers, managers, and policymakers who will lead the water resources research, planning, and management efforts in our state in the future."

Within Delaware, Kauffman serves as Delaware's first "Water Referee" appointed by the governor and General Assembly through the Water Supply Coordinating Council Act of 2000. Among other services to the Delaware region, Kauffman also co-chairs the Brandywine Christina Basin Clean Water Partnership, an interstate effort between the Environmental Protection Agency, the Delaware River Basin Commission, the state of Delaware, and the Commonwealth of Pennsylvania to restore the watershed that provides nearly two-thirds of Delaware's drinking water. Within UD, Kauffman holds a secondary faculty appointment as Associate Professor in the Biden School. He has taught undergraduate and graduate courses in hydrology, watershed science and policy, governance, and economics in the Biden School, the Department of Civil and Environmental Engineering, and the Department of Geography. He also contributes to research on water resources and watershed management.

"For me, Delaware provides one of the very finest settings in the nation to conduct public service through our institute, school, and University," Kauffman said. "Our land grant mission at the University of Delaware is a three-legged stool of public service, education, and research based on the Delaware model. Our small yet progressive state provides us the ability to translate new knowledge from research in the laboratory and education in the classroom out to our citizens and governments by public service in a way that few states and universities can match. I am very proud to be a part of it all and quite glad to receive the Ratledge Family Award this year."

Red Flag Alert! Bratfest 2022

Gerald Kauffman

On April 28, 2022, for the first time in three years, we celebrated the reemergence from the pandemic and 20 years of the annual Wisconsin-style Bratfest at the offices of the UDWRC in Newark, Delaware.

Brought east by University of Wisconsin graduate, President of the Madison student body, and UD urban affairs and public policy doctoral student Kevin Vonck, this annual lunch celebrates the beauty of the brat boiled in beer and onions and then grilled to a delicious char with sauerkraut and onions on a fresh Philly style roll. But this year an unprecedented Arizona-style Red Flag Alert by the U.S. National Weather Service with less than 10 percent humidity and over 20-mph winds shut down the grills at the office grounds. With contingency plans in effect, 100 vegan and 200 regular brats were safely cooked by the chefs at the offices of the Fairfield Watershed Association in Newark, Delaware, and delivered at noon on the appointed day.

An Evaluation of Delaware State Parks Youth Conservation Corps

Martha Narvaez

In February 2022, Martha Narvaez (UDWRC) in partnership with Troy Mix and BJ DeCoursey (Institute for Public Administration) published an evaluation of the Delaware State Parks Youth Conservation Corps (YCC) program that addressed the impact of the program on its 2014–2020 participants. The project was supported by funds administered by the Delaware Department of Labor. The YCC program is a paid internship for youth 14–21 years old and integrates professional development skills, environmental stewardship, and outdoor recreation by engaging youth at Delaware State Parks. Summer youth employment programs, like the YCC, are an established approach to paid work opportunities that provide multiple benefits to participants. There are many youth environmental-employment programs across the United States that are similar to the Delaware YCC. The City of Wilmington Green Jobs Program, coordinated by Martha Narvaez, has been a YCC program partner for many years and shares similar program goals.

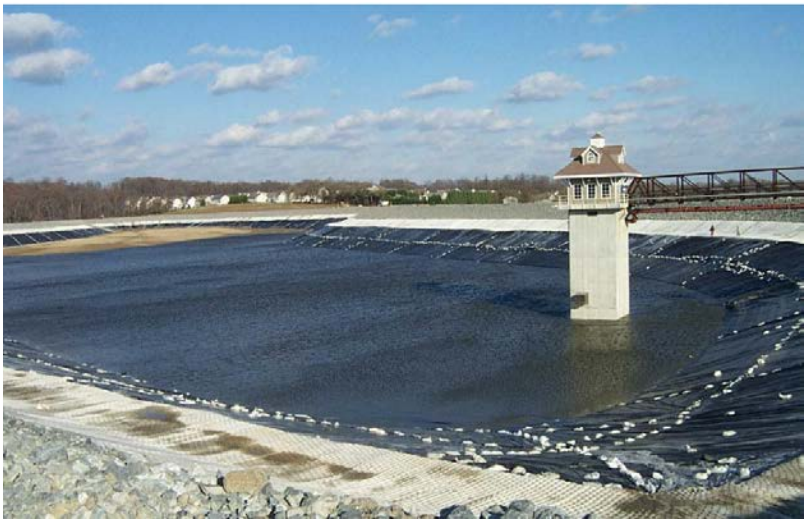
The project team designed and administered two types of surveys, structured (web-based survey) and semi-structured (phone interviews), to gather demographic and program evaluation data. From the data gathered, it was evident that the YCC initiated many young adults into the world of work, with nearly three-quarters of respondents indicating it was their first paid job of 20 or more hours per week. The participants' environmental sentiments ranked quite favorably, over 70 percent were favorable toward environmentally focused statements such as, "I like to spend time outside in nature." YCC participants positively ranked the program and nearly nine in ten would recommend the experience. Respondents felt the experience most benefitted their basic "first job" skills. Respondents seemed to gain a broad understanding of potential careers in Delaware, as well as heightened awareness of Delaware's outdoor and environmental assets and issues. Further, all the interview subjects indicated that they learned about new Delaware State Parks through YCC, and that they had a deeper understanding of the state parks after completing the program. Overall, the YCC program is a highly performing youth labor program in Delaware. UDWRC and IPA look forward to continuing evaluation and program enhancement work with Delaware State Parks.

Photo Credit: Delaware State Parks

Platinum Anniversary of the Delaware Water Supply Coordinating Council

Gerald Kauffman

On January 1, 2000, the Delaware Water Supply Coordinating Council (WSCC) was established by Governor Tom Carper and a unanimous vote by the Delaware General Assembly to transform water supply and management in the First State in the aftereffects of the drought emergencies of 1995 and 1999. The Water Supply Coordinating Council was appointed by Executive Order No. 74 on December 30, 1999. The Secretary of DNREC was appointed by the Governor as chair. The Delaware Geological Survey and DNREC were appointed as water advisory agencies. The Governor's Executive Order No. 74 also appointed the Water Resources Agency at the University of Delaware as the State's Temporary Water Coordinator for a period that expired on December 31, 2000. The responsibility of the Water Coordinator is to work cooperatively with the public and private water purveyors to ensure that additional water supplies are developed within an agreed-upon schedule without slippage. HB No. 549 was later passed unanimously by Governor Ruth Ann Minner and the General Assembly that would appoint the WSCC and the Water Coordinator through December 31, 2003, when the options for expanded water supplies identified in the Task Force report were scheduled to be completed. This foresight to give us just three years to build a million gallons of reserve water supply storage in northern Delaware was cogent as the drought emergency reoccurred in 2002 and the WSCC later built 2 million gallons of reserve storage, double the goal, to meet the demands during the next drought. Over the 22 years since the Delaware Water Supply Coordinating Council was established, there have been five DNREC secretaries, four governors, three state geologists, two state climatologists, and one temporary water coordinator. After 22 years and 31 days, the responsibility of the Temporary Watershed Coordinator for New Castle County has been fulfilled with the sunset of the WSCC on January 31, 2022.



Newark Reservoir filling (DNREC et al., 2018).

Identifying Diadromous Fish Abundance, Habitat Utilization, and Fish Passage Feasibility in the Red Clay Creek in Delaware

Gerald Kauffman

Delaware Sea Grant and the UDWRC propose to work in partnership with the Brandywine Red Clay Alliance and Inter-Fluve to conduct surveys of diadromous fish abundance and habitat utilization at three tributaries of the Delaware River and explore the feasibility of providing fish passage at 11 dams along the Red Clay Creek. Our effort is the first step to restoring diadromous and resident fish passage to 13 miles and 153 acres of spawning habitat from tidewater to 180 feet above sea level in the Piedmont plateau at the Delaware/Pennsylvania arc boundary.

We seek to collaborate with river partners to conduct a feasibility analysis and initiate discussions with the permitting/regulatory agencies about restoring fish passage of American Shad, Hickory Shad, River Herring, Striped Bass, and other diadromous fishes like American Eel to the Red Clay Creek in New Castle County, Delaware. The long-term conservation outcome of this proposal is to restore fish passage and habitat to the Red Clay Creek watershed by removing in-stream dams and/or installing fish ladders, fish notches, rock ramps, or bypass channels. Currently, there are 11 low-head (2–10 feet high) dams along 13 miles of the Delaware portion of the Red Clay Creek from tidewater upstream into the Piedmont to 180 feet above sea level. However, critical parameters for understanding the feasibility of removal including land ownership, whether the dam serves as a mill race, historic value, and potential American Shad production values are presently unknown for each of these dams. In addition to the identification of dam feasibility, we aim to better understand the spatial scale variability in alosine abundance between the Red Clay Creek, White Clay Creek, and Christina Rivers, as well as to determine how adult American Shad use these habitats using a newly established array of acoustic receivers, paired with an existing array in the Brandywine River and Delaware River estuary that will elucidate fine-scale movements within each tributary and beyond.

UDWRC undergraduate students sampling the Red Clay Creek

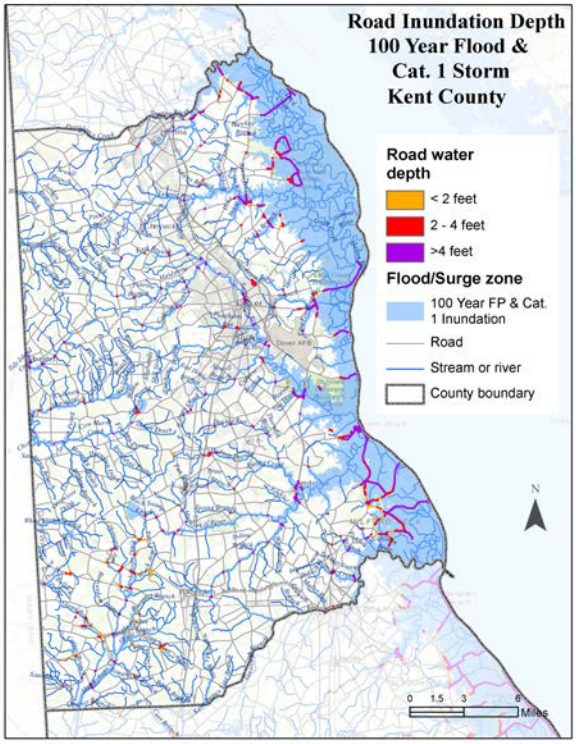
Photo Credit: State of Delaware

Roadway Flood Risk Assessment in Delaware Coastal

Communities

Gerald Kauffman

The University of Delaware Geography Department, State Climatologist, and UDWRC plan to work with DelDOT to conduct a flood risk assessment for South Bowers Beach along the Murderkill River in Kent County, Delaware. UDWRC proposes to perform hydrodynamic modeling and transportation analysis for this location using a scenario-driven approach that includes current and future conditions, including the effects of sea-level rise. Throughout Delaware, numerous low-lying roadways and transportation structures in coastal communities are regularly flooded from astronomical high tides and surge from coastal storms, such as tropical cyclones and nor'easters. The frequency of non-storm event flooding, sometimes called nuisance flooding, has been increasing in recent decades due to ongoing sea-level rise, which Delaware experiences at approximately twice the global rate. As sea levels continue to rise, major storms like Hurricanes Irene (August 2011) and Sandy (October 2012) and the regular flooding of community properties and infrastructure will have an even greater impact on our transportation system. At the NOAA Lewes tide gauge, water levels have crossed the NWS minor coastal flood advisory threshold 7–14 days per year since 2016. That number is projected to exponentially increase to 130–190 days per year by 2050 and nearly every day by 2080. Hurricanes are projected to intensify as well as precipitation and winds from coastal storms due to climate change. To make Delaware's transportation system more resilient to current and future coastal flooding, transportation officials need to understand the frequency, magnitude, and duration of flood impacts on these frequently flooded roadways under current conditions and future sea-level rise scenarios.



Road inundation in the riverine and coastal floodplain in Kent County, Delaware (UDWRC, 2021).

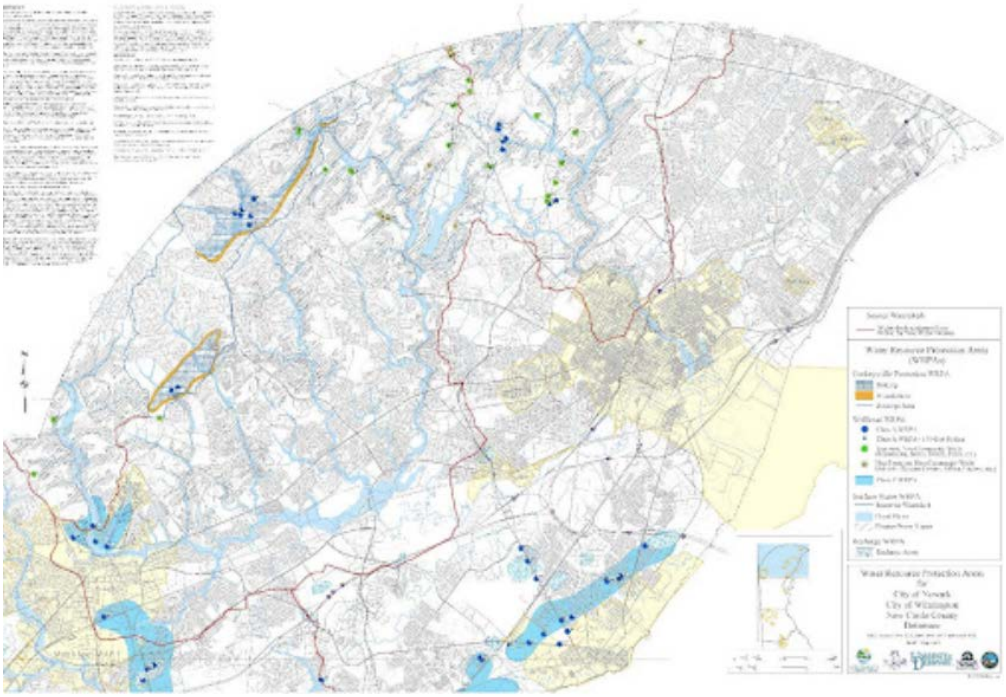
Water Resource Protection Area Mapping 2022 Update

Nicole Minni

Since 1987, the University of Delaware has prepared GIS-based Water Resource Protection Area (WRPA) mapping for New Castle County that serves to protect the quality and quantity of ground and surface water supplies as part of the Unified Development Code (UDC). The WRPA program is enabled under Section 10 (Environmental Standards) of the UDC for New Castle County. The intent of the ordinances is to protect the quality and quantity of surface water and groundwater supplies through the protection of environmentally sensitive areas important to the state's water supply. Under the UDC, all development

within recharge, wellhead, Cockeysville formation, and reservoir water resource protection areas are required to meet maximum impervious cover thresholds (20–50%) and may require groundwater recharge facilities, water monitoring, and water management facilities. Presently, over 20 percent of New Castle County's land area is protected by the WRPA provisions of the UDC. UDWRC's 2022 GIS-based mapping updates represent the sixth revision to the maps.

These maps depict several data layers that represent the four main WRPA categories in New Castle County, Delaware–Cockeysville Formation, Wellhead WRPA, Surface Water WRPA, and Recharge WRPA. The maps serve as a guide for development and assist decision-making in New Castle County, Delaware. The WRPA data will soon be available for download at Delaware FirstMap and PDF versions of the maps are available on the UDWRC website.

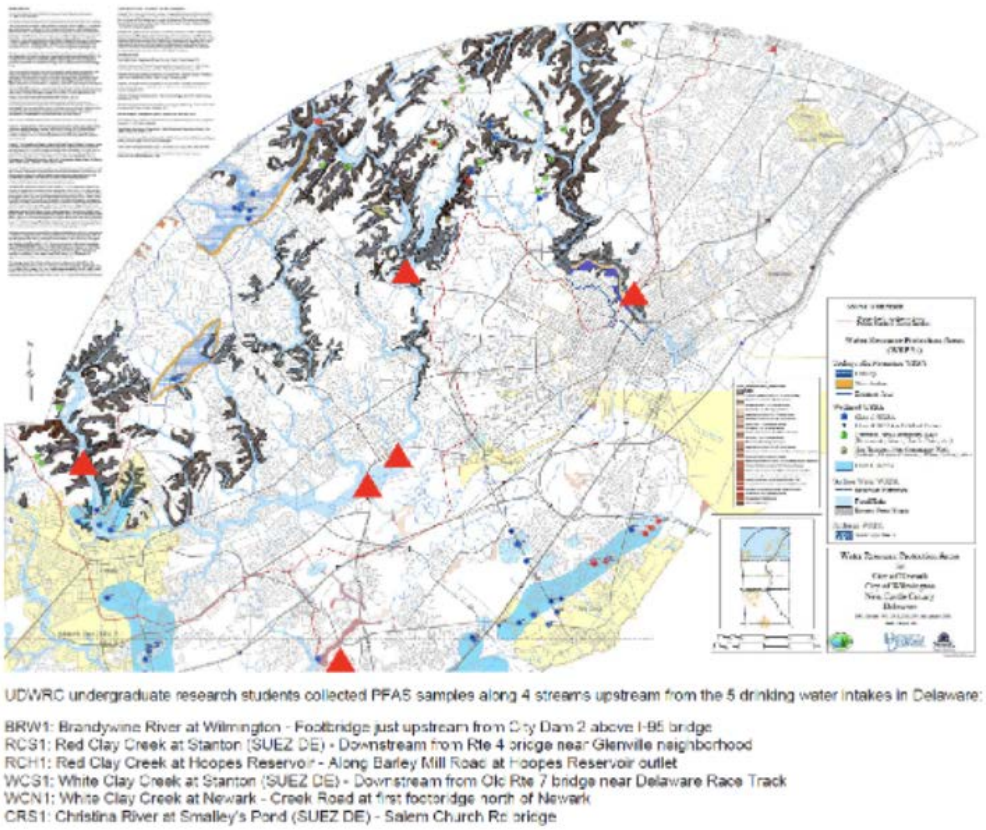


Map 1 of 3, Water Resource Protection Areas (WRPAs) for New Castle County.

PFAS Sampling along Delaware Drinking Water Streams

Gerald Kauffman

The UDWRC conducted analysis of water from the Red Clay Creek, White Clay Creek, Brandywine River, and Christina River in Delaware for 40 PFAS chemicals by the U.S. Environmental Protection Agency (EPA) method 1633. Samples were taken on November 19, 2021, from the four drinking water streams. PFAS concentrations in White Clay Newark, White Clay Stanton, Christina, and Brandywine are below the Maximum Contamination Level (MCL) of 17 ppt proposed by Delaware. Red Clay Suez analysis showed 53 ppt of PFOA, which exceeds the proposed MCL. On February 18, 2022, more samples were collected from the Red Clay Creek and the PFAS again exceeded the MCL proposed by Delaware. A majority of the PFAS are perfluorinated carboxylic acids ranging from four carbons up to fourteen. Furthermore, the perfluorinated carboxylic acids were essentially all in the linear isomer form. This suggests they originated from the telomer process typically used for fluoropolymer synthesis.



PFAS sampling sites along Delaware drinking water streams

PFAS are fluorinated chemicals first discovered in the 1930s and most prevalent from pre-1970s in firefighting foams and consumer products and have been detected in the drinking water of 16 million Americans. There is no Federal PFAS drinking water standard (MCL) although in 2016 EPA set a non-enforceable health advisory level of 70 ppt. Massachusetts, New Hampshire, New Jersey, and Vermont are a few of the states that have adopted PFAS drinking water MCLs as low as 13 to 20 ppt. In October 2021, Delaware House Bill 8 was signed, and recently the Delaware Division of Public Health has proposed MCLS of 14 ppt for PFOS and 21 ppt for PFOA and the sum of 50 percent of the PFOS and PFOA should not exceed 17 ppt.

A Wave of Recovery

Andrew Homsey and Nicole Minni

The 2022 Delmarva GIS Conference, A Wave of Recovery, was held on May 12–13, 2022, at the Hyatt Place in Dewey Beach, Delaware. After a two-year hiatus due to COVID, this year 176 attendees gathered to learn from each other and celebrate the GIS community in the state and region.

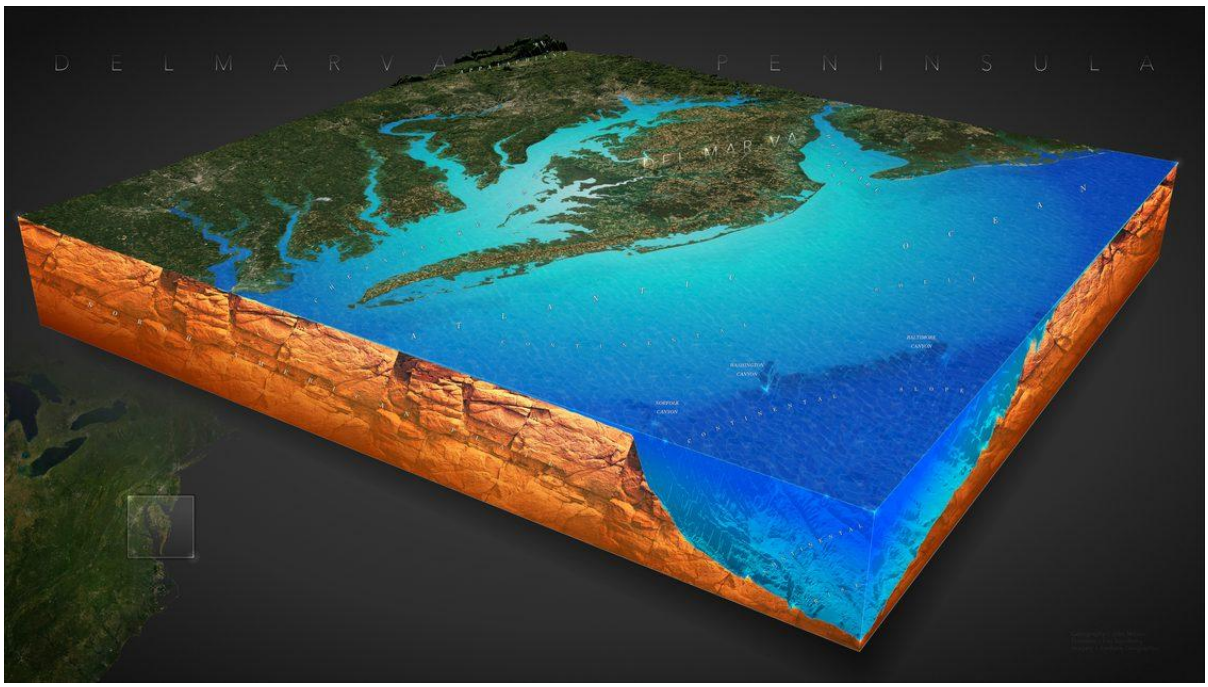
The conference kicked off with an inaugural Mappy Hour, which provided games and trivia to spark networking among conference attendees. The conference keynote, John Nelson (from Esri, a global leader in GIS software and services), provided an artistic and humorous take on tools that can be used in ArcGIS Pro to create renditions of the Delmarva Peninsula. Professor Gerald Kauffman (UDWRC) provided a historical tour-de-force of mapping and GIS through the years.

The technical program included four workshops, held on the first day of the conference, followed by 27 presentations on day two of the conference along with a Map Application Gallery. Nicole M. Minni (UDWRC) and Kym Kelly and Deborah Sullivan (Delaware Department of Technology and Information [DTI]), delivered two technical presentations, including Food Resource Mapping and Data Collection/Analyses in Delaware and Maps/Story Maps and Accessibility.

Two awards were presented during the conference: the Delmarva Geographic Community Service Award, in memory of UDWRC's own Vernon Svatos, and the GIS in Education Award. Deborah Sullivan, of DTI, won the Delmarva Geographic Community Service Award. As DTI's Chief Technology Officer, Gregory Lane, presented the award, observing that "Debbie embraced Vern's commitment to geographic education and training." Mary Schorse (from UD's Delaware Center for Geographic Education) was awarded the GIS in Education Award. Miriam Pomilio presented the award, noting that "Mary is committed to broadening teacher and student exposure to geospatial sciences and the use of GIS to enhance their learning experiences."

UDWRC's Nicole Minni, Associate Policy Scientist, and Andrew Homsey, GIS Services Manager, have been key participants in conference planning for many years. Nicole Minni has participated on the conference committee since its inception in 1998 and handles the website, signage/graphic materials, and awards. Andrew Homsey is instrumental in handling the conference finances. It is important to note that this event is only made possible because of the generosity and participation of the many conference sponsors and exhibitors. Visit the Delmarva GIS Conference website to learn more.

GIS Conference committee members Miriam Pomilio, Nicole Minni and Laurel Sullivan (left to right).



A model of the Delmarva Peninsula, created by John Nelson (Esri).

Conference attendees enjoying the plenary session.

Tropical Storm Ida: Not just the storm of the century

Gerald Kauffman

The UDWRC utilized the USACOE HECRAS hydraulic model developed by FEMA to reconstruct and examine the effects of Tropical Storm Ida remnants along the Brandywine River in Wilmington, Delaware, on September 1–2, 2021. The remnants of Tropical Storm Ida left 7.29 inches of rain in the headwaters of the Brandywine River watershed at Coatesville and 8.2 inches at Downingtown in Chester County, Pennsylvania. According to NOAA Atlas 14, the 100-year, 24-hour storm is 8.0 inches there. Ida left 5.04 inches at Newark, Delaware (10-year storm) and 3.54 inches above Wilmington, Delaware (2-year storm). Ida's peak flood level of 33,700 cubic feet per second (cfs) (>100-year) on Sep 2, 2021 was the highest on record along Brandywine Creek at Wilmington dating back to 1946. Ida's peak flood level surpassed the previous record-holder Hurricane Agnes, which reached a peak flood level of 29,000 cfs on June 23, 1972.

There are four bridges over the tidal Brandywine upstream from the mouth of the river: AMTRAK Rail Road, US Highway 13/Northeast Boulevard, Jessup Street/E. 16th Street, and Market Street (Business Route 13). Ida’s peak discharge of 33,700 cfs (>100-year flood) caused about 1 foot of backwater at the AMTRAK (elevation 9 feet) and Northeast Boulevard (elevation 10 feet) bridges and, along with likely debris jams at the bridges, contributed to flooding in the neighborhoods sitting at interior drained ground elevations at less than 10 feet mean sea level (msl). The likely spillover point was just upstream of the Northeast Boulevard bridge and backwater through storm sewers. Given that Ida just about overtopped the banks of the Brandywine at an elevation of 10 feet msl, a mildly sloped a 4–5 feet high grass Dutch-style dike (1,000 to 1,500 LF) built to 15 feet msl with storm sewer backflow valves along the extension of Brandywine Park downstream to the AMTRAK Rail Road bridge could flood-proof this neighborhood employing a modest budget.

Along the Brandywine River at Chadds Ford, Pennsylvania, on September 1–2, 2021, Ida’s flood wave

was accentuated by the inherently steep Piedmont topography in the funnel-shaped Brandywine River watershed. Peak rainfall (> 8 inches) above Coatesville and Downingtown, Pennsylvania, caused runoff that flowed down from 1,000 feet above sea level in the Welsh mountains (the foothills of the Appalachians) and the flow siphoned down to Chadds Ford, Pennsylvania, then to Delaware at William Penn's 1682 arc boundary that now separates the once co-joined states. Increased population and developed land in the Brandywine watershed is offset by the high amount of protected land (1/3 protected) and this ratio exceeds the percent recommended by Harvard biologist E.O. Wilson in his 2016 book and the UN and Department of Interior in the 30-for-30 program to protect 30 percent of the Earth and the nation's land and water. The historic Brandywine Museum in Chadds Ford, Pennsylvania, was flooded for the first time since the mill building was built during the Civil War. US Army Corps of Engineers records indicate only the January 1839 flood could match Ida in September 2021. Ida was not just the flood of the century, it was the worst flood in 200 years since the DuPonts built the Hagley gun powder mills along the river (with a drop higher than Niagara) in 1802.

Photo Credits: William Bretzger, *Delaware News Journal*

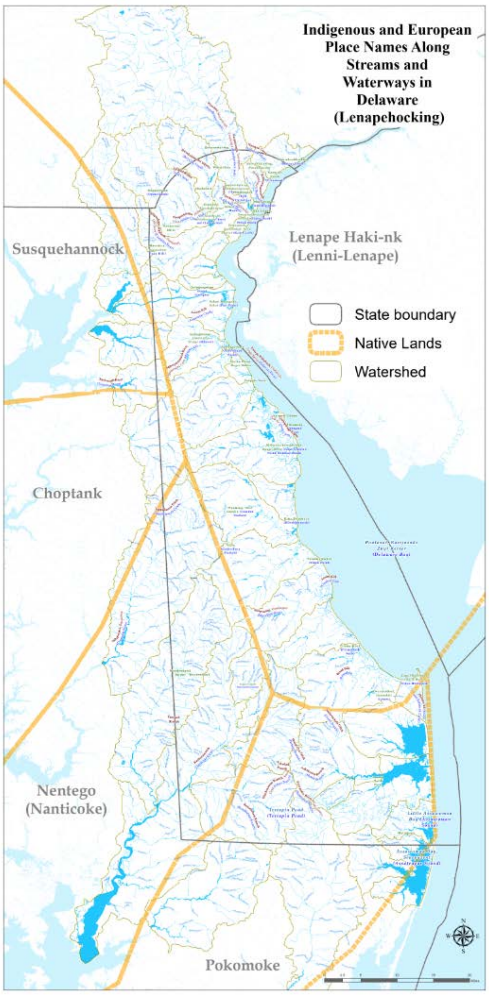
Indigenous and European Place Names Along Streams and Waterways in Delaware (Lenapehocking)

Gerald Kauffman

Recognizing the rich Indigenous history and lasting presence of the Native people, the UDWRC has dedicated a project aimed at highlighting original place names and their meanings. Indigenous names have always existed for many water-relevant locations, far outdating their anglicized replacements common today. In many places, Swedish and Dutch names established by some of the earliest settlers in Delaware are also relevant to the state's history and have been lost in a similar fashion. Utilizing 1966 U.S. Geological Survey Bulletin 1245, the UDWRC mapped original place names of streams and waterways in Delaware (Lenepehocking). Many of the original place names are derived from Lenape, Nanticoke, and Algonkian origin reflecting the indigenous people who lived here for millennia. When the Swedes and Dutch sailed here in the early 17th Century, these western Europeans left multiple variants due to differences in spelling and translation among all the influential languages in the area.

In northern Delaware, indigenous villages are found at the Clyde Farm at Churchman's Marsh, Crane Hook on the Delaware River in Wilmington, Naaman's Creek, and Brandywine River at DuPont

Eleutherian Mills at Hagley (Reed and Wallace, 2019). The Lenape held an annual fish festival in the spring on Vandever land on the ground now known as Brandywine Village. "Their encampment may be said to have had a general course or range of north west and south east from nearly opposite the present lower dam down to the shipyard and within an average distance of one hundred yards of the creek" (Dunlap and Weslager, 1960). The indigenous people named Iron Hill near Newark Marettico, meaning "hill of hard stone" or Aquasehum, meaning "a place where there is iron," and the Minqua indigenous people had a fort on the hill, which was attacked by the Seneca in 1663. At the Lenape village of Queonemysing along the Brandywine (Wawaset), a 1683 agreement by the Sachem Seketarius transferred the land between the Upland (Chester) and Christina creeks to William Penn. Queonemysing on the river of the long fish is situated at the bend of the Brandywine just north of the 1682 Penn's arc of Delaware. Lenape leadership was through matrilineage where a female matron passed down authority to her heirs and the male sachem was merely a spokesman. In 1683, Penn's William Markham entered into an agreement with Sachem Seketarius of Queonemysing and Minguanan (Machaloha) on White Clay Creek. In 1684, Penn identified one mile on either side of the Brandywine for Lenape continued seasonal occupation of Queonemysing from mouth to west branch. In 1725, Alphonsus Kirk and Samuel Hollingsworth remembered that land was reserved for Brandywine Indians and the Indians were to retain their "Town on Brandywine." Kirk remembered: "above thirty years since he saw two Papers which Saccatarius or some other of the Chiefs of the Indians on Brandywine had in their possession." In 1778, the Lenape (the Delaware) was the first nation (domestic or otherwise) to sign a treaty with the new U.S. government and Continental Congress.



The Dutch sailed here in 1616 in search of beaver pelts for the fashionable continental hats of the day and in 1630 founded the colony of Zwaanendael at Hoeren Kill (Whorekill) or Lewes Creek. In 1638, the Swedes founded New Sweden and built Fort Christina (after the teenage queen at the Rocks on the Christinakill), and in 1654 erected Fort Casimir and New Amstel at present-day New Castle. In 1664, King Charles II regained the monarchy after the interregnum of Oliver Cromwell and defeated the Swedes and Dutch here, and later the Duke of York granted land charters to William Penn after 1682. William Penn's three lower counties of Pennsylvania (New Castle, Kent, and Sussex) were declared under Quaker influence in 1704. In 1767, Mason and Dixon completed the survey of their line that separated the land of the Catholic Calverts in Maryland from the Quaker Penns in Pennsylvania, and the land in between was Delaware. In 1776, the Delaware Assembly formed the state of Delaware and separated from the Commonwealth of Pennsylvania. In 1787, at the Golden Fleece Tavern in Dover, Delaware was the first state to ratify the U.S. Constitution.

Place names of Delaware waterways have fascinating stories. Flowing from Pennsylvania to the Christina River, the Brandywine was called Suspecough the indigenous name meaning, "at the muddy pond" and comes from the Swedish snaps Brannvin a potato liquor after the Old Barley Mill built by a 17th-century Swedish surgeon near present-day Market Street in Wilmington. The Christina River was the Lenape Sickpeckons Sippunk meaning, "at the river at the muddy pond," which was named after the teenage Swedish queen. Naamans Creek was named after an indigenous chief around 1655 and may refer to an Algonkian word for fish. Nanticoke comes from the indigenous tribe the tidewater people. Hwiskakimensi Sippus is the Lenape name for Red Clay Creek meaning "young tree stream." Shellpot Creek is the Kitthantemessink from the "large stream at the scattered stones." It is also from the Swedish Skoldpaddekill or Skillpaddekylen meaning "mud turtle creek." Sockarockets Ditch flows to the Deep Branch in Sussex County and is thought to have been named for an indigenous Chief Socoroccet who took part in the making of treaties delegating the land in the eastern part of Delaware in the

1680s. The White Clay Creek is anglicized from the indigenous Lenape Swapecksiska which the Dutch adapted to Hwitlerskil.

UDWRC Photogallery

Attendees gathered at the 57th Annual meeting of the UDWRC Advisory Panel last month at Hillside Park in Newark.

UDWRC Graduate fellows outside the office: Hayley (left) and Sophie (middle) graduated in May.

UD undergraduate students getting prepped for the Northbrook tour via kayak.

UDWRC Graduate Research Assistant & current Miss Delaware Sophie Phillips with Senator Chris Coons on the Brandywine River for the Shad 2020 Meeting at Dam 2.

Trout stocking on the Red Clay Creek.

Dr. Jerome Lewis, Director of IPA, and Dr. Gerald Kauffman, Director of UDWRC, recipient of the 2021 Ratledge Family Award for Delaware Public Service.

Students including UDWRC Graduate Research Assistants Sophie Phillips (center) and Liz Shields (second from right) enjoying the UDWRC Bratfest 2022.

Water Resources Information and Training

The Delaware Section of the American Water Resources Association events information can be found here.

The University of Delaware Section of AWRA - activities can be found here.

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