# Chesapeake Community Research Symposium 2026

Session 4: Data Centers and Water, Air, and Environmental Impacts and Solution Options in the Chesapeake Watershed

Session Leads: Kevin Sellner and Charles Bott

---

**Kevin Sellner (Hood College Center for Coastal & Watershed Studies)**

Data Centers and Water, Air, and Environmental Impacts and Solutions

Data centers are our new prolific neighbors found in all jurisdictions in the watershed except the District. These new industries demand massive power from the grid and local water supplies for cooling the large racks of electronic equipment. Power supplies are inadequate for all of the ~700 centers permitted, planned, and proposed in our region. Fossil-fueled school bus-sized generators are now THE backup power for these continuously operating centers yielding several hundred decibels of noise during brown outs and excessive GHG emissions that challenge regional emission reduction goals. Similarly, aqueous cooling of center equipment may jeopardize water supplies for other major consumers (current and future residents, businesses, and public services). Discharged data center cooling waters pose problems for downstream treatment facilities, potentially reducing facility efficiencies to yield poorer water quality discharged into local waterways. Stormwater runoff from huge impervious surface pads, storage tanks, and parking lots threaten adjacent properties and wells and, as well, groundwater recharge. Most of these threats remain to be identified and quantified in order to minimize data center impacts while providing the ever-increasing computing power needed by our society. The session's goal is to entice the region's research community effort to minimize data center impacts while collecting the excessive revenues from these new industries so beneficial to our societal needs.

---

**Lauren Barbir (HDR, Inc)**

Data Centers: the water-energy nexus

Artificial Intelligence (AI), high performance chips, and data centers continue to make headlines. This session will begin with an introduction to these topics around the digital infrastructure industry, including the latest trends in data center design and what AI adoption means for water and energy usage, both direct and indirect. Data centers are the backbone of the digital infrastructure that runs our lives – data management and storage, financial modeling, web search, driving directions, and more. The growth in data centers is driven by the continued increase in data usage, plus the growth and adoption of AI. The ability to support the amount of power and water these facilities need is driven by the type of facility, the design basis, and operational design considerations, like redundancy and reliability levels. In this presentation, the

audience will learn about different types of data centers, key terminologies and acronyms, and considerations for both water and energy use in design decisions.
Presentation specific topics will include:
• Types of data centers – hyperscale, colocation, enterprise
• Introduction to the water-energy nexus – impact of design decisions
• Sustainability goals – overview of data center goals, scope 1/2/3 emissions
• Cooling designs of data centers and water use impacts – ex – direct diabatic cooling, air cooling
• Power supply options – off-site, on-site / behind the meter, renewables, and nuclear evolution

---

**Michael College, P.E. (Susquehanna River Basin Commission)**

From Megawatts to Megabytes: Advancing Dry Cooling Success in the Susquehanna River Basin

Early Pennsylvania proposals indicate that a single AI hyperscale complex can require millions of gallons of water per day. As an agency that regulates large water users, scientists at the Susquehanna River Basin Commission (SRBC) are always looking for ways to conserve, reduce and mitigate water use. One success story takes us back a decade. In 2015, electric power generation accounted for almost 75% of reported consumptive use (or 93 million gallons per day) in the Susquehanna River Basin. At the time, primarily as a result of shale gas development, there was also rapid expansion and construction of new thermoelectric power plants, presenting a unique opportunity to change the status quo. This activity prompted the SRBC to evaluate various cooling options for combined cycle gas turbine power plants related to water efficiency, and resulted in a resolution promoting and incentivizing dry cooling technology.

Since then four dry cooling power plants have operated in the basin with impressive results. Through 2024, more than 45 billion gallons of water use has been avoided by the four plants. Consumptive use rates for evaporative cooling power plants have averaged ~225 gallons per megawatt hour (MWh) of generation, while dry cooling power plants have averaged ~3 gallons per MWh, a reduction of over 98%.

Recently the Commission expanded its resolution to encourage data centers and other emerging water-intensive facilities to consider the use of dry, hybrid, or other water-saving technologies for cooling purposes. With the hyperscale data center industry in its infancy in the Susquehanna River Basin, now is the time to explore if the power plant dry cooling success story can be repeated.

---

**Charles Bott (Hampton Roads Sanitation District), Alexandria Gagnon, Kevin Sellner**

Understanding the Impact of Discharges from Data Centers on Wastewater Treatment Plants: Fundamentals and Potential Impacts

Data centers represent a rapidly growing source of industrial wastewater discharges, and their unique chemical and physical characteristics may pose challenges for municipal wastewater treatment plants (WWTPs). This presentation reviews identifies potential vulnerabilities associated with data center-related waste streams, with a focus on biological nutrient removal (BNR), bioflocculation, disinfection performance, and biosolids quality. A conceptual "source-cause-effect" framework is used to connect influent disturbances to treatment impacts and regulatory outcomes. Key wastewater treatment functions potentially affected include nitrification, denitrification, biological phosphorus removal (bio-P), solids separation, and downstream disinfection processes. Several constituents associated with data centers, including elevated salinity/total dissolved solids (TDS), cooling tower blowdown, heavy metals, cleaning and passivation chemicals, biocides, corrosion inhibitors, and heat, may cause both biological process inhibition and physical/chemical disturbances. Elevated salinity and shifts in monovalent/divalent (M/D) cation ratios can disrupt floc structure through cation exchange mechanisms, resulting in deflocculation, poorer settling, higher effluent total suspended solids (TSS), and reduced dewatering performance. Nitrification inhibition and bio-P impairment may lead to elevated effluent ammonia, total nitrogen, and total phosphorus, increasing chemical addition costs and threatening permit compliance. In addition, heavy metals and persistent contaminants may pass through treatment processes and accumulate in biosolids, potentially affecting 40 CFR 503 compliance. Overall, the work emphasizes the importance of understanding influent variability and process impacts to protect WWTP performance as data center development expands.

---

**Kendra Sveum (Loudoun Water)**

Data Center Effluent Case Study: Operations Impacts on a Wastewater Treatment Plant

This presentation will provide an overview of wastewater discharge characterization from data centers, focusing on operational flows, effluent composition, and operational challenges at the Broad Run Water Reclamation Facility (BRWRF). Drawing on event analysis over the last decade of data center development in Loudoun County, the discussion will include specific case studies on the impact of biocides, metals, and passivation chemicals on treatment processes. The overall goal is to emphasis the importance of ongoing monitoring, adaptive management, and close coordination to ensure compliance and protect water quality with evolving data center operations.

---

**Larry Band (University of Virginia), Rouyu Zhang, Tejendra Kandel, Lauren Bridges, Joao Ferreira**

Watersheds and Data Center Development Impacts

The rapid development of data centers in response to AI computational demands is a critical area of interest in the mid-Atlantic states. Data centers tend to agglomerate where required resources of electric power capacity, available water and fiber-optic infrastructure are available. Northern Virginia alone has ~40% of global data center capacity, with major concentrations in Louden and Prince William Counties. This has led to the transformation of rural and exurban land with a large increase in impervious area and water demand. While residential and commercial development can also introduce large increases in impervious area and water use, the pattern of development with very large facilities and nature of the infrastructure differs. An important question is whether the impact of data center agglomerations provides water impacts that differ from other rapid urban development in terms of water use, stormwater runoff, subsurface storage and nutrient and sediment loading. The Broad Run watershed, spanning Louden and Fairfax Counties, drains about 200 km2. Impervious area has more than doubled since 2000. While a large component of impervious area is Dulles International Airport, a large portion of the increase is associated with the development of data centers in the area north of the airport. We investigate whether and how data center development patterns and infrastructure may alter surface/subsurface hydrology and nutrient loading compared to other forms of development. We combine analysis of streamflow records and water quality sampling by the USGS and Virginia, and detailed modeling of watershed ecohydrology using a distributed ecohydrological model. The Regional HydroEcological Simulation System resolves built and natural flowpaths, with coupled water, carbon and nutrient cycling and export. We simulate pre and post development conditions, and scenarios based on surrounding residential and commercial development at high spatial resolution to evaluate impacts on water, carbon and nutrient cycling and export.

---

**Allison Welch (Chesapeake Research Consortium), Daniel Koval**

Global Data, Local Impacts: How data center development is changing your local landscape

It is impossible to ignore the rapid expansion of data centers within the Chesapeake Bay Watershed driven by growth in artificial intelligence aspirations and applications. Specifically, Northern Virginia is one of the most popular U.S. data center locations due to its existing fiber network, reliable energy infrastructure, and data center tax incentives. From high energy consumption and water usage to increased land development, there is a lot for environmental professionals to consider as this industry grows. The data centers and associated infrastructure result in the conversion of working farms and forests to development, adding significant amounts of impervious surfaces which threaten water quality, increase flood risk, and can cause biodiversity loss. Scientists from the Chesapeake Research Consortium and Chesapeake Bay Program have researched land use change over time to quantify the impacts of impervious surfaces on the Chesapeake Bay Watershed and its smaller watersheds. By using 2013, 2017, and 2021 land use/land cover data along with publicly available data on data center locations, we quantified the growth of impervious surfaces brought about by data center development. This exploratory exercise illuminates how the data center industry is changing the landscape in parts of the watershed and how that may affect stream health and stormwater runoff. This data could also inform local governments on the potential impacts of proposed data centers in many counties across the Bay's watershed. We hope our findings create awareness among citizens and public officials about the implications of data centers and the importance of utilizing land that is already urbanized.

---

**Julia Davis (University of Virginia), Landon Marston, Majid Shafiee-Jood**

A Review of Data Center Water Use, Methodological Gaps, and Policy Implications

As artificial intelligence and cloud computing drive rapid growth in data center capacity, questions about the sector's water footprint are increasingly entering local permitting, utility planning, and public debate. Yet estimates of data center water use vary widely across studies and reporting contexts, making it difficult to interpret claims, compare facilities or regions, or identify what information is most relevant for decision making. This presentation synthesizes recent water use estimates for data centers and examines why they differ, focusing on how choices in system boundaries, metrics, and underlying assumptions shape reported results. Published estimates spanning multiple geographies and scales are reviewed to identify key sources of variability and to clarify how methodological differences influence conclusions about risk. In particular, the analysis highlights circumstances in which high level estimates may obscure localized conditions that are most relevant for water supply planning and community impacts. The findings underscore the need for clearer, more consistent water use reporting and provide practical guidance for water managers and policymakers on interpreting water use claims, identifying critical data gaps, and aligning water accounting practices with planning and regulatory needs.

---

**Lauren Barbir (HDR, Inc)**

Data Centers: Trends and innovation for water use for a circular economy

According to the EPA, "A circular economy keeps materials and products in circulation for as long as possible." This session will explore how we can think holistically about the opportunity to connect wastewater treatment plants, data centers, power generation, and other industrial facilities to benefit a circular economy. The United States has the largest concentration of data centers in the world, roughly 50% of the world's 11,000 data centers as of 2024). These massive server farms play a significant role in the backbone of our digital economy – they manage the immense amounts of data collected and generated. Once concentrated in VA, CA, NY/NJ, and TX, data centers now are operating, being constructed, and/or being evaluated in most primary, secondary, and tertiary markets in the country, sometimes in very rural locations. This session will explore the current trends and innovations in water use in data centers and how these

decisions tie into site selection, power vs water use decisions, and opportunity to create a circular economy.

Topics may include the following, including example projects:

• Water use vs power use in data center design – what data centers consider in how they select their cooling basis of design
• Tech industry sustainability goals – overview of goals, scope 1/2/3 emissions
• Water source identification for data centers – ground, surface, potable, reclaimed, seawater, etc
• Expanding to more sustainable water practices – rainwater harvesting, brackish groundwater, aquifer refresh/recharge)
• Future of co-location of data centers with WTP/WWTP, power plants, and other industrial facilities – water and energy cycles and symbiosis between the facilities