# West Virginia Water Research Institute
# West Virginia University

## Annual Technical Report
## 2019

# Products

**Presentations** (Speakers underlined, *Undergraduate student researchers)

Hopkinson, Leslie, McNeil*, Wilson, Wimer*, Ethan, Hay*, Andrew, and Foley*, Hannah. "Evaluation and Water Allocation Models for West Virginia." West Virginia Water Research Institute Seminar Series, December 16, 2020. Virtual (Zoom).

Hay*, Andrew, and Hopkinson, Leslie. "West Virginia Lake Budget." Fourth Annual Undergraduate Spring Symposium: A Virtual Conference Experience. 1-30 April 2020. West Virginia University, Office of Undergraduate Research. (poster)

Foley*, Hannah, and Hopkinson, Leslie, "Changes in water demand in West Virginia." Fourth Annual Undergraduate Spring Symposium: A Virtual Conference Experience. 1-30 April 2020. West Virginia University, Office of Undergraduate Research. (poster)

Sjostedt*, E., Zégre, N. 2020. Assessment of West Virginia Water Use. December 16. West Virginia Water Research Institute Virtual Seminar Series. https://wvwri.wvu.edu/news/2020/11/13/wri-to-share-research-with-public-through-virtual-seminar-series

**M.S. Problem Report**

Thompson, Madison. "Review of Water Basin Models for West Virginia." M.S. Problem Report, West Virginia University Morgantown, WV, 2019.

**Publications**

Merriam, Eric, et al. "Flow-Mediated Vulnerability of Source Water to Elevated TDS in an Appalachian River Basin" Water, vol. 12, no. 2, 2020, pp. 384-396.

Stampoulis, D., L. Marston, T. Troy, B. Ruddell, R. Rushforth, Zégre, N., J. Sabo. "WUSA1k (1.0), a 1km monthly domestic water-use history for the conterminous United States". Planned submission to *Scientific Data*, April 2021.

# Information Transfer Program

## WVWRI Seminar Series

WVWRI hosted a three-part virtual seminar series from December 2020 through February 2021 to share current research and remediation projects with interested outside organizations and the public. Presentations available here: https://wvwri.wvu.edu/outreach/seminar-series

*The first session* featured three research projects carried out by WVU researchers with funding from the United States Geological Survey (USGS) 104b program. These projects share the common focus of water quality and quantity. Presentations included:

- Evaluation of Water Allocation Models for West Virginia: Leslie Hopkinson, Ph.D., Associate Professor of Civil and Environmental Engineering, and undergraduate student researchers Hannah Foley, Andrew Hay, Wilson McNeil, and Ethan Wimer

- West Virginia Water Use Assessment of Federal Datasets: Nicolas Zegre, Ph.D., Associate Professor of Forest Hydrology, Mountain Hydrology Laboratory, and Eric Sjostedt, Graduate Research Assistant, Mountain Hydrology Laboratory
- Bromide, Chloride, Sulfate, and TDS Trends in the Allegheny, Monongahela, and Ohio Rivers: Joseph Kingsbury, Graduate Research Assistant, WV Water Research Institute

*The second season included* an overview of The Northern West Virginia Brownfields Assistance Center program and highlighted key projects in the second session. NBAC, housed within WVWRI, assists communities in assessing, cleaning up, and redeveloping contaminated sites. This session provided introductory information for those interested in restoring a brownfield or dilapidated building in their community. NBAC speakers included:

- Carrie Staton, Interim Director, NBAC
- Nicole Dias, Project Associate, NBAC
- Ray Moeller, Economic Redevelopment Specialist, NBAC

*The third and final session* was dedicated to acid mine drainage (AMD) research and remediation. Projects included current and anticipated recipients of USGS 104b funding, as well as remediation efforts carried out through the National Mine Land Reclamation Center, a program of WVWRI. Presentations included:

- Monitoring Fecal Coliforms and E. Coli in Watersheds Impacted by Acid Mine Drainage: Emily Garner, Ph.D., Professor of Civil and Environmental Engineering, and Claire McDonald, M.S. Student in Civil and Environmental Engineering
- Lambert Run Watershed Restoration: Sarah Cayton, Program Manager, National Mine Lands Reclamation Center, WV Water Research Institute
- Deckers Creek Passive Treatment Evaluation over Lifespans, Seasons, and Storms: Christopher Russoniello, Ph.D., Professor of Geology and Geography, and Brian Hurley, Executive Director, Friends of Deckers Creek

## Additional outreach included:

**Evaluation of A Water Allocation Model For West Virginia**

One seminar presentation and two poster presentations were completed. We continue to complete technical presentations and publications. For example, an abstract was submitted to the West Virginia Academy of Science to present results at the 2021 Annual Meeting (April 10, 2021).

A fact sheet for the project is available at https://wvwri.wvu.edu/

**TSS Sampling In The Upper Ohio River Basin & Reestablishment Of Sampling Sites**

Information from this program is being transferred through the WATERS database, which is accessible to the public. A brief write-up for this project will be included on the 3 Rivers Quest website for the public.

A fact sheet for the project is available at https://wvwri.wvu.edu/

**Upper Ohio River Basin Data Analysis and Results**

Information from this program is being transferred through the WATERS database which is accessible to the general public. 10- and 5-year reports for the Monongahela, Ohio, and Allegheny River basins will also be available to the general public through the 3RQ and WVWRI websites.

A fact sheet for the project is available at https://wvwri.wvu.edu/

**Modeling Water Quality Changes In The Monongahela River Basin**

A fact sheet for the project is available at https://wvwri.wvu.edu/

**Updating The West Virginia State Water Budget: Quantifying Monthly And Seasonal Water Use, Thresholds, And Stress At The wWtershed-scale**

The information and products generated during this project were shared the WV DEP, WV DHHR, WV, DNR, the West Virginia Water Advisory Board, and other interested agencies through the West Virginia Water Research Institute Virtual Seminar Series:

Furthermore, water supply stress framework, data, and findings were incorporated into FHYD 444 Watershed Management, course taught by Dr. Zegre in Spring 2021

A fact sheet for the project is available at https://wvwri.wvu.edu/

## Student Support

| Category | Number of students supported with USGS 104b base grant | Number of students supported with matching funds | Total number of students supported |
|---|---|---|---|
| Undergraduate | 5 | 9 | 14 |
| Masters | 3 | 2 | 5 |
| Ph.D. | 0 | 0 | 0 |
| Post-Doc | 0 | 0 | 0 |
| **Total** | **1** | **5** | **6** |

## Notable Achievements and Awards

None during this reporting term.

# Evaluation Of A Water Allocation Model For West Virginia

**Project Type:** Annual Base Grant
**Project ID:** 2019WV272B

**Project Impact:**

Sustainable water management is complex. Effective management must satisfy all the demands on water resources, consider changes over time, and ensure no degradation. No matter the complexity, managers must have knowledge of water quantity. This work explored the use of water quantity models and water budgets in West Virginia. The intent is to aid in our understanding of current water usage and future needs in West Virginia.

First, existing water allocation models were reviewed. Water budgets were explored for a small lake and a stream reach with large quantity users related to the natural gas industries. The Water Evaluation and Planning system (WEAP) was selected to further explore several small-scale scenarios in West Virginia. WEAP is a software tool for integrated water resources planning. It provides a comprehensive, flexible and user-friendly framework for planning and can utilize a water balance approach.

Changes in water demand due to population changes, large quantity users along a river reach, and small-reservoir impact on water availability were evaluated. A watershed-scale simulation was initiated. While small-scale simulations were completed through this study, it will help identify future needs for the state. In addition, the developed methods can be applied at a larger scale in the future. Results from this effort will benefit the future development of a state-wide water balance.  Knowledge gained through this work will support the future development of a tool for stakeholders to use to understand how future water needs and uses would impact water resources.

# WRI 265 TSS Sampling In The Upper Ohio River Basin & Reestablishment Of Sampling Sites

**Project Type:** Annual Base Grant
**Project ID:** 2019WV273B

**Project Impact:**

This project sampled Total Suspended Solids (TSS) along with other water quality parameters at 44 sites over 12 months for a total of 528 samples in the Upper Ohio River Basin. Included in these samples was the reestablished sites of Robinson Run and White Day Creek. Using this TSS data we attempted to create a linear model using a multiple linear regression approach with our other water quality parameters, primarily dissolved metal concentrations. TSS was the response variable and our predictor variables were as follows: flow(cfs), temperature(C°), conductivity (µS/cm), pH, Strontium (mg/L), Aluminum (mg/L), Iron (mg/L), Manganese (mg/L), magnesium (mg/L), total dissolved solids (mg/L). The results of this model produced several interesting findings. One of our key findings was that significant differences exist when predicting TSS response on a river by river basis. We also discovered that Flow (cfs), Iron (Fe), and Manganese (Mn) were significant predictors across all 3 rivers. The adjusted r-squared value was 0.292 indicating a weak to moderate correlation between our significant predictor variables and TSS. While this model is helpful in pinpointing significant predictor variables, it's sub-par adjusted r-squared value indicates it probably not a very good forecast model when it comes to TSS.

## WRI 264 Upper Ohio River Basin Data Analysis And Reporting

**Project Type:** Annual Base Grant
**Project ID:** 2019WV274B

**Project Impact:**

The objective of this project was to utilize the 3 Rivers Quest (3RQ) data set to assess halogen transport and impacts in the Upper Ohio River Basin. Using a mass balance approach, several statistical analyses were used to determine the long-term trends in mass loadings, concentrations, and dilution factors for bromide, chloride, sulfates, and total dissolved solids (TDS). All significant trends detected in the Monongahela River were decreasing trends for all 4 parameters. In the Allegheny River system, many sites showed decreasing trends with the exception of the northern Allegheny River which displayed increasing mass loading trends for chloride, sulfates, and TDS. The Upper Ohio River also produced significant decreasing trends for chloride and bromide concentrations. Single point change testing showed that each system's respective trend changes occurred simultaneously around the same time within a given river basin. The Monongahela's point change for sulfate and TDS appears to coincide with the implementation of the Mine Discharge Management Plan. Dilution factors for all parameters across all river systems remained steady and no significant changes over time were observed. However, bromide in particular was prone to spiking in certain regions of the Allegheny and Monongahela Rivers indicating a potential for further investigation for point sources.

# WRI 263 Modeling Water Quality Changes In The Monongahela River Basin

**Project Type:** Annual Base Grant
**Project ID:** 2019WV275B

**Project Impact:**

Results of the present study demonstrate the myriad of spatial (e.g. land use) and temporal (e.g. variability in flow) factors that control vulnerability of source water to elevated total dissolved solids (TDS). Management decisions that do not incorporate these complexities risk ineffective or inappropriate actions. Management of TDS within this and other systems should first seek to identify and prioritize areas for reducing current sources of TDS throughout the watershed and for protection of minimally impacted streams to maintain current and future assimilative capacity. It could also be possible to leverage existing water management and reservoir systems to maintain assimilative capacity during critical low-flow periods; however, additional study would be needed to verify that these reservoirs have the capacity to maintain all authorized purposes (e.g. navigation, fish and wildlife habitat enhancement) while providing additional low-flow augmentation for maintenance of water quality. Given widespread salinization of streams and rivers, an important avenue of continued research will be to characterize the spatio-temporal vulnerability of this and other critical source waters to elevated TDS. It will be particularly important to characterize vulnerability to TDS within the context of other pollutants and under a range of future land use and climate change (i.e. flow variability) scenarios. Such efforts will be critical toward effectively ensuring sustainability of aquatic ecosystems and the vital services they provide (e.g., drinking water provision).

# Updating The West Virginia State Water Budget: Quantifying Monthly And Seasonal Water Use, Thresholds, And Stress At The Watershed-scale

**Project Type:** Annual Base Grant
**Project ID:** 2019WV276B

**Project Impact:**

Comparison of water use estimates from the USGS National Water Use dataset and the WV DEP Large Quantity Users dataset revealed similar estimates of water use across mining, public water supply, and industrial water use sectors. In the case of aquaculture and thermoelectricity, USGS data were respectively 26% and 45% greater than LQU data suggesting potential under reporting of water use by LQU.

Recent levels of water withdrawals do not appear to be stressing HUC8 or HUC12 watersheds at the long-term annual scale. However, more research is necessary to understand the hydrologic implications of water use on seasonal and monthly timescales.

Due to the large unresolved disparities in thermoelectric water use between datasets, temporal disaggregation of annual water use across all sectors to seasonal and monthly data was not possible. However, temporal disaggregation of domestic water use to a monthly timescale was successful and included in a forthcoming manuscript.