# Teaching hydrogeology in a mined site: a case study on West Run, Morgantown, WV

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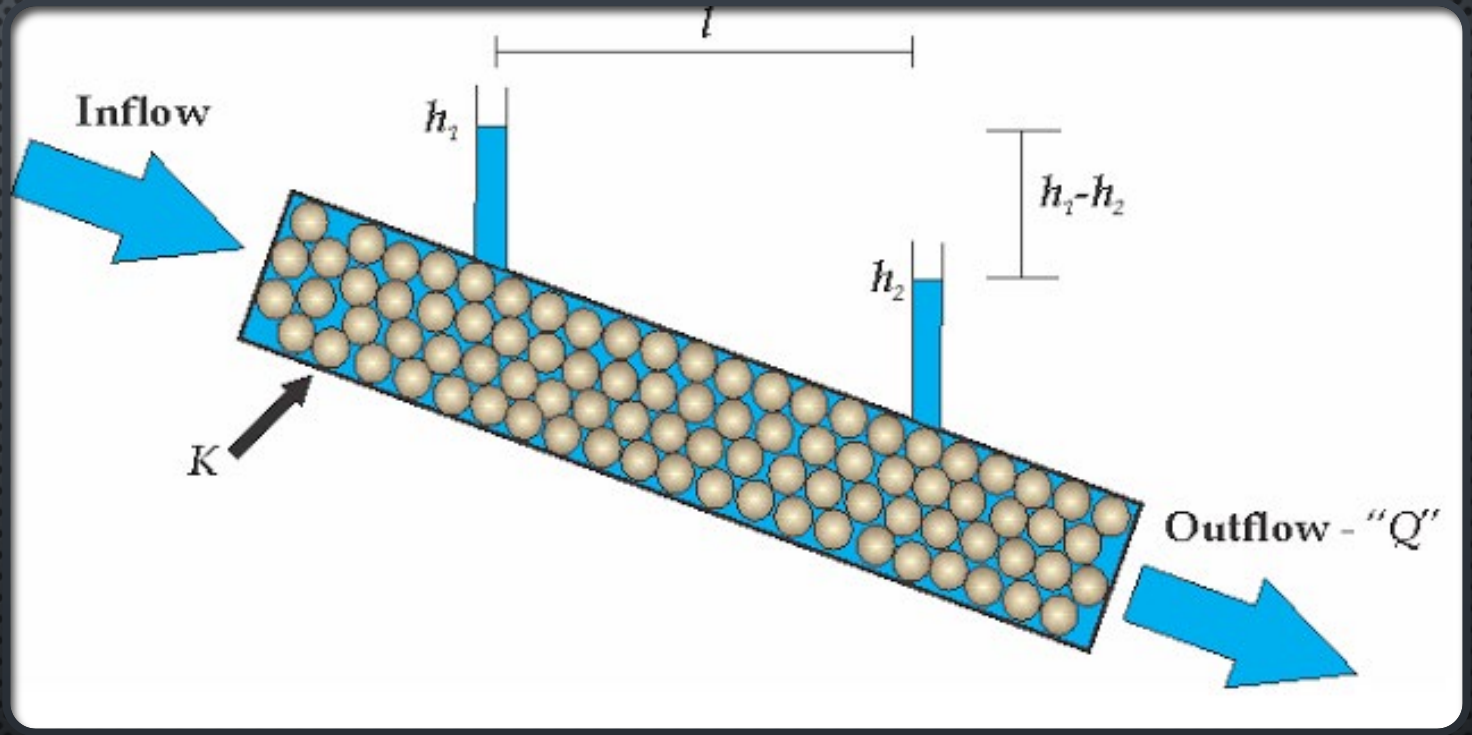
## HYDROGEOLOGY – FALL 2023

- 23 Undergraduate students
- Variety of backgrounds
  - Geology
  - Soil Science
  - Fish and Wildlife
  - Environmental Science
- No pre-requisite
- All Class levels

# Darcy is Dead?

PEDAGOGY OF HYDROGEOLOGY CAN BE STAGNANT

- RAPIDLY CHANGING WORLD:
  - CLIMATE SHIFTS
  - POLITICAL AND SOCIAL PRESSURES
  - ESCALATING HUMAN EFFECTS ON HYDROLOGICAL SYSTEMS



# THE UPS AND DOWNS

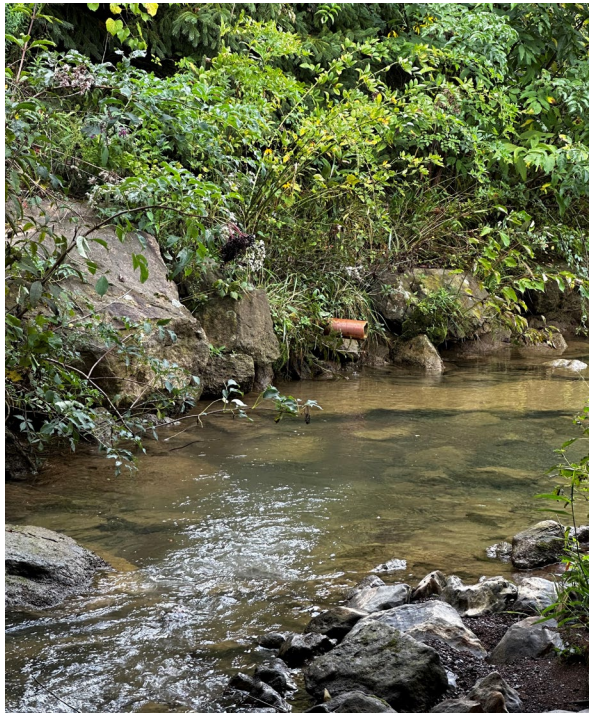
- THE DEMAND FOR SKILLED PROFESSIONALS IN HYDROGEOLOGY IS SURGING.
- STUDENT INTEREST IN GEOLOGY AND SCIENCE FIELDS IS PLUMMETING,
  - DUE TO THE PERCEIVED CHALLENGES OF MATH AND SCIENCE (STEPHENS 2009).

•URGENCY SURROUNDS THE NEED TO CONFRONT THESE ISSUES HEAD-ON AND REVOLUTIONIZE HOW HYDROGEOLOGY IS TAUGHT.

•THE SOLUTION MAY LIE IN INCORPORATING HANDS-ON, REAL-WORLD SCENARIOS INTO THE CURRICULUM

# For every action….

- We need to listen to the students:
- They don't want to be inside
- They have short attention spans
- They need to know there are jobs
- They want to know how to do things no hear about how to do things

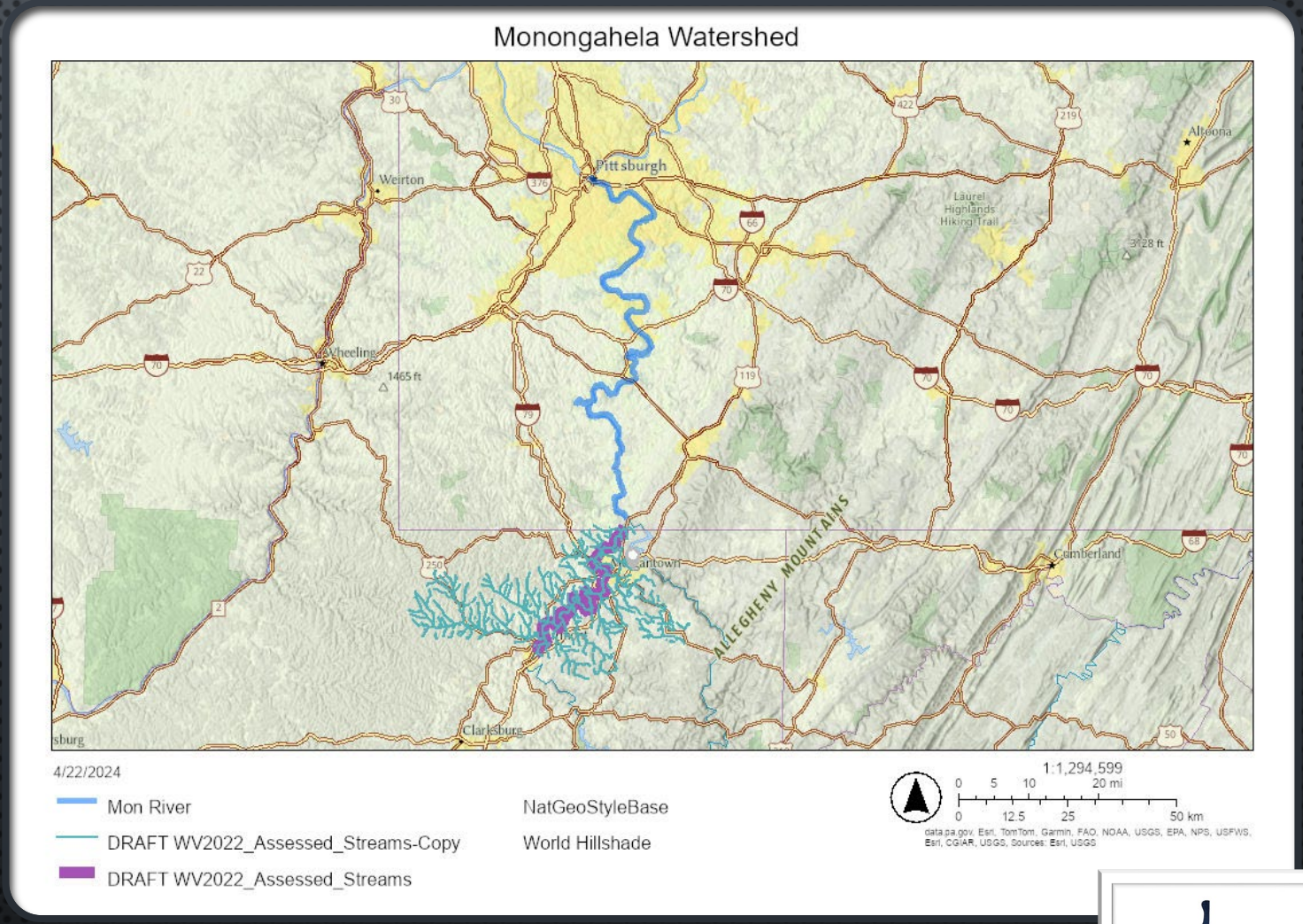


# West Run

- Runs through WVU campus
- WVU has field site locations along West Run
- Only a five-minute drive from Geology building
- Large volume of historical data available for student reading
- Provides an amazing look at natural and anthropogenic processes

# The Great Monongahela River

- West Virginia university sits in the head waters of the Monongahela River
- Many of these important feeder streams run through Morgantown, WVU campus, and adjacent neighborhoods
- Monongahela flows north towards Pittsburgh, PA



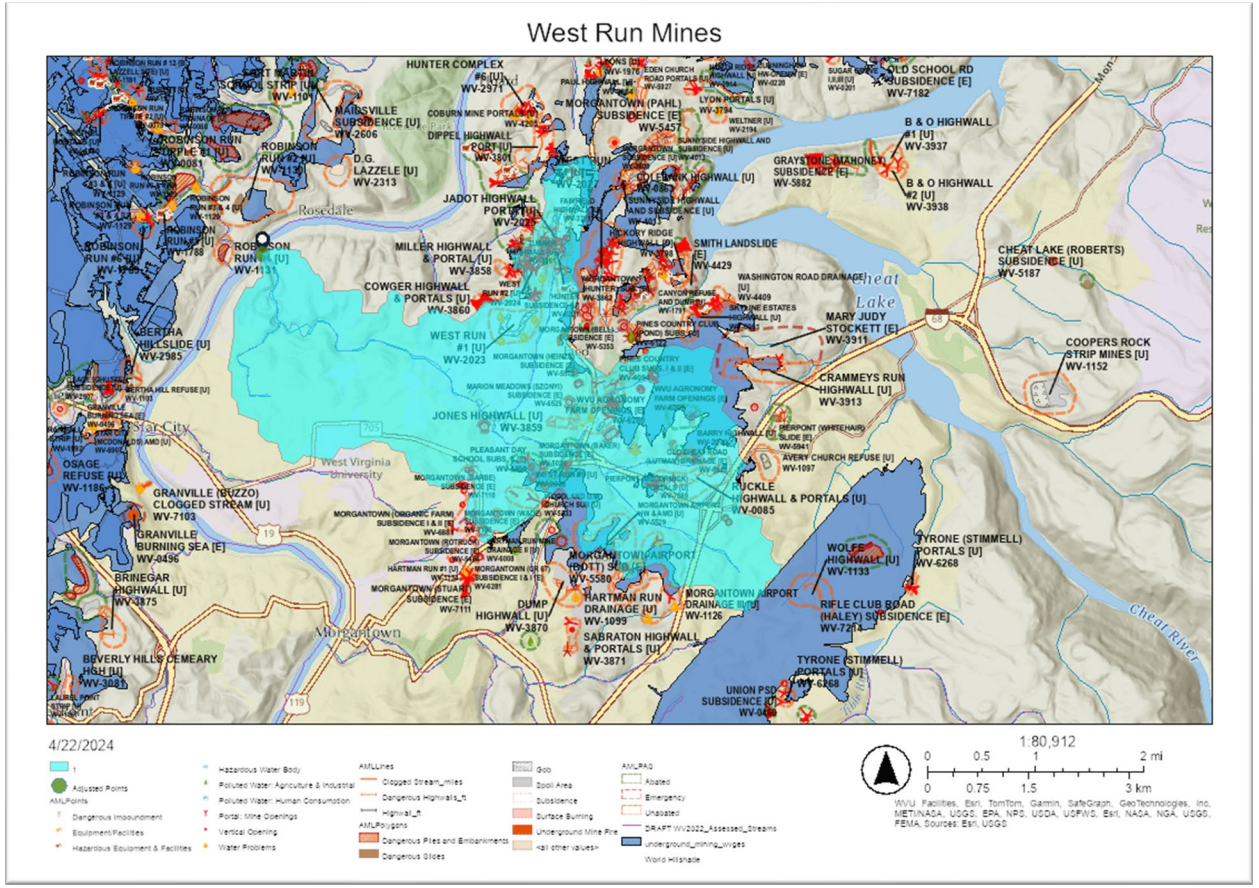
## Hydrology Cycle

- Groundwater feeds streams & Rainwater
- Monongahela flows into Ohio River
- Ohio joins Mississippi River
- Mississippi River flows into the Gulf of Mexico

# West Run

CHARACTERIZED AS AN IMPAIRED STREAM BY THE DEP AND EPA'S DEFINITION FOR EXCEEDING THE DAILY MAXIMUM LIMIT (TDML) FOR:

- IRON
- FECAL COLIFORM
- BACTERIA



# LAND USE CHANGES TO WEST RUN

# Starting out

Course Text: Hydrogeology 101: An Introduction to Groundwater Science and Engineering" (Kresic 2023)

Classical classroom instruction (Mondays and Wednesdays 9:30):

- confined/unconfined aquifers
- permeability/ porosity
- hydraulic conductivity
- water quality/contaminants
- mine chemistry and hydrology

Fridays Field Days! (8:30-11am)

Notably, this 3-credit class had no mandatory field component. In a unanimous decision during the first day of class, students voted to engage in this immersive learning format

# 3 Field Groups (7 members)

- COLLECTING AND PACKING THE NECESSARY EQUIPMENT
- MEETING AT DESIGNATED SITES
- COMPLETING SAMPLING TASKS
- LABELING DATA
- SHARING FINDINGS
- CLEANING AND RETURNING ALL

# Responsibilities once in field

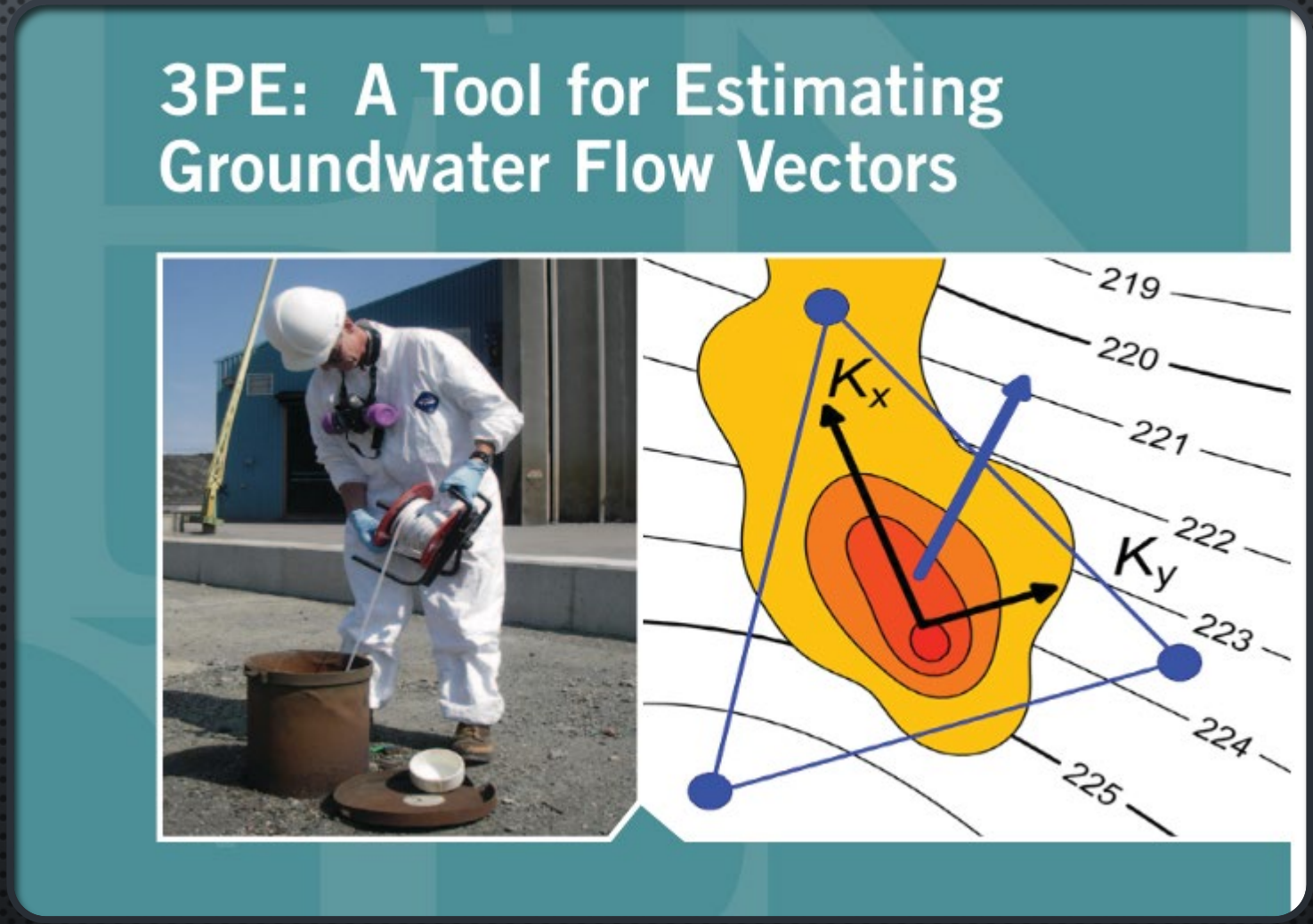
Each group was responsible for:

- redeveloping previously installed piezometers
- Installing at least 1 new pz
- Performing slug tests on all pzs
- Collecting field chemical water data including:
  - pH,
  - conductivity,
  - temperature,
  - TDS
  - salinity
- Collecting soil samples from pz or other site sampling, weighting, drying, reweighing and performing Munsell color analysis
- Perform a 3-point problem from pzs
- Collect field data
  - Weather
  - Plants
  - coordinates

# FIRST FIELD DAYS WERE ABOUT DISCOVERY AND PLANNING AND…..COWS!

# Methods for data Analysis

- Computational resources such as 3PE (Beljin 2015) and Bouwer-Rice slug USGS Excel workbooks (USGS 2004) were utilized to analyze data
- Soil characteristics and classification were determined through samples collected from auguring, using the USDA Munsell soil color comparisons and the USDA Excel soil calculator (Vanlear 2023)
- Graduate students within dept sampled points along West Run stream in study area and analyzed for cations and anions during fall break, and graciously shared data!



# Final Report

Academic journal-like template

- Groups were given discussion topics and questions to focus:
  - Descriptions of soil composition
  - Observed chemical parameter changes
  - Analyses of the overall hydraulic flow within the study area

Group submission

- Allowed for shared excel work
- Shared writing
- Shared map making
- Shared responsibility
- Anonymous group grading at end that count for 30% of total project grade

# Results

- Groundwater and stream water system is dominated by mine water
- Point and non-point source mine discharges interacts with local limestone strata to create weathered soils
- Agriculture and urban development has allowed for changes in slope vegetation causing deep erosional gashes in fields, flooding in low lying due to clay deposition, and undercutting of banks due to lack of vegetation and root systems

## West Run Final Report – Wetland Hydrogeological Connections & Water Quality Within The West Run Study Area

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**Abstract**

The impact of wetland hydrological connections on the water quality of downstream streams, rivers, and other surface and subsurface water bodies contain several factors. Within our West Run study area, there are six essential factors that tell us a story on what the West Run watershed and stream is today, and why. Soil composition, lithology of the watershed, piezometer composition and water flow, stream water composition, as well as agricultural and urban development are these primary connections.

These primary connections in our study area matter as they relate to the role of wetlands and pollution. Through installing our own piezometers, conducting slug tests to find hydraulic conductivity, performing core soil sample analysis (both wet and dry analysis) to help determine lithology, as well as water sampling and testing, these methodologies capture the complete narrative of the events unfolding within our West Run study area.

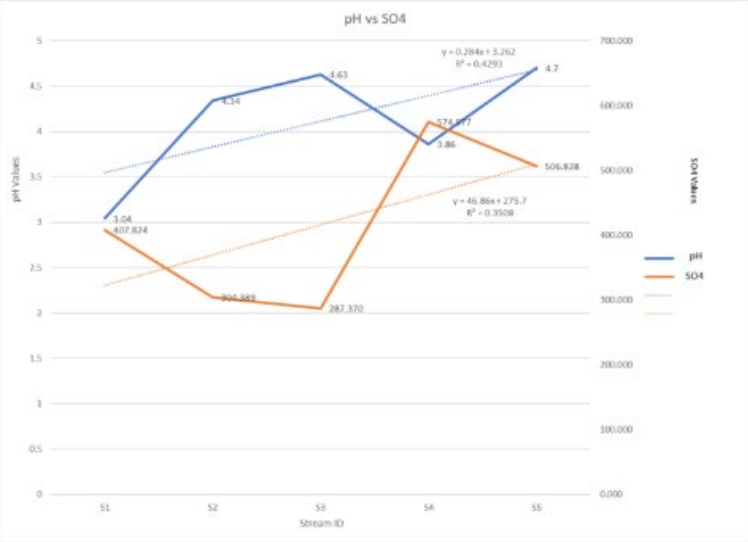



Figure 7.0: Stream sites pH vs $SO_4$

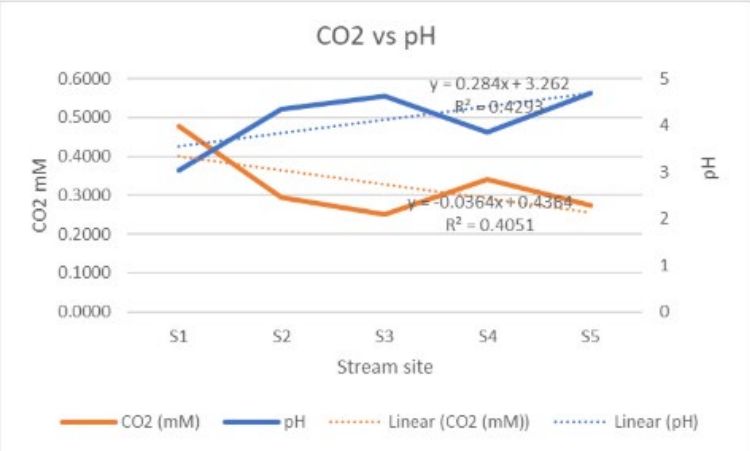



Figure 8.0: Stream sites pH vs $CO_2$

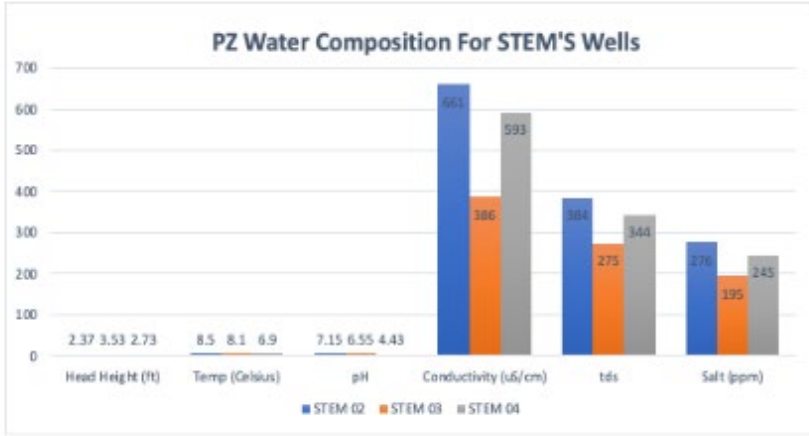



Figure 4.0: Piezometer Composition for wells STEM02, STEM03, & STEM 04

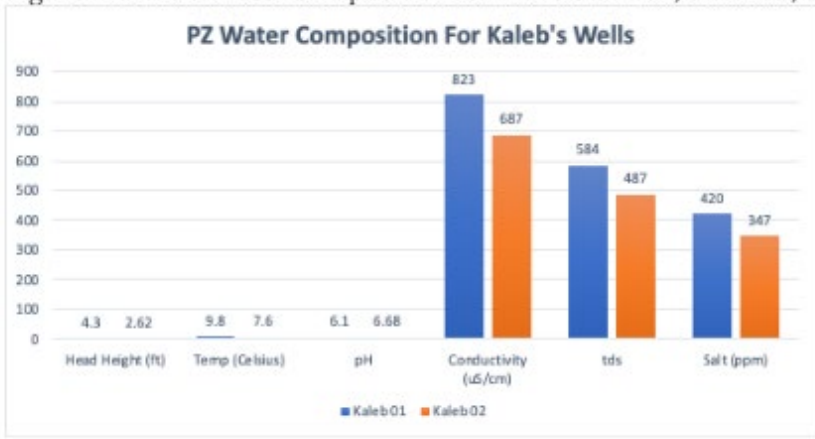
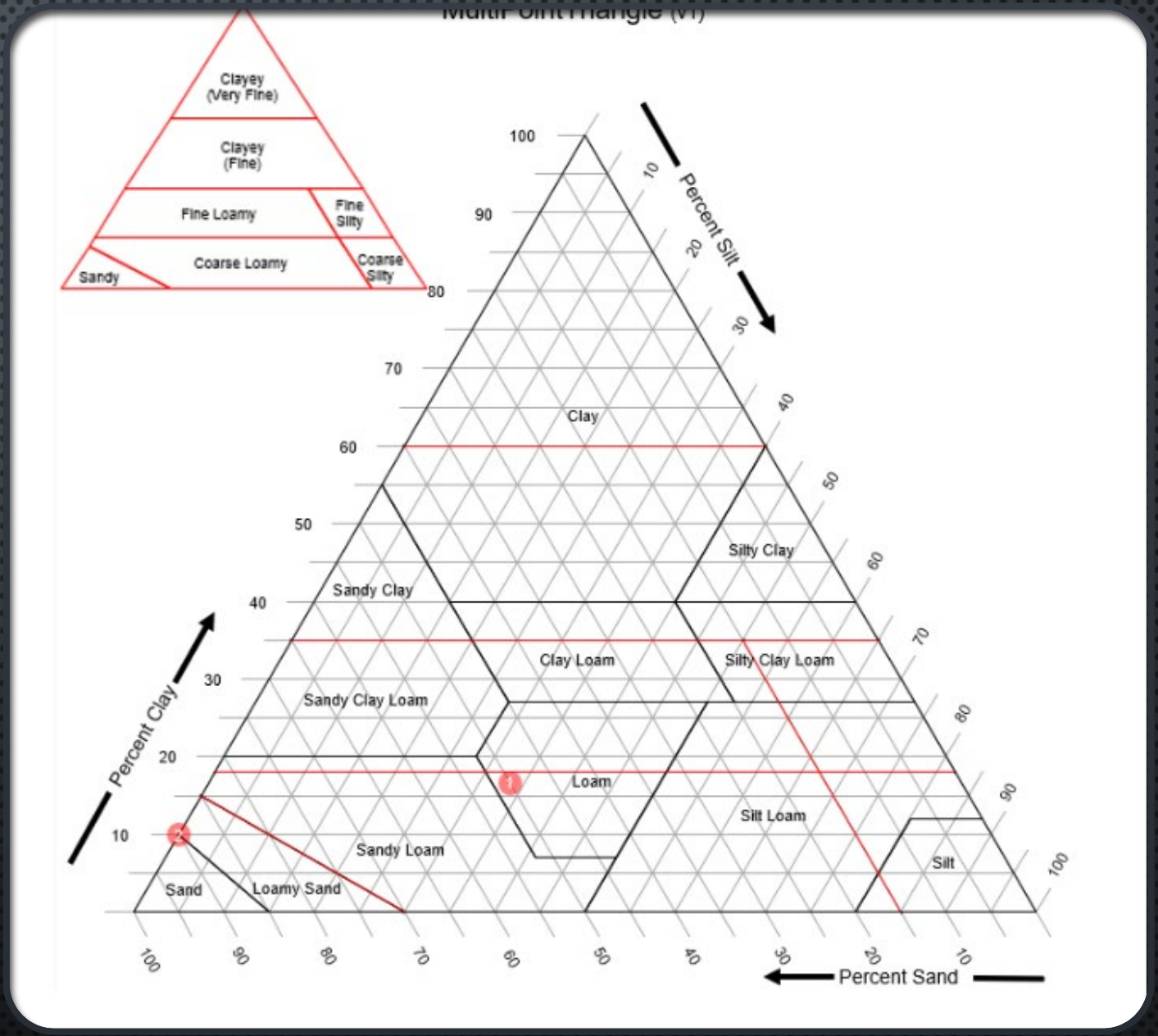



Figure 5.0: Piezometer Composition for wells, Kaleb01 & Kaleb02

# Soil

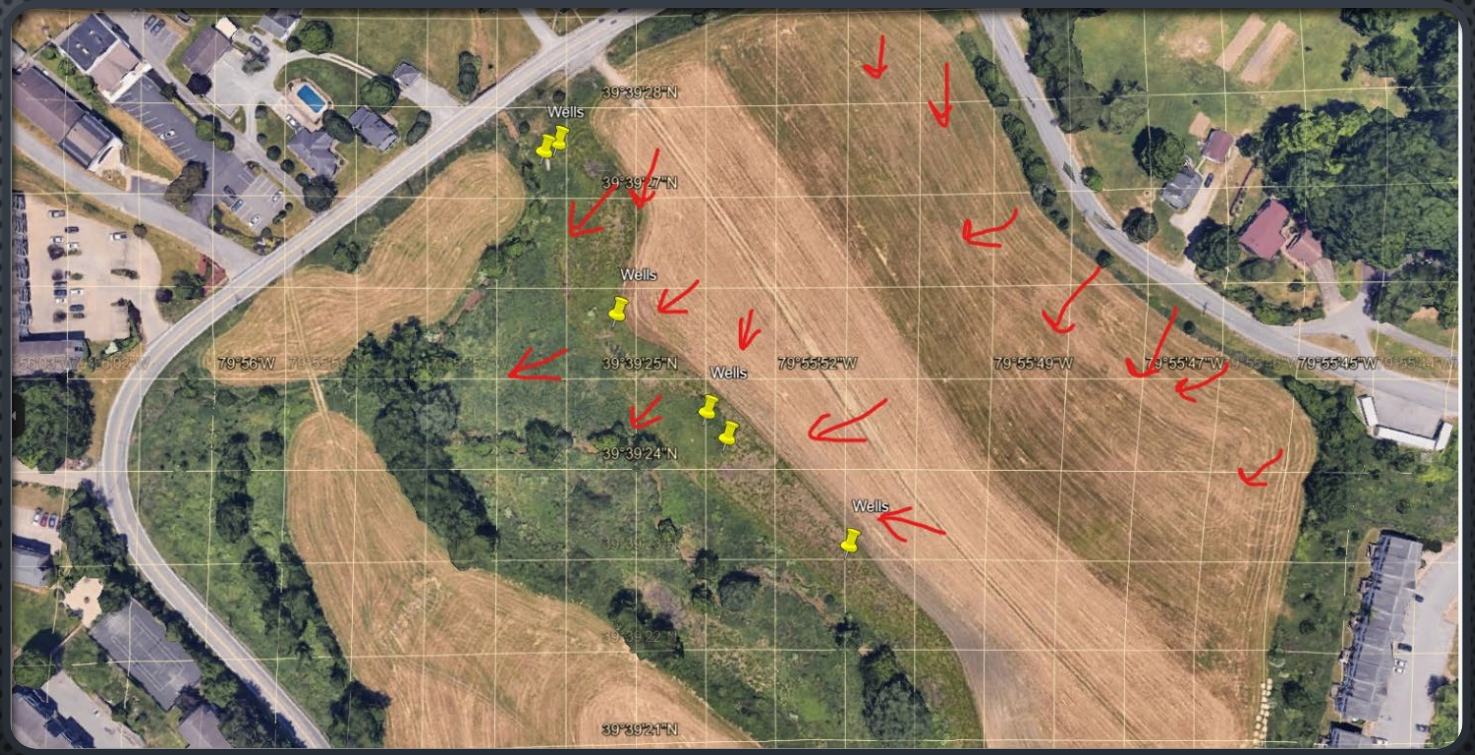
- Weathered local limestone clay soils dominated this system
- Carboniferous shale, old roots, and sand were also present including burned peat
- Study area closer to point source flooded entire time.

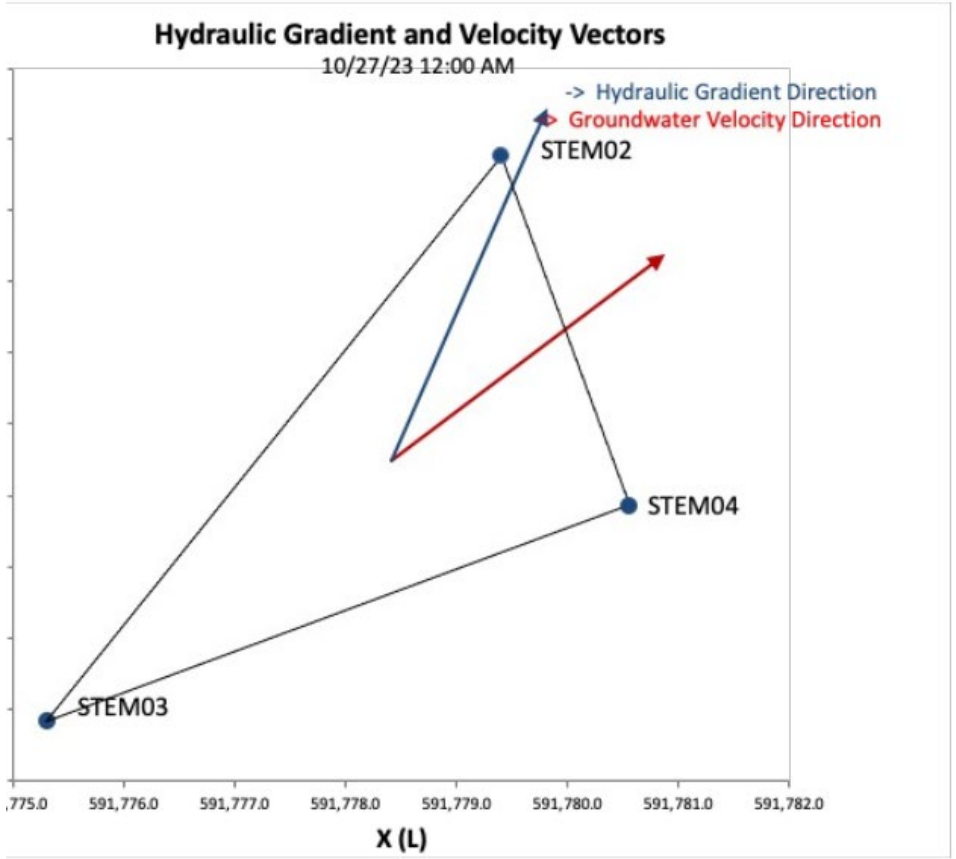


# Flows

Study area had two distinct areas of flow:

- Dominated by local geology and geography – Low permeability
- Coal Mine Upwelling & Point-source pollution from portal break-out *

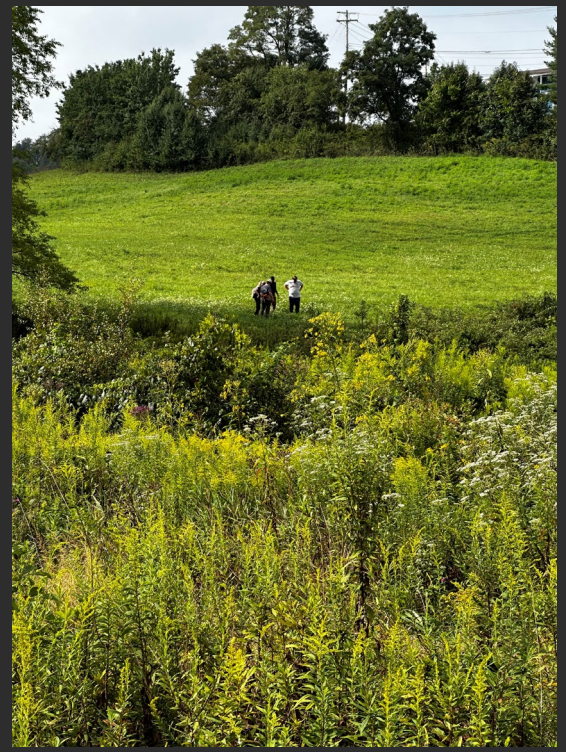



# UPWELLING FOR THE WIN!

# Conclusion

- Class engagement, morale and quality of work submitted were well above expectations for this course.
- Each group experienced uncomfortable weather conditions in the field
  - being exposed to hot and humid bug filled days
  - to the shift of icy rain at the end
  - a true field camaraderie was developed amongst the class.
- This bond seemed to enhance the learning environment and extended into their efforts to help each other in other aspects of the course.
- Course evaluations showed that fieldwork was the top ranked component of the course.
- Future efforts to develop this course include more speakers to meet us in the field – Hint, Hint!





# Questions?