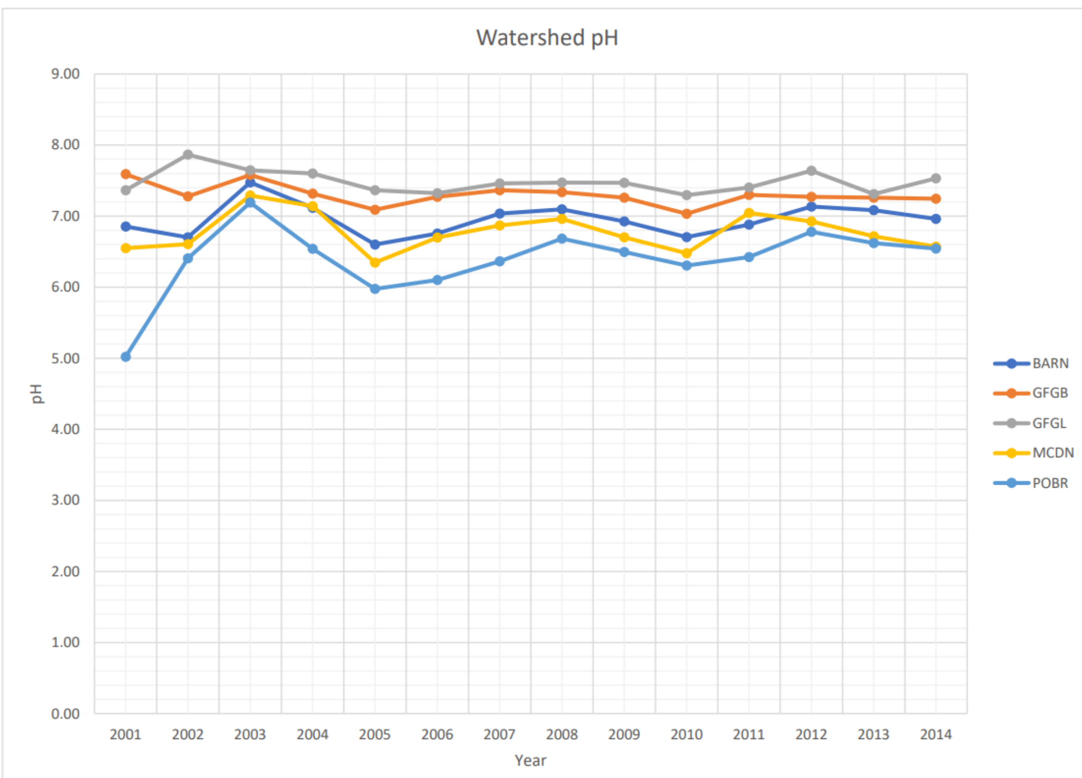
WEATHERING, EROSION & DEPOSITION MODULE

LESSON 4:

WEATHERING AND WATER QUALITY



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ICE Leadership Team

- Alan R. Berkowitz, Head of Education, Cary Institute
- Joshua Gabrielse, Director of Science, City Schools
- Kevin Garner, Coordinator of Science, City Schools
- Kia Boose, Secondary Science Specialist, City Schools
- Vonceil Anderson, Curriculum Writer, City Schools
- Jonathon Grooms, Assistant Professor of Curriculum and Pedagogy, George Washington University
- Kevin Fleming, Graduate Research Assistant, George Washington University
- Mary Ellen Wolfinger, Doctoral Student, George Washington University
- Bess Caplan, Ecology Education Program Leader, Baltimore Ecosystem Study
- Tanaira Cullens, Education Assistant, Baltimore Ecosystem Study
- Chelsea McClure, Education Assistant, Baltimore Ecosystem Study
- Martin Schmidt, Upper School Science, McDonogh School

The following lesson and associated materials are part of the Integrating Chemistry and Earth science (ICE) Urban Heat Island Module. The Module brings together important concepts from Earth science and chemistry to help students build an understanding of why urban areas have higher temperatures both during the day and at night, than their rural counterparts.

ICE Partners

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Lesson 4: Weathering and Water Quality

Driving Question: *How do we measure chemical weathering?*

Summary: Students will examine how scientists measure chemical weathering through the chemical composition of runoff in streams. They will analyze local stream data and use that data to **make and defend a claim** regarding **the impact of impermeable surfaces (such as cement) on water quality.**
Teacher Note: You have two scheduled days for this topic.

Activity Description:

Part I

- **Opening Activity:** Through a vocabulary exploration, students will be exposed to the basic concepts of watersheds and run-off through this activity using Frayer models.
    - Place students in groups of five for the whole lesson.
    - Students will complete *Frayer Models Worksheet* for the five vocabulary terms. Students may use whatever resources the instructor has available to complete the models.
        - Watershed
        - Impervious
        - Pervious
        - Storm drain
        - Limestone
        - **Teacher Note:** The *Frayer Model* file has multiple versions of the model, scaffolded for your students. Use as appropriate for your individual students.
- **Baltimore Region Watershed Sort:** Students will examine the level of development in watersheds based on satellite images and rank them from least to most developed.
    - Student groups will be presented with satellite images of five watersheds.
        - *Watershed Satellite Images slides*
    - Based on the images, students are to sequence the watersheds from least to most developed/ concentration of impervious surfaces.
    - **Questioning Prompt:** What patterns do you observe in the images presented? How did you organize them? Why?
- **Water Quality Effects:** Students will predict the impact that impermeable surfaces, such as concrete, have on the water quality within a watershed.
    - Each group make a prediction on pH and dissolved calcium content.
        - **Focus Questions:**
            - Which watershed site will produce the highest pH in the stream water?
            - Which will produce the greatest calcium ion pollution in the stream?
            - Is there a relationship?
        - **Prior knowledge questioning prompt:** "What range of pH is acidic? Basic?"
    - Have each group write their predictions on sticky notes and then post on the board.

- **Analyze Data on Long-term Stream Chemistry:** Students will analyze local watershed data to determine the impact that impermeable surfaces have on the calcium ion concentration and pH of water in streams.
    - Students complete the Water Quality Analysis Data Activity.
    - Each member of the group will graph the calcium ion concentration measured at one of the five watershed sites. (These are the same five sites from the satellite images.)
    - As a team, the students will compare their graphs with respect to patterns, similarities, and differences.
    - After examining the five graphs students will answer discussion questions in the activity.
    - Save pH graph analysis section for Part II.

EL Support: Purposefully choose one or more of the following options based upon student needs or formative assessment data to have students process and engage with content.

- Provide visuals
- Monitor responses
- Modify classwork, assessments, homework (true/false, reduced responses)
- Allow verbal and non-verbal responses (gestures)

Differentiated Instruction: Purposefully choose one or more of the following options based upon student needs or formative assessment data to have students process and engage with content.

To scaffold the Data Activity the teacher can give the student only one column of data, or have a pre-numbered graph grid, or chunk the activity by using task cards.

Lesson Summary: Students should have an idea of the following: pH is a measure of acidity of water. pH less than 7 is considered acidic. The ground cover in an area can affect the acidity of the water in the watershed area. Concepts students should still be thinking about include the impact on pH caused by runoff, what type of development has the most impact on pH, how does the concentration of calcium ion in the water correlate with the pH changes?

Part II

- **Opening Activity:** Engage students by reviewing the concepts from Part I.
    - Teacher created interactive review of previous day's topics, such as Kahoot! or Quizlet
- **Examine Data on pH:** Students will analyze the data they graphed in Part I and compare it to pH data for the same streams.
    - Students return to the same groups they were in during the previous lesson and review the data on long-term stream chemistry.
    - Students will examine the long-term pH data graph and compare it to their Ca^{2+} ion data and complete the discussion questions.
        - **Teacher Note:** *Water quality Analysis pH Graph reference sheet*
    - **Questioning prompt:** What has caused the patterns you have observed in stream

chemistry? How do you know that this is the cause? What would you predict if the farm at McDonogh built a parking lot for their visitors to use?

- **Conclusions:** Students will present their findings from the data analysis activity to the class, through a gallery walk, and give feedback to their classmates.
  - Groups will examine their initial hypothesis.
  - Each student group will write their claim, evidence, and reasoning on chart paper and present their findings. They should include information on:
    - Calcium vs. pH comparison
    - Source of calcium ions in the streams
    - Environmental impact/concerns
    - Suggestions for mitigating impact on the environment
  - **Questioning prompt:** Is the evidence presented sufficient to conclude that paved surfaces change the chemistry of our streams? If not, what additional evidence is needed?
  - Class Gallery Walk
    - Give students sticky notes to leave comments and constructive suggestions as they walk around the room.

Homework: Students will complete "Permeable Surfaces and the Law" writing activity.

Sources of Evidence of Three-Dimensional Student Learning: Student teams will produce clear, data supported claims regarding the impact of impermeable surfaces on water quality and receive constructive peer-feedback on their claim, evidence, and reasoning.

EL Support:

Purposefully choose one or more of the following options based upon student needs or formative assessment data to have students process and engage with content.

- Graphic organizers
- Reduce the writing load (sentence frames and sentence starters)
- Reduced vocabulary load
- Provide visuals
- Extended time
- Bilingual dictionary

Differentiated Instruction: Purposefully choose one or more of the following options based upon student needs or formative assessment data to have students process and engage with content.

For the conclusion presentation/gallery walk, allow students to design the format of their presentation. Allow variation in format, design, and materials as long as the required content is present and relevant.

Lesson Summary: Students should have an idea of the following: Calcium ions in the water of streams are due to chemical weathering of hard surfaces, such as paved streets. The concentration of calcium ions can be used to measure the level of chemical weathering. Highly paved areas produce more calcium ions that areas with little or no paved surfaces. Higher concentrations of calcium ions correlate with higher pH readings, thus lower levels of acid in the water. Students should be asking "Where do we see these processes in our environment?"

Water Quality Analysis

Each member of the group will create a line graph of the Calcium ion [Ca^{2+}] concentration for one of the watersheds. For each graph, the x-axis should be time (dates) and the y-axis should represent concentration in mg/L.

The five watershed sites are:

- Baisman Run (BARN)
- Gywnns Falls-Delight (GFGB)
- Gywnns Falls- Glyndon(GFGL)
- McDonogh (MCDN)
- Pond Branch (POBR)

Before you begin creating your graphs, set the scale for the x and y-axis that everyone will use. All graphs should be to the same scale and numbering convention to aid in comparison.

Data:

Date (Year)	Ca ion **BARN**	Ca ion **POBR**	Ca ion **MCDN**	Ca ion **GFGL**	Ca ion **GFGB**
1998	-	0.7		48.6	14.8
1999	6.2	1		48.6	18.7
2000	4.6	0.6	9.2	44.7	18.6
2001	5.5	0.6	9.1	56.6	19.2
2002	6.4	1.3	10.6	57.2	21.8
2003	6.6	1.2	12.4	50.3	22.4
2004	4.5	0.7	10.2	55.1	21.8
2005	4.9	0.6	10.4	55.3	20.9
2006	6	1.2	11.4	33.7	20.5
2007	5.8	1	11.9	53.3	22.6
2008	7	1.1	11.7	54.6	21.4
2009	6.9	1.1	11.7	56.9	24.4
2010	5.5	0.8	11.3	56.6	23.1
2011	7.6	0.9	12.1	53.7	28.7
2012	6.4	0.8	11.2	54.9	24.5
2013	5.9	0.9	10.9	57	25.2
2014	5.7	1	10.7	62.2	26.3

Analysis I:

1. Which site produced the greatest amount of calcium ions as measured in the water samples.

2. Which site produced the smallest amount of calcium ions as measured in the water samples.

3. Order the sites from greatest to least in terms of calcium ion concentration.

4. How does this sequence compare to the sequence of sites based on quantity of impermeable surfaces as discussed earlier? Is there a correlation? If so, describe what you found.

Ask your instructor for the pH graph based on each watershed site.

Examine the graph and compare it to your graphed calcium ion data.

5. Which site produced the highest pH?

6. Which site produced the lowest pH?

7. Sequence the sites from highest to lowest pH.

8. Compare this list to the list you made in # 3. Is there a correlation? If so, describe what you see.

9. Is there a way that you can combine the two lists so that the sequence matches? If so, write the sequence and explain how you matched the two lists.

Permeable Surfaces and the Law

Read the following column published in *The Diamondback-The University of Maryland's Independent Student Newspaper.*

After reading the article, in Claim/Evidence/Reasoning format, state and defend if you believe that the "Chesapeake Bay Needs Maryland's Rain Tax" as indicated in the Opinion piece. Be sure to use information from today's activity in your evidence and reasoning statements. (CER Rubric grading guide)

COLUMN

The Chesapeake Bay needs Maryland's rain tax

In defense of the maligned law.

By Alyssa McKinney | September 25, 2018 (http://www.dbknews.com/2018/09/25/maryland-rain-tax-stormwater-runoff-pollution-chesapeake-bay-hogan/)
Views expressed in opinion columns are the author's own.

Back in 2012, the Maryland General Assembly introduced a fee on impervious surfaces, designed to reduce runoff into the Chesapeake Bay. It was nicknamed the "rain tax" and quickly became one of the most hated and ridiculed taxes in state history. Originally, the more urban counties of Maryland were required to implement this fee, but in 2015 it became optional as long as each county demonstrated plans to reduce runoff.

Gov. Larry Hogan campaigned on affordability and repealing taxes — particularly this stormwater management fee — during the election against Anthony Brown in 2014, and he's emphasizing the same points in his current campaign against Ben Jealous. Because the fee was made optional and never really repealed, some think Ben Jealous could leverage this point against Hogan's tax-cutting campaign. But was the tax really that bad to begin with?

Stormwater runoff carries harmful pollutants such as fertilizer, pet waste, trash and car emissions into our waterways. It not only affects the rivers and streams it travels through, but also the Chesapeake Bay, damaging our marine life as well as our economy.

While pollution and trash are obvious detriments to keeping our water clean, a more hidden killer is the large amounts of nitrogen and phosphorus deposited in the bay from stormwater run-off. This feeds algal blooms that block sunlight from reaching marine plants and reduce the oxygen in the water needed to support life.

With the amount of water-resistant land in the state, one storm can have a massive effect on the health of the bay that would take an enormous amount of time and money to repair. Along the coast of the Carolinas, Hurricane Florence sent floods of coal ash, animal waste and fertilizer into the local waterways. Even as we missed the worst of Florence, the storm took a toll on the bay — the Conowingo Dam was opened to lower the Susquehanna River's water levels, sending sediment and debris down into the Chesapeake.

It's certainly difficult to reduce the areas that won't let water pass that already exist, but taxing them can bring awareness to the issue and make us more mindful about our development and land-use. It adds economic incentive for companies and individuals alike to design their properties to use less surface area and to use new technologies such as permeable pavement. It also encourages much-needed changes to our current surfaces, such as constructing rain gardens and building green roofs that help absorb the rain.

Perhaps most significantly, the money collected from these fees can fund stream and wetland restoration programs, maintain stormwater management facilities and promote other activities that reduce stormwater runoff.

The Chesapeake Bay Program is an essential component of bay restoration, but it was recently threatened by a 90 percent budget cut. While Congress approved full funding through the end of the fiscal year, that might not always be the case. We need our government to guarantee that the bay — our wildlife, economy and identity — will be protected.

We need to start making more of an effort to reduce inaccessible surfaces and stormwater runoff. As strange as the "rain tax" sounds, it is actually a good idea.

CORRECTION: Due to a columnist error, a previous version of this piece claimed the Chesapeake Bay Foundation faced a 90 percent funding cut. It was the Chesapeake Bay Program that faced the cut. The column has been updated.

At the time of publication, Alyssa McKinney was a sophomore electrical engineering major. She can be reached at: alyssa.cmck@gmail.com.