Chloride in the Pennypack Creek

This document provides intensive instructions for any teacher who wishes to implement “Chloride in the Pennypack” with their students. We welcome feedback and insights following implementation. If you would like to share your experience with “Chloride in the Pennypack,” please complete this Feedback Form (https://bit.ly/4hw7Jks). We hope you enjoy using “Chloride in the Pennypack” with your students!

<table>
<tr><td rowspan="2">Estimated total time to complete</td><td colspan="2">Part 1-4: Background and Data Analysis
• Background (35-45 minutes)
• Student Data Analysis (30 minutes)</td></tr>
<tr><td colspan="2">Part 5: Small and Large Group Consensus Building
• Small group consensus building (25 minutes)
• Whole group sharing (30 minutes)</td></tr>
<tr><td>Materials needed</td><td colspan="2">1. Color-printed Resources Maps of the Pennypack Creek Watershed and Delaware River Basin
i. A full class set is recommended
ii. 1 set per pair of students is adequate
2. Student Handout
3. Individual Devices (Chromebooks, iPad, etc. - for accessing ArcGIS data)</td></tr>
<tr><td colspan="3">NGSS alignment</td></tr>
<tr><td>DCI
• LS2.C
• ESS2.C</td><td>SEP
• Planning and Carrying out Investigations
• Analyzing and Interpreting Data
• Constructing Explanations and Designing Solutions</td><td>CCC
• Patterns
• Stability and Change</td></tr>
<tr><td colspan="3">Student outcomes</td></tr>
<tr><td colspan="3">• Students will analyze synoptic stream sampling data in order to make claims about the impacts of u processes on the water quality of an urban stream.
• Students will propose hypotheses and design an investigation based on their understanding of the (that urban processes on watershed functions and ecosystem health.
• Students will predict how the results of this study might change under different environmental and experimental circumstances.</td></tr>
<tr><td rowspan="3">Recommended prior learning</td><td colspan="2">Introduction to the Critical Zone (UCZ Data Lesson)</td></tr>
<tr><td colspan="2">Ionic compounds: Components/formation, Dissolution</td></tr>
<tr><td colspan="2">Watersheds Dynamics</td></tr>
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Background information for teachers:
The Critical Zone (CZ) is the relatively thin layer of the planet where interactions occur between the biosphere, hydrosphere, geosphere, and atmosphere. These interactions are vital to the maintenance of healthy ecosystems and the existence of life on Earth. The CZ includes everything between the deepest groundwater all the way to the tops of the tallest tree canopy (from bedrocks to treetops).

Key functions of the Earth's CZ include:

1. Water Cycling
    a. Water plays a central role in nearly every CZ process.
    b. The CZ controls the flow of water through ecosystems.
    c. The CZ regulates water's quality and availability.
2. Soil Formation and Maintenance
    a. Rocks and minerals are broken down through the process of physical, chemical, and biological weathering.
    b. Plants, microbes, and animals help break down organic matter to recycle nutrients and mix soil layers.
    c. Water carries dissolved minerals and nutrients through the soil.
3. Carbon Storage
    a. Soils and vegetation are important sites for carbon storage.
    b. Soil stores more carbon than the atmosphere and vegetation combined (second in active storage only to the ocean). SOURCE
    c. Vegetation (especially old growth forests) also stores carbon through the process of photosynthesis.
4. Ecosystem Supports
    a. All life exists in the CZ - from the smallest microbes in the soils to the tallest trees in the Amazon Forest.

Scientists and researchers around the world are studying the CZ to better understand how it responds to both natural and human changes. The study of the CZ involves interdisciplinary collaboration between scientists from a range of disciplines, including (but certainly not limited to) geologists, hydrologists, ecologists, engineers, and sociologists.

Video: Explore the Critical Zone (https://youtu.be/8gW-Vy7zFdU?feature=shared) WSKG Public Media

Lesson Breakdown		Planning Considerations
"Part 0"	Prior to beginning the lesson, distribute the resource materials.	Laminated class sets of colored maps will allow you to reuse materials multiple times.
Part 1: Introduction to the Pennypack	Figure 2.1 Analysis *5 minutes*	Consider strategic pairing.
	Figure 2.3 Analysis *5 minutes*	
	Class check-in and share out *5 minutes*	● Emphasis on the following questions: ○ Describe the ways (if any) that the land use changes as you move from outside the boundary of Philadelphia county inward toward the southern end of the Pennypack Creek watershed.

		○ How might these changes impact the Pennypack Creek Watershed?
	Delaware River Basin Analysis *5 minutes*	
Part 2: Salts in Watersheds	Background reading, connecting to prior knowledge. *5-7 minutes*	
Part 3: Study Background and Data Basics	About the Study *5-7 minutes*	
	The Data (Legends only) *5-7 minutes*	
	Class check-in and share out *5 minutes*	● Emphasis on: ○ Types of urban processes ○ Correctly reading the legend
Part 4: Individual Analysis	Individual Student Data Analysis *30 minutes*	● If you choose not to include the Watershed Data (a screenshot of the ArcGIS data) as part of the printed map sets provided to students, you will need to project or in some other way share this reference document with students. ● Some instructors may choose to collect and score individual analyses before moving on to group discussion.
Part 5: Group Discussion & Consensus Making	(a) Small group consensus building *25 minutes*	● Small groups - 2 pairs per group (4 students total). Consider strategic grouping. ● If whiteboards are unavailable, alternative options are a Google Slide composition or using poster paper.
	(b) Full class consensus building *30 minutes*	● Approximately 5 minutes per question ● See talk moves for facilitating discussion between student groups.

Instructor Notes - Lesson Guide

<u>Suggested Student Work Teams</u>

- In pairs: Parts 1, 2, 3
- Individually: Part 4
- Small Group: Part 5a
- Full Class: Part 5b

<u>Background and Data Analysis</u> (Parts 1-4)

This Data Lesson is designed to be student-centered and student-motivated. In this lesson, the instructor will act as a facilitator, as the students take the lead in investigating and understanding the data.. Prompting questions have been provided to help the instructor with facilitation. It is suggested that students work in pairs (groups of 3 or more should be avoided, to ensure that all students are actively engaged during the activity) on each section of the student handout, and independently on the

Student Analysis questions. The lesson breakdown offers a proposed check-in and timing sequence, but the instructor will use their own discretion for pacing.

If the instructor wishes to collect individual analyses as a formative means of assessing individual students' understanding, we recommend doing this before small and full group sharing (in between Parts 4 and 5).

<u>Small and Large Group Consensus Building</u> (Part 5)

1. Small group consensus
    a. Combine two pairs of partners from the Background and Data Analysis segment (groups of approximately 4)
    b. Students should take turns, in a round-robin style, sharing out their responses for each of the Data Analysis Questions
        i. Consensus should be reached within the group for #2 and #5
        ii. Agreement on the validity of everyone's responses for #1, 3, 4, 6, 7
            1. There may not be one "right" answer for these prompts, but students should try to avoid sharing inaccurate information with the full group.
            2. From those responses that the group agrees are valid, select 1-2 that they would like to add to their whiteboard.
        iii. All students should share their responses for #8 within the small group - no consensus required.
            1. Ask the groups to consider volunteering or nominating one or more of the responses from this question that they think are particularly interesting or thoughtful.
    c. The instructor should circle and listen, recording student ideas of note (those that may need to be redirected, those that should be elevated). This will also help with full-group facilitation discussion.
2. Full-class share out
    a. <u>After</u> small group discussion has completed, assign the questions to groups for sharing on their whiteboard.
        i. Group 1 - #2, 3, 6 (8 - optional)
        ii. Group 2 - #2, 4, 7 (8 - optional)
        iii. Group 3 - #5, 4, 6 (8 - optional)
        iv. Group 4 - #5, 3, 7 (8 - optional)
    b. Each question will be shared out by two groups (e.g. question #2 will be discussed by Groups 1 and 2).
        i. Ideas for discussion facilitation
            1. If the two groups that are sharing one particular question disagree on any part of the question, ask the rest of the class to weigh in. Consensus should be reached for questions #2 and #5, agreement on validity for #3, 4, 6, 7.
            2. If the two groups that are sharing one particular question agree with each other, ask the other groups if anyone: disagrees, agrees but has something additional in their response, has questions/would like clarification.
            3. If there were any notable student comments or discussion from the instructor's walk about during the small group discussion segment, now would be a good time to bring these up.
3. INDIVIDUAL EXIT TICKET - Summative prompt/reflection of some sort.