



Bridging the Watershed
An Outreach Program of the Alice Ferguson Foundation
in Partnership with the National Park Service and Area Schools



WATERPOWER



A Curriculum Module Written for Harpers Ferry National Historical Park

RANGER GUIDE

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WaterPower Curriculum Design

Title	Lesson 1	Lesson 2	Lesson 3	Field Study	Lesson 4
	Pre-Industrial WaterPower In Europe	Catherine's Cotton Factory	Rivers and Their Environments	Harpers Ferry National Historical Park	Contemporary River Use Conflicts
Time and Materials Needed	90 minutes Copies of “Your Village” Crayons, Markers, or Pencils: Blue, Brown, Red, Black, Orange, Yellow, Green	45 minutes without optional homework assignment Copy of “Locating a New Mill” map	45 minutes, unless students need additional time for composition. Copies of graphic organizers (see teacher guide for explanation)	30 minutes in the classroom, 2-3 hours in the park. Harpers Ferry Map, Student Field Guide, clipboards. Supplied by park: oranges, compass, timer, 10 m tape, turbidity kits, permeability kits, 3 m measuring rod.	45 – 135 minutes Access to research tools. Lined paper for writing. Art supplies if alternative assessments such as posters are allowed.
Unit Summary	Introduces the idea and effects of waterpower use by humans, setting the stage for the following lessons and the field study at Virginus Island.	Introduces students to the workings of a 19 th -century cotton mill and teaches them, in depth, how the turbines power all of the machines used to weave cloth.	Introduces students to the behavior of a naturally-flowing river during both normal conditions, and flood conditions, and contrasts that river with one that has been used to generate power for human use.	Students perform experiments to determine what happened to the industries on Virginus Island.	Requires students to research and evaluate a 21 st -century river use conflict.
Enduring Understandings	Human use of resources, in this case a creek, impacts both human life and the resource itself.	Rivers possess an enormous amount of energy that can be harnessed relatively easily.	Under normal conditions, rivers undergo a natural cycle of sedimentation and scouring, but that process can be interrupted by humans.	Choices have consequences; our relationship with nature is two-way, decisions that were appropriate for one time may not be appropriate for another time.	There will always be conflict related to the use of rivers, every option has both costs and benefits, and different solutions are appropriate for different circumstances.
Essential Questions	How does the environment shape human experience? In what ways does human use of natural resources alter those resources? When humans use resources, are conflicts inevitable? Why?	How much power do rivers really possess? How much of a river's power can be harnessed for human use?	How do rivers behave under normal or “natural” conditions? How do rivers behave when they have been modified to provide power for human use?	What are the consequences of using rivers as power sources? How do humans place value on natural resources? Has human ability to manage nature improved over time? Is attempting to manage nature a reasonable goal?	What happens as we run low on resources? Is cooperation always the best solution? How much are our rivers worth? Should we go to war over them?

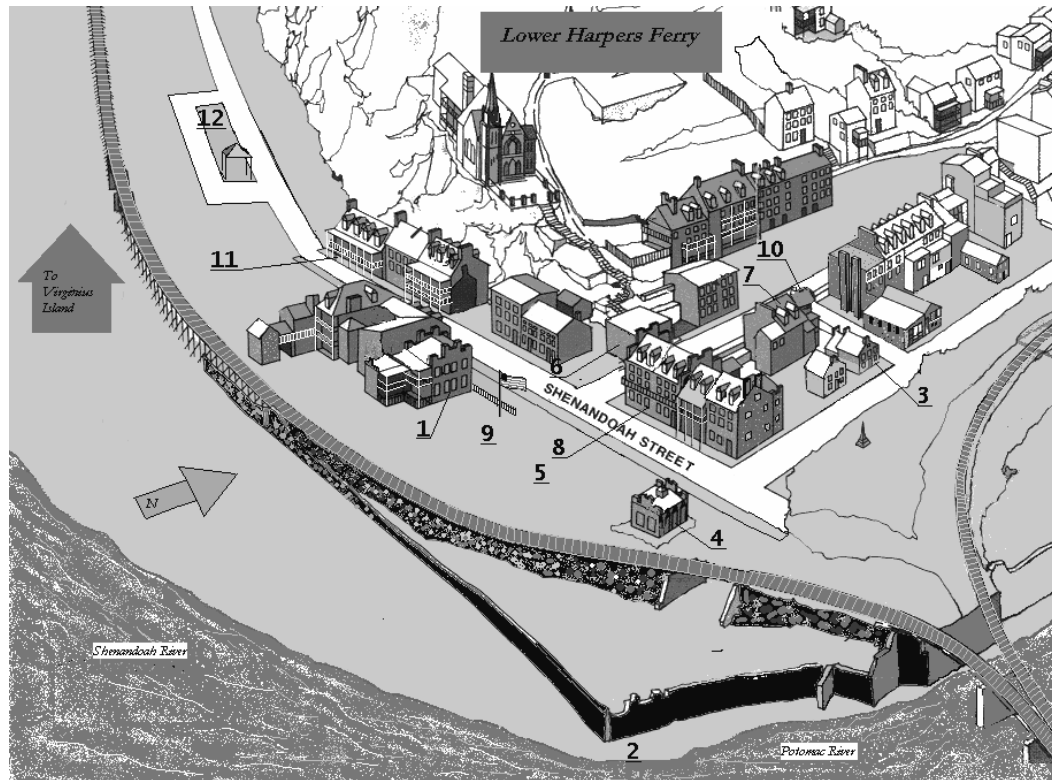
WaterPower Curriculum Design (continued)

Title	Lesson 1	Lesson 2	Lesson 3	Field Study	Lesson 4
	Pre-Industrial WaterPower In Europe	Catherine's Cotton Factory	Rivers and Their Environments	Harpers Ferry National Historical Park	Contemporary River Use Conflicts
Key Knowledge & Skills	<p>Describe how waterpower was used in pre-industrial Europe.</p> <p>Demonstrate changes in settlement patterns as the use of waterpower intensified.</p> <p>Predict pollution and other negative consequences of intense over-use of a water resource.</p>	<p>Water wheels are inefficient because they fight gravity and waste head; in addition, they only use a small percentage of their surface area at any time.</p> <p>Turbines eliminate all of those weaknesses and produce much more power.</p> <p>Power can be utilized by many hundreds of machines simultaneously.</p>	<p>Run-off from forests is vital to the life of a river.</p> <p>Floods are good for rivers and the environments around them.</p> <p>Human use of rivers as a power source can interrupt a river's distribution of nutrients and its behavior during flooding.</p>	<p>Background of Harpers Ferry</p> <p>Experimental procedures will be learned in the field - - turbidity, permeability, soil type</p>	<p>Varies depending on the river conflict chosen by individual students.</p>
<p>Performance Tasks</p> <p>Students will:</p>	<p>Predict how life will change when the people in a village move to a site near the creek.</p> <p>Read and answer questions from a description of how waterpower changed several trades in pre-industrial Europe in order to compare and evaluate various uses, find causal relationships among uses and types of pollution, and predict how increased waterpower use could result in future conflicts.</p> <p>Design a village that uses water power from a local creek to drive several trades. Label point sources of pollution and explain what caused them. Identify opportunities for overuse, and what the consequences of that might be.</p> <p>Optional: Demonstrate an ability to integrate their recent learning into a scientifically valid narrative of how their imaginary village would be affected by its creek.</p>	<p>Read a letter from a 19th -century girl to her cousin in which she describes her job at the Cotton Factory and the working of its machinery.</p> <p>Read an article describing how river power is converted to mechanical power by water wheels and turbines.</p> <p>Compose a letter back to the 19th - century girl explaining in detail how the turbines at her mill operate.</p> <p>Use the map "Locating a New Mill" to describe the best place to build a new factory and defend their individual opinion in a paragraph.</p>	<p>Work in teams to complete two sets of map/graphic organizers that describe river behavior.</p> <p>Write, individually or in teams, two short essays using the information contained on their map/organizers.</p> <p>Assert and defend a position related to human use of river power.</p>	<p>In the classroom, visit the NPS Harpers Ferry website and label personal copies of the Harpers Ferry map.</p> <p>Perform experiments to assess the Shenandoah River's impact on Virginian Island.</p> <p>Reflect on the location as an industrial site.</p>	<p>Discuss and evaluate categories of river use conflicts.</p> <p>Learn about five conflicts and place each in its appropriate category.</p> <p>Independently research a 21st -century river use conflict and report on it to the class.</p>

Interpretive Program: A Story of *WaterPower*

Theme	The physical and historical geography of the Harpers Ferry area demonstrates how landscapes shape human history, and how human endeavors profoundly affect natural landscapes – a powerful reminder that the actions of today determine the opportunities of tomorrow.
Goals	Students will come to a deeper understanding of how human manipulation of river ways affects those rivers and how those rivers in turn affect human settlement.
Objectives	<p>Students will be able to:</p> <ul style="list-style-type: none">• Name three ways the Shenandoah River reacted to human changes to the environment.• Describe how the Shenandoah's pattern of flooding affected the industrial and human development on Virginius Island.• Define erosion, turbidity, sedimentation, river head, water speed, and permeability.• Use data collected during the field study to forecast how future development of Virginius Island would be affected by the Shenandoah River.• Form and defend an opinion on the value of Virginius Island as a waterpower location.
Universal Concepts	Fortune building, Control, Death, Prosperity, Prestige, Power, Destruction, Loss, Legacy
Tangibles	Shenandoah River, Shenandoah Valley, Riverbanks, Virginius Island, Cotton Mill, Factories, Herr's Dam, Turbines, Canals, Headgates, Data collected, Structure remains of Island, Forest, Sediment, Water, Waterpower, Human development, Industrialization, Flood
Intangibles	Greed, Risk, Growth, Dreams, Hopes, Progress, Force, Consequences, Influence, Home, Surprise, Optimism, Arrogance, Ownership, Investment

Harpers Ferry National Historical Park



Key to Lower Harpers Ferry

- | | |
|---------------------------|----------------------------------|
| 1 Information Center | 7 Storer College Niagara Exhibit |
| 2 The Point | 8 John Brown Museum |
| 3 Meriwether Lewis Museum | 9 Flagpole |
| 4 John Brown's Fort | 10 Ice Cream Stores |
| 5 Arsenal Square | 11 Bookstore/Restrooms |
| 6 Black Voices Exhibit | 12 Shuttle Bus Stop |

Field Study Outline

Objectives

- To recall what they learned in the pre-lessons about waterpower and river dynamics.
 - To perform experiments on Virginius Island.
 - To relate their collected data to their prior learning.
 - To estimate the value of Virginius Island as a waterpower location.
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Essential Field Study Components

- I. Introduction at the Flagpole
 - II. Interpretation in the Industry Museum
 - III. Instructions at Bridge to Virginius Island
 - IV. Field study on Virginius Island
 - V. Data Comparison and Reflection
-

Other Possible Activities

- Initial ranger-led orientation to HFNHP's history and mission
- Secondary field study activities such as a geology tour, John Brown narrative, or living history walk
- Visit to the Point or Jefferson's rock

Field Study: WaterPower

I. Flagpole

Greet the students, introduce the rangers and BTW educators, and assess the students' prior knowledge. Also, assess student preparation and address other logistical questions. Review safety guidelines.

1. Are students dressed appropriately? What other clothes did they bring?
 2. Did they bring maps completed in the classroom?
 3. Did they do the pre-lessons?
 4. Are they already in groups?
 5. Did students bring their lunches?
 6. Are there previously unidentified special needs students?
 7. Present safety instructions.
 8. Identify the locations of the bathrooms, the restaurants, the bus stop, and any other relevant sites.
-

Field Study Scenario

Explain that for today's field study we will be pretending that during recent excavation on Virginius Island, a lockbox full of stock certificates was found and that all students participating in the field study had ancestors who bought shares in the Virginius Island Cotton Factory and the land under it. In order to gauge the value of these certificates, we will be taking scientific measurements of the Shenandoah River and Virginius Island. We will be using those measurements to answer three primary questions:

1. **What was the land under the Cotton Factory worth as a waterpower location in 1850?**
2. **What environmental factors impacted the economic value of the land value—positively or negatively, after the factory was built?**
3. **What value does the land hold today as a waterpower site? Are your recently inherited shares worth anything?**



Proceed to Industry Museum.

Continued on next page

Field Study: WaterPower, Continued

II. Interpretation in Industry Museum

Focus students' attention on the mural and describe the scale of the industrialization of Virginius Island in 1850, the value of the rivers, the railroads, and the Armories. Conclude with a brief summary of the motivations that drove the building of the Cotton Factory and the scale of the local financial and moral support.

Interpretive Points:

- The river shown is the Shenandoah and next to it is the Shenandoah Canal, coming south with barges full of coal and timber for the rifle works and agricultural goods for the pulp mills. It will, just a few feet off the edge of the mural, meet the Potomac, which flows all the way to Washington. A canal was built alongside each river to allow uninterrupted flow of commercial traffic in both directions. This location made Harpers Ferry a natural place to build factories to use, modify, or improve those raw materials before they went to market (what is now called processing or value-adding).
- Three separate railroads intersected in Harpers Ferry and connected the town with Baltimore, Washington, Pittsburgh, and other cities, the fertile mountains and valleys to the West. Their intersection made it very cheap and easy to move large quantities of both raw and finished goods into and out of town.
- In addition, two highways met in Harpers Ferry. This additional means of communication and transportation meant that even small farmers and merchants could trade goods here.
- With the U.S. Government Arsenal and Armory located in Harpers Ferry, there were many well-trained and well-paid workers, as well as their wives and children. Harpers Ferry was the largest town in Jefferson County. Lots of wealth was created in Harpers Ferry and lots of money was spent, especially on payday. This brought all kinds of shopkeepers and other purveyors of wares.

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Field Study: WaterPower, Continued

II. Interpretation in Industry Museum (continued)

- The Cotton Factory was built by Southern investors as a way to return the profits from Southern goods, such as cotton. The vast majority of the cotton grown in the south was shipped to factories in the North to be refined for sale, and the Northern factories ended up keeping more of the total profits than were returned to the Southern farmers. The Cotton Factory on Virginius Island was seen as a first step in ending that inequity. It would process Southern cotton in the south, with Southern laborers and investors keeping the profits. This desire, an outgrowth of pre-war sectionalism, was the motivation behind such an enormous investment of capital on such expensive land. Much of the money came from local residents who bought shares in the company.
- At the conclusion of this discussion, students should answer the questions on the worksheet at the front of the student field guide booklet. An example of the worksheet with answers filled in follows this section. Then invite students to offer answers to the first primary question –

1. What was the land under the Cotton Factory worth as a water power location in 1850?

Industry, Transportation, and Investment at Harpers Ferry, West Virginia

1. What were three types of industries at Harpers Ferry?
Cotton Factory, Guns, and Flour Mill
2. What were three methods of transportation to and from Harpers Ferry?
Railroads, Roads, and Canal
3. List three local natural resources that were used by Harpers Ferry's industries.
Timber, Coal, and Rivers
4. Name three potential markets for goods produced at Harpers Ferry.
Washington / Georgetown, Baltimore, and Pittsburgh
5. Based on these answers, were mid-nineteenth century investors wise to build here?
Yes, this was a great place to do business – industries were in place and there were natural resources, transportation options, and ready markets.

 Proceed to the Virginius Island Bridge.

Continued on next page

Field Study: WaterPower, Continued

III. Instructions at Bridge to Virginus Island

Stop at the Virginus Island Bridge and re-orient the students using their maps (Figure 8 – Virginus Island Trail Map). Divide students into groups to be accompanied by a ranger/educator, and explain that they will be performing their field studies at four locations along Virginus Island. Use the Field Study Map on page 11 to orient students to the island. Students have the same map in the Student Field Study Guide



Bridge to Virginus Island

IV. Measure River Speed

At the **Cotton Mill Wall**, students measure the *river's speed* and are told of the impressive 14 feet of head. As students gather their data, the ranger/interpreter leads a brief discussion of the value of the combination of the river head and water speed at that location on the Shenandoah River.

Interpretive Points:

- From the curve of the river under the present bridge to where the Shenandoah meets the Potomac, there is a 14-foot drop in the river's height. That 14 feet of head, coming as it does over such a relatively short section of the river, represents enormous power potential to industry.
- The water in the Shenandoah Canal and the Inner Canal would have been as high as the water is at the curve of the river under the bridge. It would only have "fallen" to the river's lower height as it was dumped onto the turbines or water wheels. In that way, almost all of the 14 feet was used by the machines, even ones as far downstream as the Cotton Factory.

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Field Study: WaterPower, Continued

IV.

Pose Questions

1. George Washington was among the first to recognize the waterpower potential of this location when he surveyed this area for the Crown long before our Revolution. Years later, as President, he ordered our National Armory built here. What made this spot so unique that he remembered it decades later?

There were two rivers, and both had substantial speed and head, making this a great place to locate industries. In addition, there were many raw materials available from the Shenandoah Valley, including timber, coal, stone, and agricultural products. Proximately located to Washington City, this location generated economic prosperity for the region.

2. Have those characteristics changed in the 200 years between then and now?
Not substantially.

3. Is the waterpower potential that Washington sought to exploit just as valuable today?

It still exists in the same amounts, but whether it has the same value is open to debate. Do all of our carbon-based energy sources make waterpower less important, or does the high cost of carbon-based power make waterpower more valuable? It depends on one's perspective. What is certain is that the rivers still flow past the town with the same potential that they did 200 years ago.

IV: Measure Turbidity and Erosion

At the “island” just west of the Cotton Mill, the students measure *water turbidity* and *erosion*. Inquire what their data indicate about the amount of sediment in the river, about the amount of erosion that occurs, about Virginus Island’s suitability as a building location, and about its ability to withstand floods. In addition, ask what evidence students have found that sedimentation and erosion had occurred. That discussion leads into thoughts of how the sediment would have affected the Inner Canal, the turbines, water wheels, and the industrial machines, and how the erosion would have impacted the retaining walls.

Interpretive Points:

- The jagged retaining wall that extends along the path above the island was the limit of the island in 1850. Instead of the present beach area and island there was only rushing river.
 - The area between the railroad and the river was not forest then but homes and additional shops. Remember how crowded this area appeared on the mural?
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Field Study: WaterPower, Continued

IV: Measure Permeability

Along the path towards the Intake Arches the students will measure *soil permeability*. They will perform the experiment several times, testing the permeability of the path, the forest, and the area near the railroad tracks.

Possible question for discussion:

What does low permeability indicate would happen at a time of flooding?
The water would flow quickly over the island, not being slowed or absorbed at all.

IV: Measure River Height and Soil Type

At the **Intake Arches**, students will measure the river's *height* and the *soil type*. Point out to students that the railroad tracks approximate the height of the river during its worst flood. Then ask students to estimate the damage that surging waters of that height would have on the industry of Virginius Island. In addition, ask them to gauge the effectiveness of Herr's Dam, the Intake Arches, and the Inner Canal in controlling the river under those conditions.

Interpretive Points:

- Herr's Dam extended from the Southern edge of the Intake Arches up-river, eventually bending to the south to meet the other shore almost directly under the present bridge. The Dam was only a few feet high and only diverted water into the Inner Canal during times of drought; otherwise, the river ran right over it.
- During drought, the main channel of the river could run completely dry if all of the water was sent into the Canal. Because of this, the Canal never ran dry, so the factories never had to shut down because of low water (e.g., though they did stop for repairs, heat, ice, and disease).

Questions for thought:

1. During drought, when all of the waters of the Shenandoah were being diverted into the Inner Canal by Herr's Dam, what would the main channel of the river have looked like?
It would be dry.
-

Continued on next page

Field Study: WaterPower, Continued

IV: Soil Type (continued)

Questions (continued)

2. Do you think that we could do a better job “managing” the river today than they did then?

Students may have differing answers to this subjective question.

3. If we failed at controlling the river level and a powerful flood came, what would happen to our buildings?

The same thing that happened to all of Virginius Island’s buildings – they would be destroyed.

4. If we attempted to rebuild the Dam and Inner Canal in order to again begin using waterpower on Virginius Island, would people raise objections on environmental grounds? What kinds of objections? Could we easily address their concerns?

The students should recognize that many people would fight that kind of development.

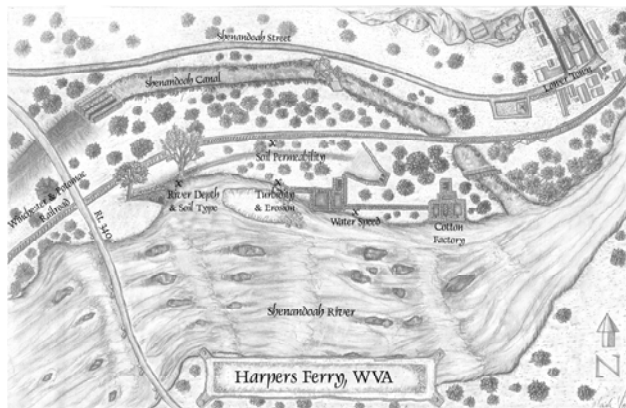
5. Is this type of soil likely to resist erosion and displacement by the river?

No, it is likely to be eroded and deposited downstream.

6. Where did this soil come from? Is it the natural result of succession by the forests?

This soil came from eroded locations upstream. It is not a result of succession or decomposition.

As the students walk back down the path towards the bridge, they will draw on their maps (Fig. 7–Harpers Ferry, WV Student Map) the water’s course through the Intake Arches, down the inner canal, then the Arches, where it turned the Cotton Factory’s turbines, and finally through the exit from Virginius Island into the Shenandoah Canal. The students will also label any features on their map that they were not able to identify in the Industry Museum.



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Field Study: WaterPower, Continued

V. Data Comparison and Reflection

Proceed to a location suitable for reflection. A whiteboard or other surface is used to compare data from different groups.

Pose the second primary question to the class:

2. What environmental factors impacted the economic value of the land— positively or negatively, after the factory was built?

During this discussion, the students will use their field data and prior knowledge of river dynamics to evaluate Virginus Island's suitability as an industrial location. For instance, they learned during the pre-lessons that rivers that have been modified for use as power sources behave differently during floods than rivers in a more natural condition, and they may incorporate that information during the discussion.

Then, the third primary question is raised:

3. What value does the land hold today as a waterpower site? Are your recently inherited shares worth anything?

Finally, pose the larger thought question:

Having done this field study, what are some issues that you now think we should consider when making decisions about using rivers as sources of waterpower?

Harpers Ferry, WV Student Field Study Map

