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

STUDENT BOOKLET

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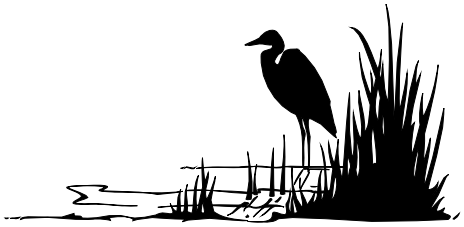

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WaterPower

Table of Contents

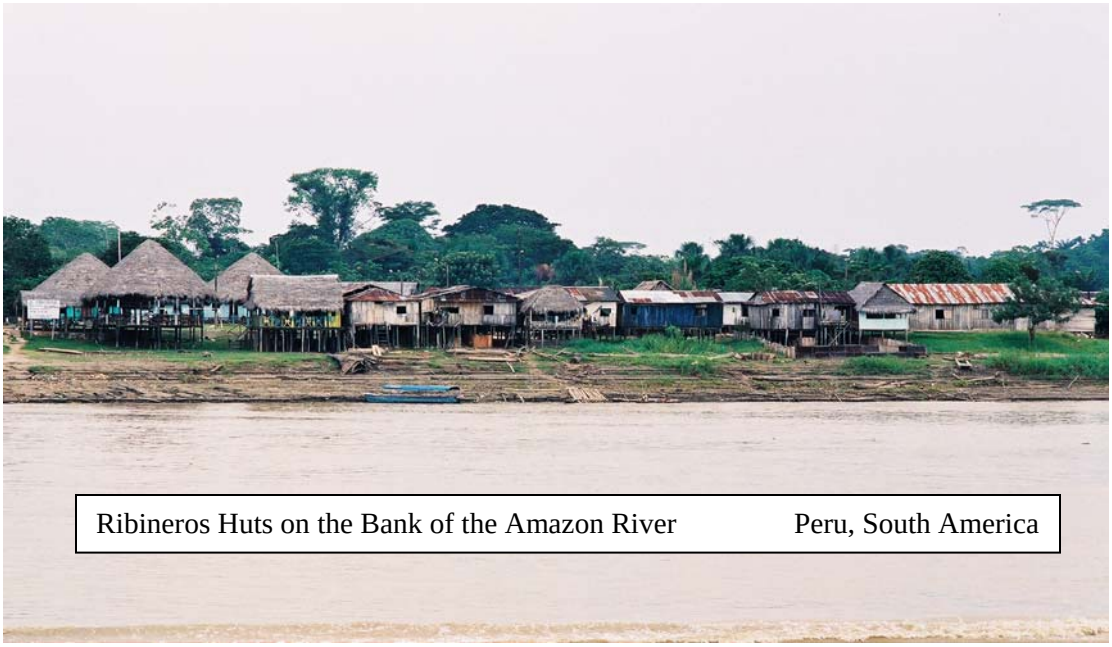
Pre-Field Study Classroom Activities

Post-Field Study Classroom Activities

Introduction to WaterPower

Importance of Rivers

When given a choice, early humans always built communities along the banks of rivers. Sometimes these communities grew into great civilizations, such as those in the Nile River Valley, the Tigris-Euphrates Gulf, or the Indus-Bhramaputra Plain.



Ribineros Huts on the Bank of the Amazon River Peru, South America

Other times, small communities stayed that way as the years and centuries passed, although sometimes invading peoples replaced the original inhabitants. In all cases, the relationship of humans and their rivers did not fundamentally change. They used the rivers for washing, for transportation, for irrigation, and for mechanical power. It is that last use, mechanical power, which you will study in this module.

What You Will Study and Do in This Module

Starting in pre-industrial Europe, and traveling well into our 21st-century future, you will examine how the mechanical power provided by rivers can drive industrial machines, shape human lives, and alter our environment. You will perform a field study among the ruins of factories and homes on Virginius Island, Harpers Ferry, West Virginia. On that field study, you will measure the Shenandoah River's speed and depth (among other things) and assess its effect on the industries that had been built on the adjacent shore. You will evaluate the decisions made in the 18th and 19th centuries to locate industries and homes along the river, and speculate about how industries and homes might work there today. Finally, you will use what you have learned about using rivers as sources of mechanical power to forecast how well decisions being made today in other parts of the world will succeed.

Continued on next page

Lesson 1. Pre-Industrial WaterPower in Europe

Objectives

- To describe early uses of waterpower.
- To demonstrate understanding of a village's potential water use conflicts.

A Village in Europe in 1500

Imagine you live in Europe in the year 1500. Your village has fifty families, most of whom are farmers, but there are also a few trades people, including a blacksmith, a carpenter, and weavers. Because of a recent serious event, perhaps a forest fire, an outbreak of disease, or a war, the villagers have decided to move to a new location. The new site, presently undeveloped forest, is similar to the one you've abandoned, except that the new village has a fast-flowing creek running through the middle of it. All of your homes, shops, and farms are within the creek's watershed, meaning that all of the land area drains into your creek.

As you read the next four paragraphs that describe how the use of water in pre-industrial Europe changed, <u>think about</u> the following:

1. How might the presence of this creek affect life for you and the other villagers?
2. Will it impact the farmers more, less, or differently than it might the tradespeople?
3. How might the village change over the next generation because of the creek?
4. How might the creek change in that time because of the presence of the village?

Early Uses of WaterPower

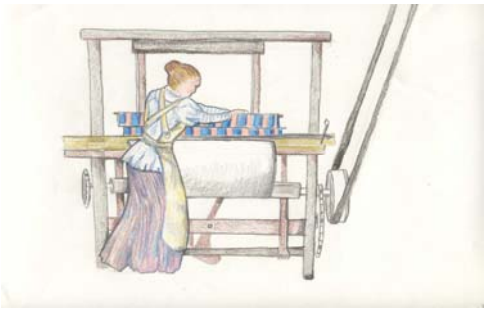
People have always settled near creeks and rivers to use the water for drinking, bathing, cooking, and transportation. The earliest use of water as a power source in pre-industrial Europe was for milling, which is the grinding and crushing of grains such as wheat or barley between two large stones. The early mills were built around very simple water wheels, which used the power the water exerted as it flowed downstream to turn the mill stones. These small mills were easily built and operated, often used by only one family. In most cases, the mills were only used seasonally after the family's crops were harvested. The mills processed the grains grown by one family and perhaps their neighbors and were almost never used by farmers who lived far away. These mills were relatively inefficient, at least compared to later designs, but that did not matter since the waterpower was free, and the farmers were milling grains that they or their own animals were going to eat, not producing processed grain for sale. To give you an example of how commonplace these early mills were, there were more than 5,000 in England alone in the 11th century.

Continued on next page

Lesson 1. Pre-Industrial WaterPower in Europe, Continued

Later Uses of WaterPower

During the Middle Ages, the use of waterpower expanded to other trades and industries. Weavers used water-driven looms to ease their labor, and leather workers used waterpower in the tanning and brushing of hides. Carpenters used axles turned by water wheels to drill, sand, and saw; in addition, the manufacture of paper was made simpler through the harnessing of waterpower. Even large industries were affected; for instance hydraulic pressure generated by water wheels was used to pump the excess water out of flooded mine shafts, and conveyer belts driven by waterpower were used to carry coal out of mines up to the surface. Perhaps the most important development during this time was the use of waterpower to create much more force than a single person could in order to pound large hammers against cooling metals to create harder, stronger tools and weapons.



Easing Labor

All of these applications of waterpower allowed work to be done faster, more reliably, and on a larger scale than had been previously possible. For instance, before waterpower was used, weavers turned their looms by continuously pressing a pedal with their foot, a process that inevitably turned the loom at uneven speeds and resulted in the weaver tiring after only a couple of hours of work. Once waterpower was used to turn the looms, these limitations were removed, and the weavers could do a better job for a much longer length of time. For another example of how waterpower allowed work to be done faster and better, ask yourself how coal got out of the mine shafts before there were water-driven conveyor belts or, how heavy is your backpack?

Effects on the Environment

A consequence of work being done faster and better was that instead of one or two families in each village doing all of the weaving or blacksmithing for that village, with another tradesperson laboring similarly down the road in his/her village, the trades became concentrated. Over time, certain villages became known for having many of the same kinds of skilled workers, and if you wanted to purchase a manufactured item, an axe for example, you would travel to a town with many blacksmiths and find exactly the size, shape, and quality of axe you wanted. Often these tradesmen used the same water source for their power, creating conflict over the rights to it and concentrating negative effects such as pollution at these locations. We don't often think about pre-industrial peoples creating very much pollution, but consider how the dyes used on fabrics or the solutions used to soften and tan leather or the chipped wood from the saw mills would affect the ecology of a stream or river.

Continued on next page

Lesson 1. Pre-Industrial WaterPower in Europe, Continued

Effects on the Environment *(continued)*

In addition to concentrating the industries in specific locations, the increased use of waterpower meant that water wheels were being used year-round, often 12 hours a day, six days a week, which constantly disrupted the flow of the water in the stream or creek. In time, the course of the water was permanently changed, and the plant and animal life that depended on the river either adjusted to the change or died. In addition, humans have found alternative, faster forms of transportation.

Task 1: Questions about Pre-Industrial WaterPower

Answer the following ten questions on page 2 of *Student Worksheets.*

1. What kinds of people owned early water-powered mills?
2. How often were these mills used?
3. What was done with the "products" of these early mills?
4. How much environmental impact do you think these early mills created? Why or why not?
5. Of the many trades which started to use waterpower, which do you think was Changed the most? That is to say, which industry had the greatest change in process, quality, or efficiency as a result of waterpower? Why?
6. The title of the section "Easing Labor" suggests that after people started using waterpower they would be less tired, having worked less hard. Do you think waterpower delivered on that promise? Why or why not?
7. Waterpower was described in "Early Uses" as being free and its efficiency was described as being unimportant. Could we, as waterpower's uses were expanded, continue to make those claims? Why or why not?
8. If you were a farmer living downstream from a town with many waterpower-driven industries, what kinds of complaints might you have? Do you think you would be able to sell your crops to the townsfolk? Could you always guarantee them a good, bountiful harvest? Why?
9. If fish caught in the town's creek were an important part of the townsfolk's diet, what decisions might they make about the number and type of industries that were powered by the creek?
10. Describe two potential conflicts that might occur during a drought. In each case, who should win? Why?

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Task 2: Your Village and Its Water Conflicts

Now that you have a better idea how waterpower was used in pre-industrial Europe, how its use changed settlement patterns and the environment, and how these changes led to conflicts, you are ready to draw your own village and predict how its use of waterpower will affect its residents. Read all of the directions before responding to the instructions so that you will be able to plan your village wisely.

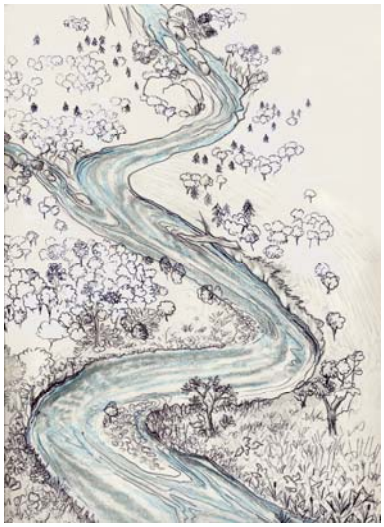

Figure 1: New Village Site

Procedure:

1. On "New Village Site" map (Figure 1), take a moment to observe the river, the forests, the fields, and the other features. Think about how a pre-industrial village (e.g., homes, farms, shops, roads, wells, and the locations of water wheels) would be situated on this landscape.
2. On page 5 of the *Student Worksheets* you will find "Your Village" map. This map is the same landscape as Figure 1 with the majority of the natural features removed to give you sufficient workspace to create your village. You may replace as much or as little of the vegetation as you would like as you plan and layout your new village.
3. On your map, determine and draw the direction the stream is flowing.
4. Draw the village. Be as specific as you can within the space provided. If you like, leave the wild spaces such as forests and undeveloped fields in their natural state or build on them and cultivate them. This is your village; you can make it as populous and developed as you like, provided it remains a pre-industrial village.
5. When you have drawn in all of the features, label them. Some will be easy to write right on top of, but others will need to be indicated with the use of arrows. Just try to keep it as neat as possible; this will be graded.
6. Using the color code on the next page and color along the river's length where it would probably be polluted by the use of waterpower and the other human activities in the village. Then, trace each color back to its source, be it a mill, a farm, or just a bathroom behind a crowded tavern. Your map, when you are finished, should look something like a thick vein of colors with smaller branches of individual colors coming off of the center.

Continued on next page

Task 2: Your Village and Its Water Conflicts *(continued)*

Color	Description of Use
Blue	Dyes and chemicals used to treat fabrics
Brown	Sawdust and wood chips
Red	Iron and other heavy metals pumped out of mines as they drain
Black	Coal dust and dirt washed into the water
Orange	Flakes of copper, bronze, and other metals used in tools and weapons
Yellow	Human and animal wastes that have flowed into the river
Green	Excess plant products dumped into the creek after processing

7. After you have described the possible pollution sources, identify three points of potential conflict over the river. Using a wide marker or making several passes with your pen or pencil, circle three places on your map where you think there could be conflicts. These could be conflicts between people over access to the river's water, they could be conflicts between people and animals or plants, or they could be between people and the river itself such as an attempt to change its course.

8. Describe (on page 6 of *Student Worksheets*) each of the three potential conflicts you circled by naming who is in conflict, what each side wants, and what the result of each conflict will probably be.

9. Finally, return to your map and decide where you would want to live if you were transported back in time to this village. Place an "X," name one of the buildings "My House", or otherwise indicate where you would be most comfortable. Be prepared to explain why.

Task 3: Impact of the Creek in Your Village

At the beginning of this lesson, you were asked to imagine that you lived in Europe in the year 1500 and that your village was forced to move to a new location. That new location had a creek running down the middle of it. You were asked to think about how that creek would affect your village, how your village would affect it, and how life would be different for the next generation as a result. As a way to demonstrate how much you learned in this lesson, answer those same questions again. Use what you learned from the reading, from the village you planned, and from the answers and explanations you provided. Be creative if you like, but be sure to include the key idea in the unit.

Your village has fifty families, most of whom are farmers, but there are also a few tradespeople, including a blacksmith, a carpenter, and weavers. Because of a recent serious event, perhaps a forest fire, or an outbreak of disease, or a war, the villagers have decided to move to a new location. The new site, presently undeveloped forest, is similar to the one you've abandoned, except that the new village has a fast-flowing creek running through the middle of it.

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Task 3: Impact of the Creek in Your Village *(continued)*

On page 6 of *Student Worksheets* answer the following four questions.

1. How might the presence of this creek affect life for you and the other villagers?
2. Will it impact the farmers more, less, or differently than it might the tradespeople?
3. How might the village change over the next generation because of the creek?
4. How might the creek change in that time because of the presence of the village?

Lesson 2. Catherine's Cotton Factory

Objectives

- To compare the efficiency of water wheels to that of turbines.
- To explain how a 19th -century cotton factory operated.
- To propose a location for a new water-powered mill.

A Letter from Catherine

Read the following letter that could have been written by Catherine, a fictional character representing workers who once operated the cotton factory on Virginius Island. Then, read the following explanation in order to learn more about the turbines that power her factory and write a letter back to her explaining how they work. Finally, using your knowledge of how turbines convert river power into usable energy for manufacturing, decide where along a river's path to build a new factory and explain your decision.

February 17, 1850
My Dearest Family,

It seems like an eternity since I left you all in Springfield. I hope this missive finds you well and in good health. I am sorry I have not written sooner, but life has been a whirlwind with my work at the factory, settling in with the family I am boarding with, and leaving some opportunities for my many suitors. Harpers Ferry is a fascinating village, populated by people from Virginia, Massachusetts and Pennsylvania, many immigrants from England, Ireland and Germany, and black freemen and slaves. The pretty, little town sits between two magnificent rivers and in the shadow of the surrounding hills.

Continued on next page

Lesson 2. Catherine's Cotton Factory, Continued

A Letter from Catherine *(continued)*

With two canals, three turnpikes, and the railroad, the town seems constantly in a bustle. The shops line the streets and all are arrayed with the latest goods and fashions out of the port of Baltimore. I have joined the local Temperance League. I am also busy teaching several of the local girls how to read and write. I am surprised how many girls from good families are unschooled. I hope perhaps to visit Baltimore or Washington City, both only a six-hour journey from here but that will have to wait. This place reminds me of home with its shops and factories. Well, I am sure you want to hear about my work; let me take you on a tour of my cotton factory.

Completed just last year, the factory is the largest in the entire South and competes directly with our factories in Springfield, Massachusetts. It cost $60,000 to build and is four stories tall, all of them brick, complete with a bell tower and a polished tin roof. At night we work by gaslight, and in the winter we have steam heat. I work as a spinner, earning $4.57 a month. About half of the employees are girls or women and half are men. Most of the men do the heavy lifting and maintain the machines. They earn $16.00 a month – three to four times as much.

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Lesson 2. Catherine's Cotton Factory, Continued

A Letter from Catherine *(continued)*

What is amazing to me is that the whole factory is powered by the river. The Shenandoah, a little part of it actually, turns these contraptions called turbines down in the basement, and that turning action is translated to axles hung from the roof of the ceiling in each room. These axels in turn drive all of the machines via smaller axles or belts. For the life of me, I cannot understand how that little bit of water drives this entire factory.

Let me officially start your tour. On the first floor is the carding department, where the cotton delivered fresh from the fields by barge, wagon, or train is opened, cleaned, and wound into initial clumpy strands. This is accomplished by two picking machines, eighteen carding engines, and six double roller spreaders, all powered by the river.

On the second floor, where I work, the clumsy, coarse threads are spun into uniform, sew-able threads. There are eighteen frames, each with 132 pairs of spindles and bobbins, and all of them are driven by an overhead axle bringing the river's power to our work stations. During the day this floor is unbearably noisy, and all of us put cotton into our ears.

Continued on next page

A Letter from Catherine *(continued)*

The third floor is where the thread is weaved into cloth. There are ninety-seven looms, and on them the cloth is weaved, pressed, and brushed. The whole factory revolves around the weavers. If they work fast one day, the men unloading the cotton and those of us doing the spinning have got to hurry to keep up because, if the looms sit idle, the factory does not make any money. In contrast, if several of the operators get sick (cholera is a constant problem here) or weather forbids them to walk to work, the managers close the whole factory, arguing that the loom operators are the ones that actually make the factory money. If there are not enough of them to pay everyone's salary, it is cheaper to wait until they return.

The fourth floor is not interesting. Up there the finished cotton bundles are banded, covered for shipping, and tagged for their destinations. I guess I find it uninteresting because the process of creation has ended; the fourth floor is just names and addresses and invoices. The banding machine and the bagger are also powered by the river, however, and require a great deal of energy to

Continued on next page

A Letter from Catherine *(continued)*

handle those huge bundles of tightly woven fabric. I just do not know how the river does it!

There was a big celebration last week with an article in the paper, because the factory shipped 300,000 pounds of cotton the month before, a new record. My friends and I were hoping for bonuses or some recognition, but all of the speeches were reserved for the investors and managers. Oh well, I should not feel too badly – the river did not get any recognition either. I did use the occasion as an excuse to buy a new bonnet, which I wore to both the ceremony and a soiree afterward. In my next missive, I will write you of my new family and my new friends. The other girls and I are enjoying the company of many fine, young industrious men. Most of them are gainfully employed as mechanics, masons, factory wrights or farmers.

Please write when you get a chance; I can not wait to hear how you all are adjusting to life without me.

I will now close, remaining, as ever, your faithful daughter and sister.
Catherine

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How Water Wheels and Turbines Power Factories

Read the following description of how and why water wheels were gradually replaced by turbines, and then use the information to write a letter back to Catherine explaining how her factory works. A list detailing what must be included in the letter is provided on page 17.

Figure 2 – Colvin Water Wheel

Horsepower and Torque

A water wheel is like any kind of engine; it develops two kinds of power – horsepower and torque. **Horsepower** is a measure of the speed the water turns the wheel and therefore how fast machines connected to the wheel can be turned. The faster the river is rushing downstream, the more horsepower it can provide to the machines connected to the wheel. **Torque** is a measure of the force the water delivers to the wheel and therefore how much weight it can lift or friction it can overcome. This force is determined by how much downhill travel the water is experiencing at that moment, and that travel is called the river's head. **Head** is measured in feet, indicating the difference in elevation between how high the river started and how low it ends up. For example, water pouring off a desk onto the floor has a head of about 60 cm, while water poured from your outstretched arm when you are standing would have a head of 1.5 to 2 meters. The water you poured while standing would impact a water wheel with more energy than the water from the desk, allowing the water wheel to transfer more torque to its machines and therefore to do more work.

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Weaknesses of Water Wheels

Water wheels worked well enough for centuries, but during the industrial revolution as human needs for mechanical power grew, certain drawbacks became apparent. First, the water is only pushing in one direction—down. If the wheel has 12 slats, only three or four are being pushed against by falling water at any one time, in the meantime, the other slats are useless. In addition, the force required to turn the unused slats back up to the top took away energy that could have been turning machines. Second, if the bottom of the wheel gets submerged, the wheel stops turning and becomes useless. There cannot be any depth of spilled water around the wheel; therefore the water must be evacuated quickly. Third, since the pouring water impacts the wheel near its top, much of the water's head is wasted. It would be better if it could build force before hitting the slats. All of these drawbacks meant that water wheels never exceeded 75% efficiency; that is, they never transferred more than 75% of the river's power to the machines, and it was often closer to 60%.

A New Technology – Turbines

Turbines were invented in the 19th century specifically to overcome the weaknesses of water wheels. See Figure 3 below for a drawing of a water wheel and turbine. In a turbine, the wheel is placed on its side, and the water is dumped inside it using a pipe. The water wants to exit the wheel, and does so through the hollow slats, turning the wheel as it goes. In this way, the water is pushing against all of the slats at once. In addition, the water is able to fall a greater distance since the turbine lies flat at the bottom of a basin or waterfall. The turbine works underwater, so there is not as pressing a need to evacuate the spilled water, and the turbine is often made of iron, not wood, so it requires less maintenance. The turbine can convert up to 88% of the water's energy into usable mechanical energy and does so more reliably than water wheels could.

Water Wheel *Turbine*

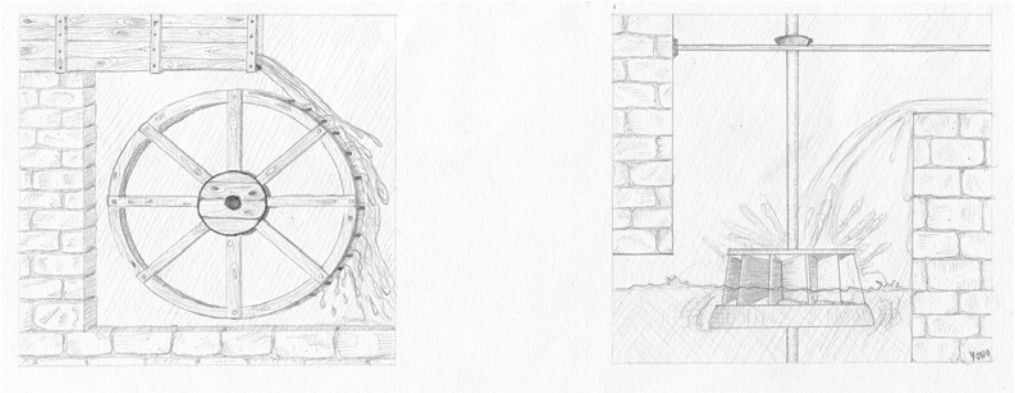

Figure 3: A comparison of a traditional water wheel and a mid 19th -century turbine

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Catherine's Cotton Factory and Its Turbines

During this time period, Southern industry had been seen as poor, unsophisticated, and backward. This factory, built in the same town as the very important U.S. government rifle factories, was seen as one of the first steps in changing Southern manufacturing. The factory had two brand-new turbines in its basement, each almost two meters in diameter. The turbines used water brought from the Shenandoah via a specially dug underground Inner Canal and had access to over four meters of head. On average, they generated 60-70 horsepower for the machines, depending on the speed of the river. The turbines were connected to a central axle that traveled straight up through the center of the factory and fed power to secondary axles that ran along the ceiling of each room.

The turning motion of these axles was transmitted to the individual machines via smaller axles or leather belts. (see Figure. 4: Virginius Island Cotton Factory). The machines were completely dependent on the turbines and, therefore, the river. If the river ran dry or the turbines broke, or the central axle malfunctioned, all work stopped. There was no back-up coal, wood, or animal power.

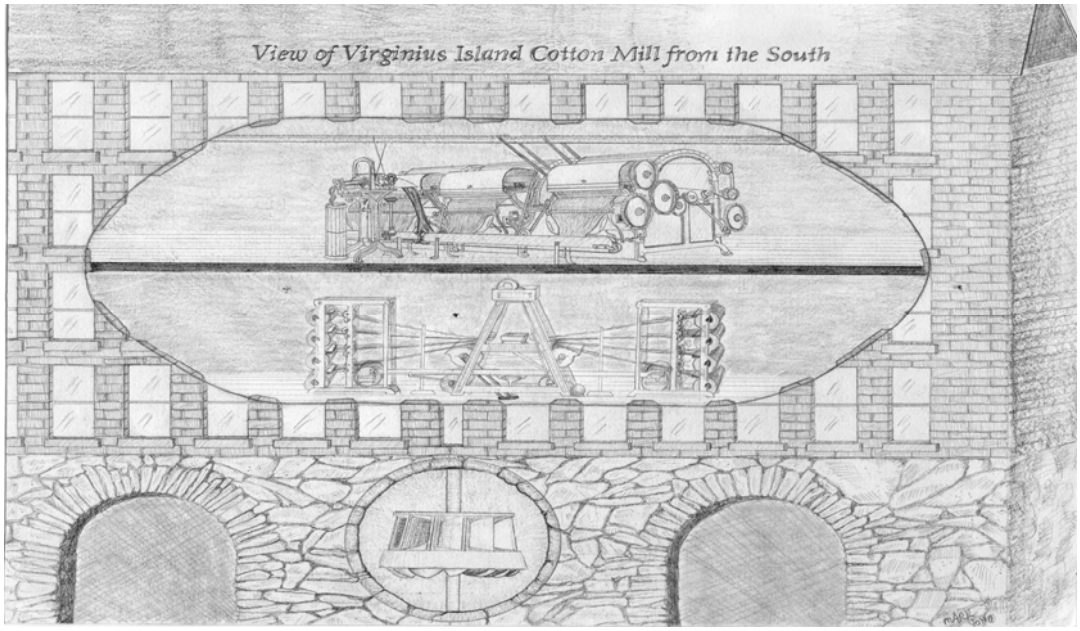

Figure 4: Cross Section of Virginius Island Cotton Factory

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Task 4: Instructions for Writing a Letter to Catherine

Pretend you are Catherine's cousin Beth or, if you prefer, Beth's fiancé John. You two have just received Catherine's letter about the cotton factory where she works, and you want to write back to her. By coincidence, you have also just read an article by a leading engineer in the field of water-driven manufacturing. He described how turbines work and how the power they generate is transferred to machines, and he used as an example of this process the nation's newest cotton factory, the one in Harpers Ferry, Virginia. Proud of Catherine and her new job, you want to explain to her how her factory is powered and how those "contraptions called turbines" operate.

On page 7 of Student Worksheets, space has been provided to write your letter to Catherine. It would be important to consider the following points as you write your letter.

- The excitement and pride you feel for her and her new job
- The kinds of power the river creates
- Why old technologies (water wheels) are insufficient
- How newer turbines are better than older water wheels
- The details of her factory's machinery
- How you came to learn all of this

Continued on next page

Task 5: Locating a New Factory

Throughout the 19th -century, as more and more waterpower was used for manufacturing, decisions had to be made about where to build new factories. Often these decisions were based solely on the river's head and speed at particular locations, but other times factors such as proximity to towns, impacts on farming, and aesthetics were also considered. Now that you understand how a river's head and water speed provide power for manufacturing, you are qualified to evaluate the power-producing potential of several possible locations for a new factory. You can also consider other, less mechanical factors if you feel they are important. Carefully study the map of the area where a new factory is going to be built and decide which location is best (see Figure 5: Locating a New Mill: Student Map). Once you have picked a spot, write a one-paragraph justification for your choice. In addition, include a second choice in case the first spot cannot be bought by the town. Justify it as well.

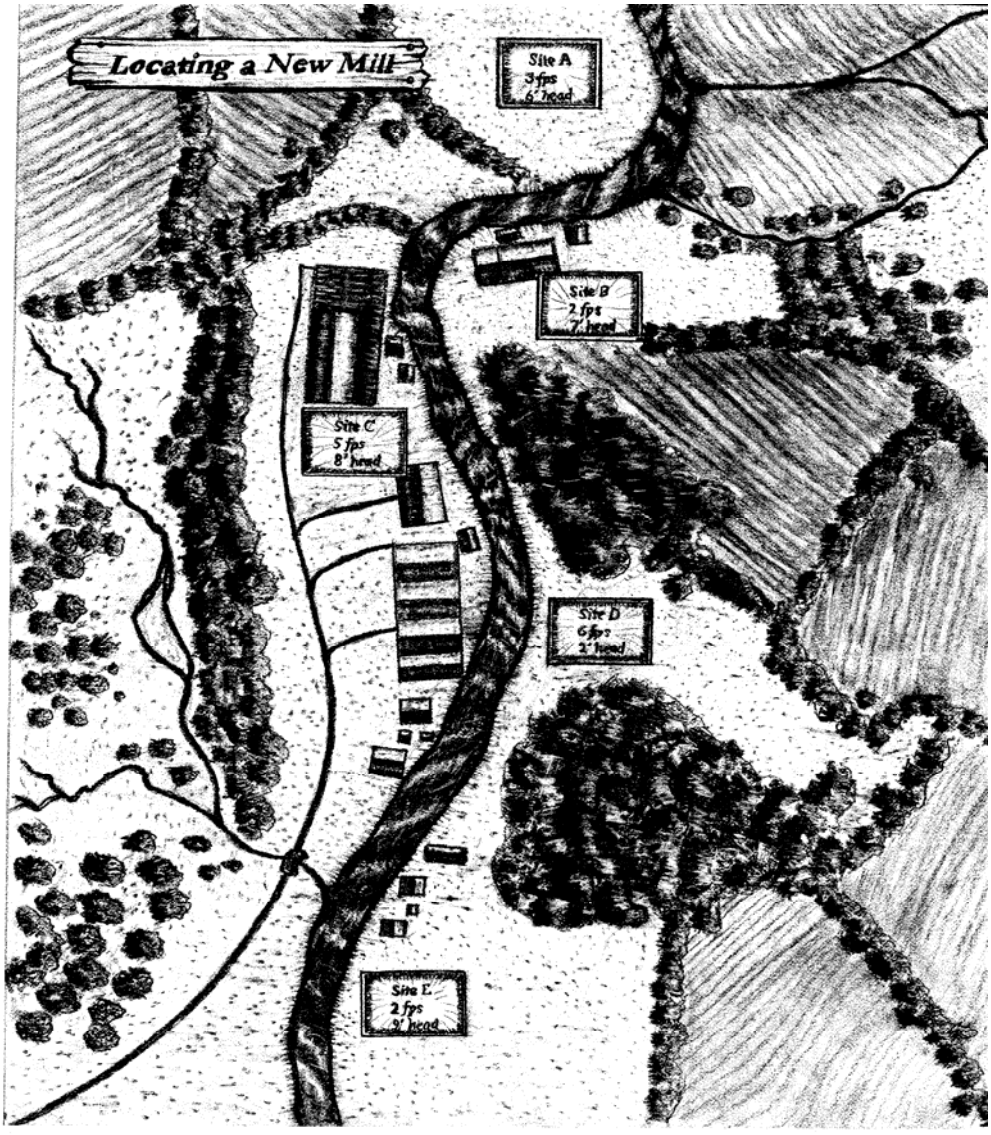

Figure 5: Locating a New Mill: Student Map

Lesson 3: River Environments

Objectives

- To discuss and explain the differences between a river that has been used as a power source and one that has not.
- To estimate two rivers' potential to cause damage during floods.
- To place a value on the use of rivers as power sources.

Task 6: River Environments and Human Impact

Think about a river you have visited. Perhaps you swam, fished, or rafted in it. At some point in its history, that river has almost certainly been used by humans as a source of power. Do you think that the river, when and where you visited it, looked any different because of that use? In what ways? Why or why not?

Procedure:

1. Each member of your three-member team will use one of three drawings (Fig 6: Version A, B, or C found on pages 9, 10, and 11 of *Student Worksheets*) that shows a river environment and provides some information about a particular part of that environment. Your graphic organizer will have different information pre-printed on it than the organizers of the other members of your team.

2. Each team member will have an opportunity to share information on his/her version while the other members of the team copy the information being shared. This process is repeated until information from all three versions is shared. There is space on the drawing for you to write in information from the other versions.

3. Use your drawing and information recorded to respond to the following short essay question:

   I. During heavy rains, spring melts, or other flood conditions, how do the river and its environment respond? How might the area appear different after a flood than it did before?

4. Each member of your three-member team will be issued one of three drawings (Fig 7: Version D, E, or F found on pages 12, 13, and 14 of *Student Worksheets*) that shows a river being used as a power resource.

5. Each team member will have an opportunity to share information on his/her version while the other members of the team will copy information being shared. This process is repeated until information from all three versions is shared. There is space on the drawing for you to write in information from the other versions.

Continued on next page

Task 6: River Environments and Human Impact *(continued)*

6. Use your second drawing and information recorded to respond to the following short essay question:

   II. Which condition, normal rainfall or flooding, is more detrimental to the river itself and the wildlife that live in it when a river is being used as a power source? Why?

7. Now that you have a better understanding of the effects of human use of river power on the river and its environment, write a response to the following prompt.

   III. Rivers can provide enormous amounts of cheap, low-polluting power for generations. However, with the technology presently available, use of river power presents both drawbacks and risks. Defend or criticize the use of river power and provide three reasons in support of your argument.

Before You Visit the Park

Objective

- To identify several locations on Virginius Island, Harpers Ferry, West Virginia.

Task 7: Orientation to Harpers Ferry NHP

Figure 8: Virginius Island Trail Guide, is the park's official map of the area where you will conduct your field study to collect data about the waterpower of the Shenandoah River. To familiarize yourself with the area, on page 15 of *Student Worksheets*, locate the following places on the map: Shenandoah Canal, Winchester & Potomac Railroad, Shenandoah River, Intake Arches, Water Tunnels, and the Cotton Factory (Note that you want the larger Cotton Factory that you read about in Catherine's letter, not the smaller Cotton Mill.)

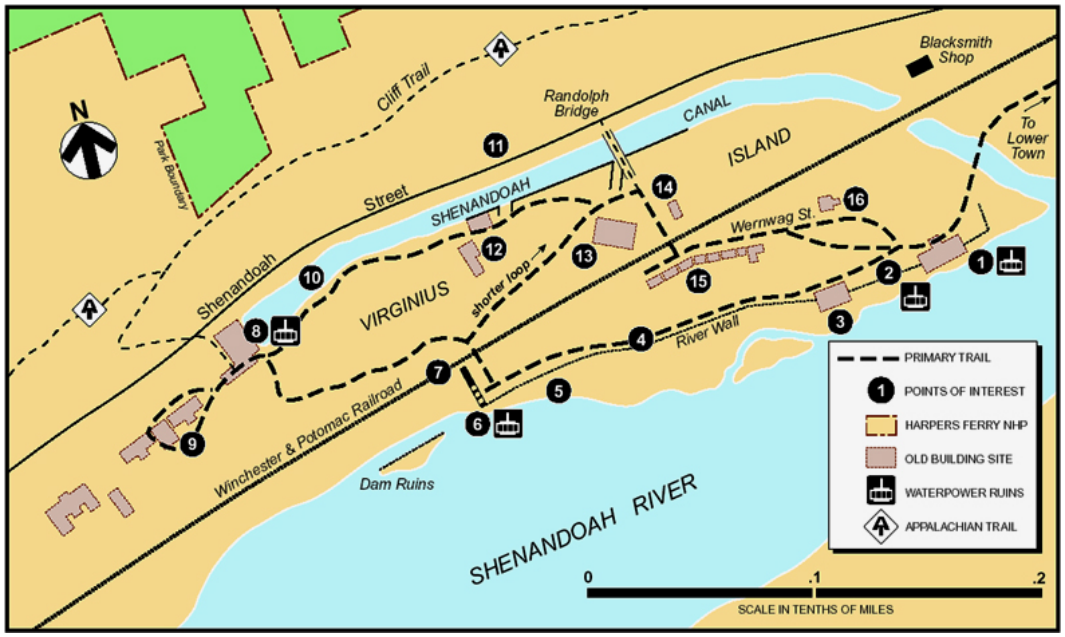

Figure 8: Virginius Island Trail Guide

Plan Wisely for Your Field Study in the Park

Things to Bring

- There will be no place to buy food. You must bring a bag lunch and plenty to drink, preferably water. The hotter the weather, the more you should bring to drink. Pack your lunch and drinks in a backpack or bag that you can easily carry into and out of your park work site.
- Keeping in the ecology-minded spirit, make your lunch as trash free as possible. Some areas and parks have no trashcans. What you pack in you must pack out. Remember, there is nothing beautiful about trash.
- Bring sunscreen and insect repellant.

Park Stewardship

- While you're in the park consider how parks can educate, inspire, and provoke thought.
- Remember, no collecting of any type is permitted.
- Take only photographs. Leave only footprints.

Tips About Clothing

- Wear comfortable clothing that allows you to easily move, hike, bend, and climb. You may gather data in a wet and muddy environment, so choose clothes you don't mind getting wet and dirty.
- Dress for the weather. In cool weather, wear layers of clothing to keep you warm in the early morning that you can remove later in the day or while working. If the forecast calls for possible rain, wear a waterproof jacket, hat, and shoes, and bring a plastic bag for your materials.
- Even in warm weather, wear long pants and a long-sleeved shirt as protection from poison ivy and briars. You may be in a wooded area or walk through tall grass.

A Rewarding Experience

Now that you know the materials to bring, remember to also bring a positive attitude to the experience. Be willing to participate in new adventures and to enter into new things.

Protection of these irreplaceable ruins is your responsibility. Please leave them undisturbed.

Lesson 4: Contemporary River Use Conflicts

Objectives

- To categorize five river use conflicts.
- To investigate another conflict of your own choosing.
- To explain that conflict to your classmates.

Task 8: Possible River Conflicts

Throughout this unit, you have been studying human use of river power and the conflicts that arose as a result. Some of the conflicts have been between people with different priorities, some have been between people and the river's environment, and some have been between the river and the structures or landforms along its banks. What kind of conflict do you think will be the most prevalent in the 21st century? Will most of the issues center around use of the rivers for industry or as a water source or as a recreational opportunity? Will most of the conflicts be between governments of different countries or between business people and environmental activists, or between citizens who want to use the river in more than one way? Make a prediction and explain why you feel the way you do.

River Use Conflict Readings

In this lesson, you will be asked to perform two tasks related to 21st-century river use and the conflicts that have resulted. First, you will read five very short descriptions of conflicts that are occurring today and categorize each by the type of river use conflict it represents. Then, you will research a conflict, either one of the five examples or a different one of your choosing, and write a description of it.

Each of the short readings that follow describes a different kind of conflict related to use of rivers. These five types of conflict are not the only kinds possible, but they represent most of the conflicts in the world today. Read the list of the five types of conflicts on the "River Conflicts that Result from Human Impact" chart on page 17 of *Student Worksheets*, then read the five descriptions and decide which modern conflict falls into which category. Using the chart, explain the ways each river's conflicts fall into each of the categories.

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Nile River

The **Nile River**, located in northeast **Africa** and running north to the Mediterranean, is one of the world's oldest and most important examples of human use of waterpower. Egyptians have been using the Nile as a source of power, irrigation, transportation, and drinking water for more than five thousand years. Recently, however, many of the countries that are paths for or sources of the Nile's water have been demanding greater access to it than they are presently allowed. Ethiopia and Kenya in particular want to use Nile-bound water to irrigate their fields and are also considering building dams to provide hydroelectric power. Egypt's government has refused to discuss the issue with its neighbors; one Egyptian official even went so far as to say that Kenya's plans, if pursued, would amount to an act of war.

Caura River

Venezuela, South America has many rivers and has exploited several of them for the generation of electricity and agricultural uses. One of its rivers, the **Caura**, is an exception in that it is not going to be used for any purpose. The Venezuelan government has decided to leave the Caura, and the region through which it flows, unexploited. The Caura River Basin measures approximately 45,000 square miles and hosts almost 500 species of tropical birds, several hundred fish species, and 2,700 types of plants. The government, utility companies, indigenous peoples, and international environmental organizations all agree that there is no need to use the Caura for any purpose at this time, and that there is substantial benefit in leaving it untouched.

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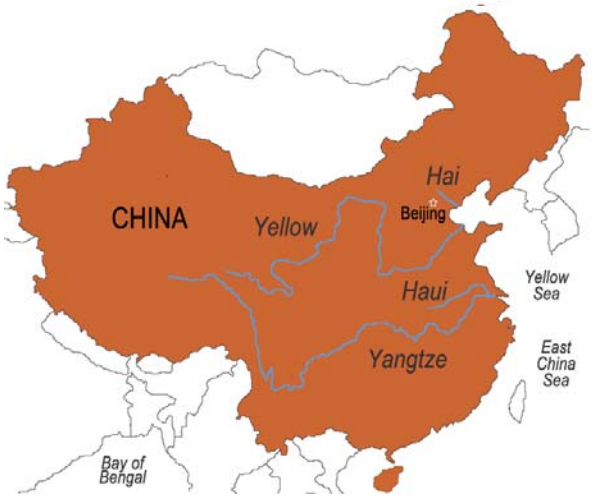
Yellow, Haui, Hai, and Yangtze Rivers



China, on the continent of Asia, is in the midst of a terrible long-term water crisis. A combination of population growth, increased per-capita consumption, inefficient agricultural practices, and poor decision-making concerning the locations of industries have created the crisis, and none of the factors is easily corrected. One of the most severely hit regions is in the dry northeast of the country, where the **Yellow**, **Haui**, and **Hai Rivers** don't provide enough water for domestic, agricultural, and industrial uses. The government plans to address this problem by cutting three 800- mile long channels from the **Yangtze River** in the south and diverting much of its water north to the Yellow, Haui, and Hai Rivers. Chinese and international environmental organizations fear that the Yangtze cannot provide enough water to the north-east and still satisfy those who have come to rely on it in the south. They also fear that the channels will have detrimental effects on the regions through which they are cut.

Colorado River

In August of 2003, a new dam was completed in the Elfin Forest of **California**, creating a reservoir of freshwater for communities near **San Diego**. The reservoir, which will use water from the **Colorado River**, is not intended to be a daily source of water but is to be used in emergencies such as earthquakes or severe droughts. The dam was built to survive an earthquake up to 7.2 on the Richter scale, and the reservoir it protects holds enough water for 50,000 homes for one year.

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Cherry River

In November of 2003, the city of **Richwood, West Virginia** experienced severe flooding. As a result, the mayor of Richwood supported a petition drive that encouraged the construction of a flood-control dam on the **Cherry River**. Many West Virginians opposed the idea on the grounds that it would be expensive and destructive to the environment and that the use of dams to control floods is an old, ineffective idea. Others agreed that something needs to be done to limit the damage done by flooding, but they suggest other methods would be more effective.

Task 9: Prepare a Presentation

Now that you have learned a little about several different types of 21st-century river use conflicts, you are ready to investigate one of them more fully. Either choose one of the examples you just read or pick another river use conflict you are aware of and consult encyclopedias, journals, or other media sources to find out more. When you have done so, prepare a brief presentation in which you include:

- The location of the conflict and the name of the river
- The type of conflict, using either one of the categories already provided or one of your own invention
- The most important or likely options being discussed by the parties involved
- The environmental impact of each option
- The economic impact of each option
- The human (as opposed to economic – could be moral, aesthetic, political...) impact of each option
- Finally, recommend one of the options and explain why you think it is best.

On page 18 in *Student Worksheets*, you will find a rubric that you can use as a guide to help you write and, then, assess the quality of your work.