Minnesota Valley National Wildlife Refuge

Landforms

In a Nutshell

Exploring the Lower Minnesota River Valley, students will gain an understanding of how various land formations, moving water and human activities affect the watershed.

Grade 4 - 6
Season Fall & Spring
Location Rapids Lake Education and Visitor Center

Learning Objectives

- Describe how various land formations were created
- Explain how water moves through the water cycle
- Understand the affects human activities have on watersheds

Literature Connection

- ***Rivers and Valleys*** by Philip Sauvain
- ***This Is The Rain*** by Lola M. Schaefer
- ***The Snowflake: A water cycle story*** by Neil Waldman

Pre-Activities

Project WET activity, *Incredible Journey (upper elementary)*

With a roll of the die, students simulate the movement of water within the water cycle. From their movement through the water cycle, students will compose a story of their travels as a water droplet.

On-site Activities

Using maps, models, demonstrations and a hike, students will explore the Minnesota River watershed. Learning about the history of the Minnesota River focusing on the changes in human culture, technology and the resulting environmental impacts, students will utilize problem-solving skills to predict changes that can be achieved with environmentally responsible behavior.

Classroom Connection

Any of the following Project WILD or WET activities:

Project WILD, *Eco-Enrichers (5-8)*

Students observe the contributions of plants and animal matter to soil and recognize that many forms of wildlife contribute to the diversity and balance of ecological systems.

Project WET, *Wetland Soils in Living Color (middle school)*
Students learn properties of wetland soil and how to classify soil types using a simple color key.

Project WET, *Just Passing Through (upper elementary)*
Students investigate how vegetation affects the movement of water over land surfaces.

Teacher Resources

- ***River of Words: Images and Poetry in Praise of Water*** ed. by Pamela Michael
- ***Watersheds: A Practical Handbook for Healthy Water*** by Clive Dobson

Landforms
Pre-Activity

Materials

- 9 station labels
- 9 station dice
- Clipboards (1 per student)
- Datasheet (1 per student)
- Pencils (1 per student)
- Bird call
- Water cycle poster

Incredible Journey

Inside Visitor Center (45 minutes)

Follow the Project WET activity, The Incredible Journey (page 161) with the following adjustments:

To introduce the activity, follow the warm up discussion from the lesson. Discuss how water travels around the earth through the water cycle, using the water cycle poster to illustrate.

#2. Before starting the program, tape the station signs around the classroom for easy transition from station to station.

#5. Ask students to move individually from one station to another throughout the whole activity.

#7. Instruct students to use the data sheet for recording their rotations.

#8. Use a bird call to begin and end the activity.

Wrap-UP

Ask students to begin a creative story that chronicles their travels as a water droplet. Give examples of what you want the stories to include:

- The states of water they change into. From a solid to a gas or a liquid to a solid. Did they change from a liquid to a vapor rising to the clouds? Did they change from a drop of liquid to a solid as they moved through the cold winter sky?

- The action of change; evaporate, melt, freeze, thaw, vaporize, etc. Did they evaporate from a leaf? Did they melt, drop by drop, from an icicle on a warm winter day? What caused them to move? Were they eaten while in a plant, slurped up by a deer, or left behind by a bear?

- Adjectives that show how they felt as they moved. Adverbs to describe the movement. Were they ever bored being stuck in a glacier? Did they explode from the clouds during a violent thunderstorm? Did they shiver as they floated to the ground during the first snowfall.

If there is not enough time for students to complete the stories ask teachers to give them additional time to complete them before their fieldtrip. Students should vote for the story they like the best, bring the winner to the fieldtrip to be read during the fieldtrip Introduction.

Explain to the students that during their refuge fieldtrip, among other things, they will hike along the Minnesota River discovering how water moves through the refuge watershed.

The Incredible Journey

Place an “X” at the station you **travel to or stay at** for each roll of the dice. At the end, add the total number of times you were at each station.

Roll of Dice	Clouds	Plants	Animals	Rivers	Oceans	Lakes	Glaciers	Ground Water	Soil
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
TOTAL									

Landforms
On-site Activities

Materials

Introduction

- Refuge map
- 2 Shower curtains
- Watering can filled with water
- Assortment of different sizes plastic buckets or flower posts
- Posters: *How Does Your Watershed Flow, Water Cycle, Tree Silhouette*
- Whiteboard/ FlipChart with markers
- Water-related prize for winning author of the Water Cycle Story (jar of bubbles, bag of water balloons, mini-water soaker, etc.)

3-D Watershed Maps

- Upper Midwest 3-D map (one per student team)
- Minneapolis-St. Paul 3-D map (one per student team)
- 3-D glasses (one per student)
- Confluence photographs (Minnesota and Mississippi Rivers)
- Vocabulary list

Stream Table Demonstration

- Stream Table (available only at Rapids Lake Education and Visitor Center)
- Demonstration Tool Kit
  - 3 sponges to represent wetlands, rocks, sticks for stream bank rip-rap, toy house , plastic covered square to represent parking lot , cedar and spruce clippings to represent natural vegetation /parkland / forest, spray bottle to represent rain
- Stream Table Set-up Tool Kit
  - Vaseline, rubber hammer, sand, small shovel/trowel

Watershed Hike

- Digital cameras (1 per student)

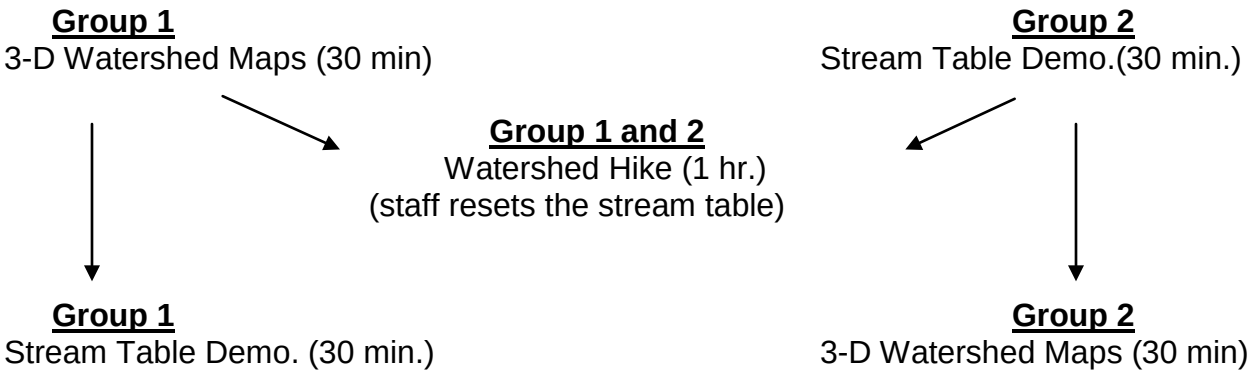
Introduction

Inside Visitor Center (15 minutes)

Allow students visiting from the Minneapolis/St. Paul area a restroom break when they arrive. Gather students in the classroom for a welcome, orientation and discussion of the plan for the day. Using the refuge map, show students where Rapids Lake Education and Visitor Center is located in relation to their school and the Bloomington Visitor Center (if the group normally visits the Bloomington site).

If the class brought a winning water cycle story invite the author to read it aloud to the class. Award the winner a water related prize for their work and creativity. Briefly review what students learned from playing the Incredible Journey.

Explain the rotation of fieldtrip activities, inserting lunch and breaks as necessary. Here is a sample plan of the day dividing a 30 student class into two groups.



Shower on the Land

Outside Visitor Center (15 minutes)

Outside the Visitor Center (in an area protected from the wind), gather students around a shower curtain spread out on flat ground.

Review the three ways water can move through earth systems (refer to the water cycle poster): percolate into the ground, run-off the ground surface, or return to the air through transpiration or evaporation.

Begin the activity by asking students the question: What is a watershed? *(A watershed is the land area from which surface runoff drains into a stream channel, lake, reservoir, or other body of water. A watershed is also sometimes called a drainage basin.)* The pattern of water flow in a watershed can be compared to the branches of a tree. Using the *Tree Silhouette* poster show how smaller creeks and streams (represented by the branches) flow from higher elevations to lower elevations and eventually join up with large rivers (represented by the trunk). Using the *How Does Your Watershed Flow?* poster, show students the three major watersheds in Minnesota. Select a few volunteers to locate the watershed we are living in. Ask students where they think all the water in our watershed ends up? (Minnesota River and then the Mississippi River or directly to the Mississippi River)

Ask for a student volunteer to become your “model mountain.” Direct the volunteer to lie down on one curtain in the fetal position and cover them with the other shower curtain, being careful to fully cover the bottom curtain so water doesn’t pool underneath the student. If the ground is cold or no volunteer is forthcoming, use an assortment of objects under the shower curtain. (Inverted buckets work well.)

With the model of a *rugged landscape* set before the group, ask students to make the following predictions if rain should fall on this model.

- Where will the water travel when rains falls on “mountain tops”?
- Where will small streams form?
- Where will larger rivers be located?
- Where will streams join together?
- Where will ponds and lakes form?

Using a watering can, slowly pour the water over the model. Advise students to watch where the water flows. Were their predictions correct? Can students find smaller watersheds within larger watersheds? You may wish to pour water more than once in order for students to make detailed observations.

Moving water is a very powerful force of nature and can affect natural systems as it moves. To counteract this force, nature has built in safety "stops" along the way to minimize the damaging effect of moving water:

- Vegetation: plant roots hold soil is place limiting the ability of water to carry away too much soil as it moves along.
- Wetland plants and soil act similar to a sponge, holding water and slowing the water pace reducing the damaging effects of floods.

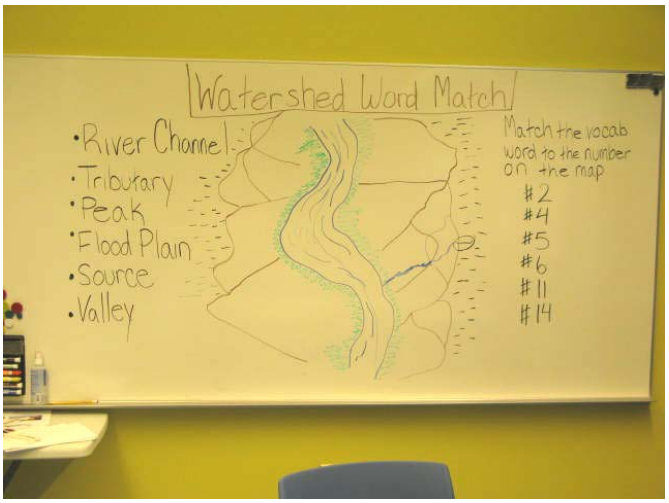
When we alter or remove these natural "stops", fast moving water is allowed to cause major damage more quickly.

Explain to students when at the Stream Table Model they will observe ways moving water may affect a system. Students will have a chance to change the stream system and predict the consequences.

Activity Stations
(30 minutes each)
Split the class into 2 groups. Groups will first do one of the 30 minute stations; either 3-D Watershed Maps or the Stream Table Demonstration. Both groups then join together for the 60 minute hike after which the class splits again to complete the 30 other minute activity.

3-D Watershed Maps
Visitor Center Classroom (30 minutes)
Divide the group into student teams. Provide each team first with the Upper Midwest map and one pair of 3-d glasses for each student. Write the following vocabulary words on the board as shown in the picture below.

Vocabulary for the Upper Midwest Map
12 River Channel
3 Drainage Basin
4 Elevation
5 Flood Plain
6 Glacier
9 Plateau
13 Slope
14 Source
16 Tributary
17 Valley
18 Confluence



Lead the class in interpreting the vocabulary words and then trying to find the corresponding landform on the 3-d map. IF students are having difficulty identifying a landform, use the numbers on the map that correspond to the vocabulary list. When finished, collect these maps and pass out the MSP map.

While students look over this new map write a second set of vocabulary words on the board (without the corresponding numbers). Lead the class in interpreting this new vocabulary and trying again to match the corresponding number on the map. Map numbers again correspond to the vocabulary list.

Vocabulary for the MSP Map

1 Contour Interval
2 Contour Line
7 Gorge
8 Peak
15 Topographic Map

Leave the vocabulary list with the teacher for follow-up back in the school classroom.

Stream Table Demonstration
Visitor Center Basement (30 minutes)

Set up the stream table 2 days prior to the activity, to assure the system functions properly and to practice a "dry run" of the activity. Set-up instructions are provided at the end of the curriculum.

Start the activity by asking students to look at the model. Identify the locations of the following terms within the stream model:

- **Streambed**- the bottom of the channel through which a stream flows or once flowed
- **Stream bank**- the steep sides of a stream
- **Channel**- the bed where a natural stream of water runs; the deeper part of a river, harbor, or strait
- **Slope**- the part of a hill or mountain that is at an angle
- **Delta**- a triangular deposit of sand and soil at the mouth of a river or inlet

Explain what items in the model represent wetlands (sponges), woodlands (spruce and cedar clippings), development (square "parking lot"), and erosion control (rocks or sticks for rip rap). Ask students to observe what happens to the stream banks and channel at low flow and then at a high flow. Open the water valve to start circulating water through the stream table model.

Ask students the following questions based on their stream table observations. Write each law on the board or flipchart as they are identified. Each question highlights one of five **Laws of River Physics.**

1. Why do natural rivers and streams usually not flow in straight lines?

   Rivers Follow the Path of Least Resistance

   Rivers and streams follow the path of least resistance and flow around obstacles on their way from higher to lower elevation. This is what gives rivers and streams their shape or "course".

2. Look closely at the speed of the water in the stream system. Does the speed of the water stay constant throughout the streambed? Where does it appear to be moving faster, and where does it appear to be moving slower?

   Water that "meanders" moves more slowly than water moving through a narrow channel. *Water that moves on the outside of the bend moves faster (this is physics) and the water on the inside moves more slowly. Water also picks up speed in straight sections and where it encounters objects like rocks and debris.*

   How could more water be added to this system naturally and what would happen? *Precipitation, snowmelt, increase in slope angle, etc. More water moving through a streambed means it must move faster. Faster moving water creates more erosion. Look for examples of these two principles along the stream's course.*

3. Do the banks look the same throughout the entire course of this stream?

   Generally, banks on the inside curve have a gentler slope. The slower moving water is not eroding soil away but dropping sediment as it slows down. This alternating between erosion and deposition is what slowly makes the river channel "move" across the landscape.

   How could more water be added to this system naturally and what would happen? *Precipitation, snowmelt, and runoff are some ways water could be added to this system. More water moving through a streambed means it must move faster. Faster moving water creates more erosion. Look for examples of these two principles along the stream's course.*

4. Does the streambed look the same throughout the system?

   Faster water causes more erosion and carries more sediment downstream. Water deposits sediment as it slows down.

   No, when water picks up speed around objects it scours under and around rocks. The deeper areas in rivers and streams provide good fish habitat. Fast moving water will carry soil sediment as it travels. When the water slows down along the inside of a curve, the sediments will drop. This process will make the inside of the bend shallower than the outside of the bend. If 4 people were in a canoe, where would the preferred route in the streambed be?

5. Where do the stream banks seem the most stable?

   Vegetation naturally decreases soil erosion.

   Vegetation is very effective at holding soil in place, even where the water is moving rapidly. Rocks and debris may also be stabilizing, although usually not to the same degree as natural vegetation.

Can You Predict the Outcome?

Go through one or more of the scenarios below, as time allows, with the group. Have the group come up with predictions of what would happen in each scenario. After someone in the group explains their prediction, make the changes described in the scenario. Ask the class as a whole to watch what happens. Was the prediction correct? Ask for ideas on what may be done to lessen the damage along the riverbank. Allow students to add rip-rap, “plant” vegetation, “recreate” wetlands or make other changes they think can prevent further damage downstream.

Stream Table Scenario 1

It was a hard Minnesota winter with a great amount of snowfall. An unusually warm spring arrives early and quickly melts the heavy snow pack.

- What’s your prediction?
- How do you think this will affect the river and those living downstream?

Stream Table Scenario 2

Several hundred acres of forest is being cleared to expand an existing farm. To get as many crops in as possible, the landowner decided to clear the area right up to the riverbank.

- What’s your prediction?
- How do you think this will affect the river?

Stream Table Scenario 3

A county agency would like to reduce parkland that is being lost to the natural meander of their local river. With support from their local government, the agency receives a permit to create a river channel that t will take the water away from the park.

- What’s your prediction?
- How might this affect the communities living downstream?

Stream Table Scenario 4

An excited landowner, who was not familiar with river physics, bought a beautiful piece of property along the banks of his hometown river. He built his dream home on the edge of the bank. Over many years, land use changes up stream changed his property.

- What’s your prediction?
- Do you foresee any problems down the road for this nature-loving homeowner?

Stream Table Scenario 5

A large retailer decided to build in the local community. A large parking lot and mini-mall was built on top of a wetland. Rainfall and snowmelt soaked into the ground and is now trapped on top of the asphalt.

- What’s your prediction?
- How do you think this extra water might affect the stream?

Watershed Hike
(60 minutes)
Hike along the Minnesota River pointing out the landforms and activities discussed during the stream table demonstration and the 3-D Watershed Map activity. Discuss how plants and animals use the watershed to survive.

When the hike activity is about half way complete, give the students a chance to use digital cameras. Write the students names (using masking tape & markers) on the cameras. Explain to students how to properly use the cameras. Let students know that if they use the cameras inappropriately (taking pictures of friends for example) or irresponsibly (swing them or dragging them along the ground) they will be asked to return the cameras to the leader for the remainder of the hike. Ask students to photograph different land formations (river, river bluff, slope) plants, wildlife, or people using the river (boaters, anglers).

At the end of the hike instruct students to delete all but two of their best photos from their camera. Explain that refuge staff will either print out the photos on each camera or create a classroom photo CD and mail them to their teacher. Collect the cameras.

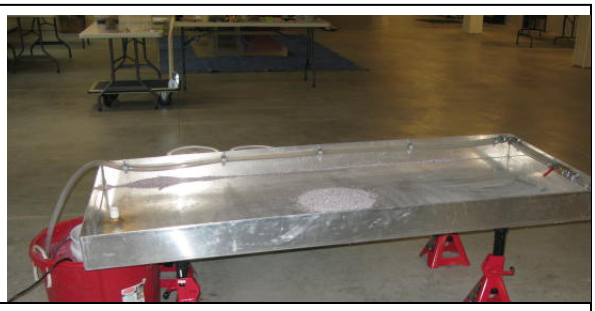
Wrap-Up Management Connection
Restoring Habitat
Staff working for the Fish and Wildlife Service improve and restore the landscape as close to the original pre-settlement habitat as possible. This improves habitat for the native plants and animals of the refuge. This may involve many different management plans including:

- Installation of water control structures to manage wet and dry wetland cycles;
- Removal of agricultural drain tiles to restore natural wetlands;
- Removal of non-native and invasive plant and animal species;
- Prescribed burning to stop woody vegetation from invading prairie habitat

Vocabulary Definitions

1. **Contour Interval**: The distance in elevation between contour lines
2. **Contour Line**: A line on a topographic map that connects points of equal elevation
3. **Drainage basin**: A system of rivers and streams that drains an area
4. **Elevation**: Vertical distance or height above sea level
5. **Flood Plain**: Land that is covered by water during a flood, formed from sediments deposited by a river
6. **Glacier**: A large body of moving ice
7. **Gorge**: A narrow, deep valley with nearly vertical rocky walls
8. **Peak**: The highest point of a landform, usually a mountain
9. **Plateau**: A large, nearly level area that had been lifted above the surrounding area
10. **Riverbank**: The high ground on the side of a river
11. **Riverbed**: The bottom of a river
12. **River Channel**: The course a stream follows; the deepest part of a river
13. **Slope**: The angle or slant of a stream channel or land surface
14. **Source**: Where something comes from; its beginning
15. **Topographic map**: A map that uses contour lines to show the shape and elevation of the land
16. **Tributary**: A stream flowing into another stream or river
17. **Valley**: A low area between higher areas through which a river or stream often flow
18. **Confluence**: The place at which two river join

Step-by-Step Stream Table Assembly Instructions

Place the aluminum “table” squarely on four car jacks. Be sure you have centered the model with enough space that students can move around it freely. Raise two jacks at the top of the table until you reach about a 20 degree slope.	
Adjust two of the jacks at the opposite end (the end with the drain hole) to the lowest level needed to slide the red catch basin holding the 10 gallon bucket sieve underneath the bottom of the table.	
Be sure the water control valve is in the OFF position. This should be at the “top” of the model. Follow the tubing down to the bottom of the model to locate the free end.	

Step-by-Step Stream Table Assembly Instructions

Attach the free end of the tubing securely to the water pump intake valve.

Place the water pump on the bottom of the red catch basin. It should fit snuggly between the white 10 gallon bucket and the side of the red catch basin.

Smear petroleum jelly on one end of the white plastic drain pipe. Insert the greased end of the pipe into the drain at the bottom of the aluminum table.

Step-by-Step Stream Table Assembly Instructions

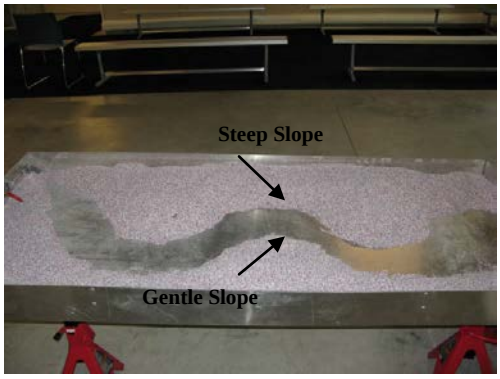
The bottom of the drain pipe should extend below the table into the white 10 gallon bucket sieve. This ensures any plastic “sand” carried by the water is caught in the bucket sieve and doesn’t enter the water pump.

Begin to add the plastic sand, one bucket full at a time, to the table until there is none left.

Begin with the plastic sand evenly distributed in the table.

Step-by-Step Stream Table Assembly Instructions

Using your hands and the sand tools included in the assemble kit, carve a sharply curved river bed into the center of the substrate. To simulate natural riverbank design, pack steep slopes on the outside of the river curves and gradual slopes on the inside of the curves.

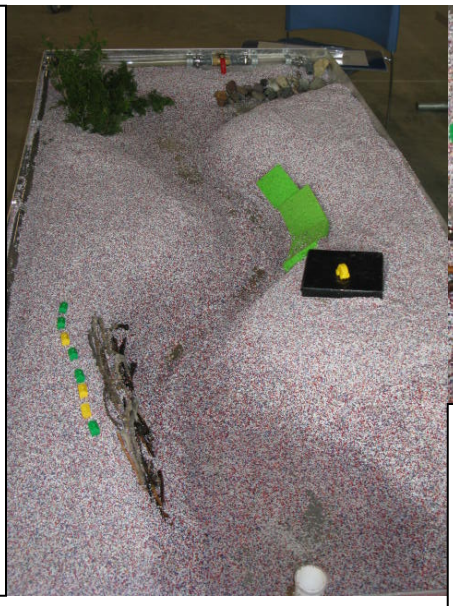


Add natural vegetation, clippings from cedar works well, along the outer river curve at the top of the model. Add stones to the beginning of the stream bed, near the valve where water will initially enter the system.

The green sponges represent wetlands. Add them, already dampened, to the inside of a curve.

The black plastic represents a parking lot.

Monopoly house are placed along the edge.



Add sticks, to represent rip rap, an erosion control method, along another outside curve.

Stream Table Helpful Hints

1 Allow at least three hours to completely assemble the Stream Table, run water through the system, and allow the plastic sand time to settle.

2 Double-check the battery. It is recommended to have a backup battery.

3 Remember not to add too much water initially. Start with enough water to almost fill the catch basin. When the pump stops running (in-between programs or over night) water in the substrate will empty into the catch basin. If too much water is added initially, it may overflow.

4 ALWAYS HAVE A FILLED BUCKET READY DURING THE DEMONSTRATION. Some of the scenarios will require that water runs through the system faster than it is being pumped back and you may have to add water.

5 Start with a dramatic zigzag in the river channel with gradual bends around the corners. This will slow down the water and will allow students more opportunity to observe erosion and settling along the course of the river.

6 Tape down the extension cords to the floor to ensure a student does not trip over anything.

7 Before start the demonstration, ask students to stand back, away from the model, and explain the need for caution and awareness! Students may not touch (unless asked to do so by the instructor) and can never lean on the table. They must also be aware of their footing so that the jacks are not knocked out from under the table. Any student who does not follow instructions will be sent back upstairs.