**DEP Environmental Education Curricula**

**Lesson Plan**

**GRADE/LEVEL: Middle School**

**LESSON TITLE: Watershed**

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| **Next Generation Science Standards** |  |  |
| **MS-ESSC-3**  | **MS-ESS3-3** | Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. |
|  | **Science and Engineering Practices** | [**Constructing Explanations and Designing Solutions**](http://www.nap.edu/openbook.php?record_id=13165&page=67) **-** [Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.](http://www.nap.edu/openbook.php?record_id=13165&page=67) |
|  | **Disciplinary Core Ideas** | [**ESS3.C: Human Impacts on Earth Systems**](http://www.nap.edu/openbook.php?record_id=13165&page=194) **-** [Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things.](http://www.nap.edu/openbook.php?record_id=13165&page=194)[Typically, as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.](http://www.nap.edu/openbook.php?record_id=13165&page=194) |
|  | **Crosscutting Concepts** | [**Cause and Effect**](http://www.nap.edu/openbook.php?record_id=13165&page=87) **-** [Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.](http://www.nap.edu/openbook.php?record_id=13165&page=87) |
| **Objectives** |
|  |  | **Objective 1:** Define a watershed and those factors that can help keep a watershed clean.**Objective 2:** List and discuss what services watersheds provide.**Objective 3:** Determine what types of threats may affect the function of watersheds in the future. |
| **Vocabulary** |  |  |
|  | **Aquatic Ecosystem** | An ecosystem in water – plants and animals interacting with geography and chemistry of the system. |
|  | **Biota** | The animal and plant life of a particular region, habitat, or geological period. |
|  | **Evaporation** | The process of turning from liquid into vapor. |
|  | **Flow Regime/Stream Flow** | Characteristic pattern of flow magnitude, timing, frequency, duration, and rate of change. |
|  | **Fluvial** | Of or found in a river. |
|  | **Geomorphology** | The study of the physical features of the surface of the earth and their relation to its geological structures |
|  | **Hydrology** | The branch of science concerned with the properties of the earth's water, especially its movement in relation to land. |
|  | **Infiltration** | Permeation of a liquid into something by filtration. |
|  | **Precipitation** | Rain, snow, sleet, or hail that falls to the ground. |
|  | **Riparian**  | Relating to or situated on the banks of a river. |
|  | **Saturation** | The degree to which something is absorbed compared with the maximum possible, usually expressed as a percentage. Here we will typically reference saturation of soil with water. |
|  | **Transpiration** | The act of root systems of plants absorbing water from surrounding soil, the water moves through the plant and escapes to the atmosphere through the leaves.  |
|  | **Watershed** | An area or ridge of land that separates waters flowing to different rivers, basins, or seas. |
| **Background** |  |  |
| **Teacher Version**Selected Materials from …Healthy Watersheds Protection | **Source:** https://www.epa.gov/hwp/basic-information-and-answers-frequent-questions |
| **What is a Watershed?**A watershed –– the land area that drains to streams, lakes and/or rivers – affects the water quality in the water body(s) that it contributes to. The type of land use on the watershed will also affect the water quality. Like water bodies (e.g., lakes, rivers, and streams), individual watersheds share similarities but also differ in many ways. Every inch of the United States is part of a watershed – in other words, all land drains into a lake, river, stream or other water body and directly affects its quality. Because we all live on the land (with few exceptions), we all live in a watershed — thus watershed condition is important to everyone.**What is a Healthy Watershed?**A healthy watershed is one in which natural land cover supports:* dynamic hydrologic and geomorphologic processes within their natural range of variation,
* habitat of sufficient size and connectivity to support native aquatic and riparian species, and
* physical and chemical water quality conditions able to support healthy biological communities.

Natural vegetative cover in the landscape, including the riparian zone, helps maintain the natural flow regime\* and fluctuations in water levels in lakes and wetlands. This, in turn, helps maintain natural geomorphic processes, such as sediment storage and deposition, that form the basis of aquatic habitats. Connectivity of aquatic and riparian habitats in the longitudinal, lateral, vertical, and temporal dimensions helps ensure the flow of chemical and physical materials and movement of biota among habitats. A healthy watershed has the structure and function in place to support healthy aquatic ecosystems. Key components of a healthy watershed include:* intact and functioning headwater streams, floodplains, riparian corridors, etc.;
* natural vegetation in the landscape; and
* hydrology, sediment transport, fluvial geomorphology, and disturbance regimes expected for its location.

\*A stream’s flow regime refers to its characteristic pattern of flow magnitude, timing, frequency, duration, and rate of change. The flow regime plays a central role in shaping aquatic ecosystems and the health of biological communities. Alteration of natural flow regimes (e.g., more frequent floods) can reduce the quantity and quality of aquatic habitat, degrade aquatic life, and result in the loss of ecosystem services.**Are Healthy Watersheds Very Common?**According to the EPA healthy watersheds are uncommon, particularly in the eastern U.S. as well as in most other parts of the nation that are urbanized, farmed, or mined. Large tracts of protected wildlands, mostly in the western U.S., are where most healthy watersheds can be found. However, some healthy watersheds exist in many regions of the country where water pollution has been prevented or well controlled, and where communities maintain the benefits of their clean waterways. Here in Maine we generally have healthy watersheds, but also have some threatened and degraded watersheds.Changes to watersheds – such as adding impervious cover, stream channelization, riparian corridor integrity, and land use changes – affect how clean waters are by impacting sediment runoff and other pollutant loads. **How Might Healthy Watersheds Affect Me?**You may potentially benefit from healthy watersheds in numerous ways, generally unseen and unrecognized by the average citizen:* Healthy watersheds are necessary for virtually any high quality outdoor recreation sites involving the use of lakes, rivers, or streams. Great fishing opportunities are usually due to healthy watersheds that surround the waters that people love to fish.
* Your drinking water, if it comes from a surface water source, might be substantially less expensive to treat, when a healthy watershed around the water source filters pollution.
* Your property values may be higher, if you are fortunate enough to reside near healthy rather than impaired waters.

**Why Do Watersheds Need to Be Protected?**Healthy watersheds not only affect water quality in a good way, but also provide greater benefits to the communities of people and wildlife that live there.Healthy watersheds provide critical services, such as clean drinking water, productive fisheries, and outdoor recreation, that support our economies, environment and quality of life. The health of clean waters is heavily influenced by the condition of their surrounding watersheds, mainly because pollutants can wash off from the land to the water and cause substantial harm. Streams, lakes, rivers, groundwaters and other waters are interconnected with the landscape and all its activities through their watersheds. They are influenced by naturally varying lake levels, water movement to and from groundwater, and amount of stream flow. Other factors, such as forest fires, stormwater runoff patterns, and the location and amount of pollution sources, also influence the health of our waters.These dynamics between the land and the water largely determine the health of our waterways and the types of aquatic life found in a particular area. Effective protection of aquatic ecosystems recognizes their connectivity with each other and with their surrounding watersheds. Unfortunately, human activities have greatly altered many waters and their watersheds.**What is Being Done to Protect Healthy Watersheds?**A wide range of activities could be called healthy watersheds protection. These may include regulatory and non-regulatory approaches. EPA’s healthy watersheds protection activities are nonregulatory. Approaches used at state and local level could be either. The private sector is also actively involved in many forms of protection. After decades of focusing almost exclusively on restoring impaired waters, EPA created the Healthy Watersheds Program (HWP) to bring emphasis to proactively protecting high quality waters, following the Clean Water Act (CWA)'s objective “…to restore and maintain the chemical, physical, and biological integrity of the Nation’s waters.” The HWP takes a non-regulatory, collaborative approach to maintaining clean waters by supporting EPA and its partners in their efforts to identify, assess and protect watershed health through Clean Water Act programs. This approach is essential for addressing future threats such as:* emerging water quality problems,
* loss and fragmentation of aquatic habitat,
* altered water flow and availability,
* invasive species, and
* climate change.
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| **2nd topic source**What is a watershed? | Source: https://water.usgs.gov/edu/watershed.html |
| **Not all precipitation that falls in a watershed flows out!**There are many factors that determine how much water flows in a stream:* **Precipitation:** The greatest factor controlling streamflow, by far, is the amount of precipitation that falls in the watershed as rain or snow. However, not all precipitation that falls in a watershed flows out (infiltration occurs), and a stream will often continue to flow where there is no direct runoff from recent precipitation.
* **Infiltration:** When rain falls on dry ground, some of the water soaks in, or infiltrates the soil. Some water that infiltrates will remain in the shallow soil layer, where it will gradually move downhill, through the soil, and eventually enters the stream by seepage into the stream bank. Some of the water may infiltrate much deeper, recharging groundwater aquifers (which may also discharge into the waterbody). Water may travel or remain in storage for long periods before returning to the surface. The amount of water that will soak in over time depends on several characteristics of the watershed:
	+ **Soil characteristics:** Soil that absorbs less water results in more runoff overland into streams.
	+ **Soil saturation:** Like a wet sponge, soil already saturated from previous rainfall can't absorb much more ... thus more rainfall will become surface runoff.
	+ **Land cover:** Some land covers have a great impact on infiltration and rainfall runoff. Impervious surfaces, such as parking lots, roads, and developments, act as a "fast lane" for rainfall - right into storm drains that drain directly into streams. [Flooding becomes more prevalent](https://water.usgs.gov/edu/impervious.html) as the area of impervious surfaces increase. Conversely, forested areas tend to absorb more rainfall, reducing the amount and speed of runoff.
	+ **Slope of the land:** Water falling on steeply-sloped land runs off more quickly than water falling on flat land, thereby reducing recharge to groundwater or absorption by plants.
* [**Evaporation**](https://water.usgs.gov/edu/watercycleevaporation.html)**:** Water from rainfall returns to the atmosphere largely through evaporation. The amount of evaporation depends on temperature, solar radiation, wind, atmospheric pressure, and other factors.
* [**Transpiration**](https://water.usgs.gov/edu/watercycletranspiration.html)**:** The root systems of plants absorb water from the surrounding soil in various amounts. Most of this water moves through the plant and escapes into the atmosphere through the leaves. Transpiration is controlled by the same factors as evaporation, and by the characteristics and density of the vegetation. Vegetation slows runoff and allows water to seep into the ground.

**Evapotranspiration**Source - https://www.thinglink.com/scene/489518255187165186* [**Storage**](https://water.usgs.gov/edu/watercyclefreshstorage.html)**:** Reservoirs store water and increase the amount of water that evaporates and infiltrates. The storage and release of water in reservoirs can have a significant effect on the streamflow patterns of the river below the dam.
* **Water use by people:** Uses of a stream might range from a few homeowners and businesses pumping small amounts of water to irrigate their lawns to large amounts of water withdrawals for irrigation, industries, mining, and to supply populations with drinking water.
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| **3rd topic source** **Surf Your Watershed** | **Source Material taken from** https://cfpub.epa.gov/surf/state.cfm?statepostal=ME |
| Go to the following site (<https://cfpub.epa.gov/surf/state.cfm?statepostal=ME>), click on the interactive Maine map on your geographic location and determine the following watershed information for your town: **Places Involving this Watershed:** *Counties, States, Other Watersheds Upstream, Other Watersheds Downstream* |
| [**Cause and Effect**](http://www.nap.edu/openbook.php?record_id=13165&page=87) **-** [Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.](http://www.nap.edu/openbook.php?record_id=13165&page=87)[Typically, as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.](http://www.nap.edu/openbook.php?record_id=13165&page=194) Discuss how a student’s actions may affect the health of a watershed. Why might it be beneficial to consider pollution control on a watershed level versus by individual bodies of water (such as individual lakes or streams)? |
| **Project: School Grounds Watershed**  | **Selected Materials adapted from Source:** https://www.tarleton.edu/timberlakeranch/documents/Lesson%203.3.pdf |
| **Note****Prior to starting this activity 1) visit** <https://cfpub.epa.gov/surf/state.cfm?statepostal=ME> **and show the students the location of their watershed in the state of Maine.****2) Go to Google Earth Web (using Chrome browser)** <https://earth.google.com/web/> **and use the search feature to find a view of your school for the following project. Print this view for each student (or team of students) to use during their activity.**School grounds are part of our watershed. Students will perform a scavenger hunt to look at land use (building, parking lot, playground, gardens, etc.) and pollution (that on the watershed ground that may be swept into the waters) on school grounds. This information will be used to create a map of the school grounds showing problem areas and acting as a basis for suggestions by students to alleviate identified issues.**Note****This is a good activity to do on a day when you have had a recent rain so that students can see where water is accumulating and running off.**In this scavenger hunt students will look for places on the grounds of the school where water flows, infiltrates or accumulates. They will also look at land use and places where something could change the quality of the water in our watershed. Students will also consider what future actions they could take to promote a healthy watershed.Students will remain on school grounds for the scavenger hunt, under supervision. Remind students that they are standing in a watershed and that everything around them is part of a watershed, because rainwater falls on everything in a watershed. Pass out your simplified map of your school grounds to each child for use during the hunt.Have students consider the following questions as they explore their school grounds watershed.1. What land use is seen on the school grounds?
	1. (this could include buildings, parking lots, lawns, sports fields, etc).
2. Where does the water collect or accumulate on the school grounds?
	1. Identify low places, any rivers, streams, or ditches.
3. Do you see signs of runoff?
	1. Such as water running out of gutters, or where water flows during periods of rain (such as a sloped parking lot, etc).
4. Is there an area of erosion showing?
	1. Such as areas where students or teachers have made a pathway in the grass or soil where no plants are growing or areas where water always flows during a rain, removing any growth from the surface of the ground.
5. What areas have high water flow during a rain, and why?
	1. Things that affect water flow include elevation, land contours, erosion, impermeable surfaces, etc.
6. What are some sources of pollution in this watershed area?
	1. Fertilizers, thermal pollution, soil erosion, etc. (ask school officials if necessary).

Return to the classroom and as a group discuss the following questions:1. Where are problem areas in your school’s portion of the watershed – areas of erosion, pollution transport etc. These can be shown on a group map or listed with student contributions.
2. How does human activity contribute to erosion and pollution transport?
3. What can be done to reduce the human contribution to the problems or erosion and pollution transport?

Consider sharing your students’ results with school officials. |
| **Teacher Prep**  |  |  |
|  | **Advanced Preparation Steps &****Duration** | 1. Read and consider associated background material, demonstration procedures, and questions for discussion. Make copies of Google Earth view. (2 hours)
2. Review What is a Watershed? YouTube Video (2 minutes)
3. Review Watershed PowerPoint (15 minutes)
4. Assemble Scavenger Hunt Materials & Practice (1 hour)
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|  | **Additional Materials for Teacher Enrichment** | 1. Summary on watersheds <https://www.youtube.com/watch?v=2pwW2rlGla8>
2. Build your own watershed <https://www3.eap.gov/safewater/kids/activity_grades_9-12_buildyourownwatershed.html>
3. Droughts <https://serc.carleton.edu/eslabs/drought/2a.html>
4. Watershed <http://new.coolclassroom.org/files/adventures/1/Activity_Watershed.pdf>
 |
| **Needed Materials**  |  |   |
|  |  | What is a watershed? (1:17) Battle River Watershed <https://www.youtube.com/watch?v=QOrVotzBNto>1. Simplified map of school grounds.
2. PowerPoint What is a Watershed?
3. Internet connection
 |
|  | **Duration of activities** | 55 minutes |
|  | **Safety notes** | Remind students to stay on school grounds during the scavenger hunt and obey all school conduct rules as they do their scavenger hunt. |
| **Procedures for instruction** |  |  |
|  |  | Introduce the class to the idea of watersheds.  | ~2 minutes |
|  |  | Show the associated film What is a watershed?(Battle River Watershed) | ~1:17 minutes  |
|  |  | Introduce Watersheds | ~15 minutes(PowerPoint) |
|  |  | Watershed Scavenger Hunt | ~25 minutesConducted on School Grounds |
|  |  | Discussion | ~10 minutes |
| **Student Materials** |  |  |
|  | Background Informational Sheet | Reading assignment prior to the demonstration day. |
|  | Vocabulary List | Available for clarification of terminology as students read their Background Informational Sheet and Demonstration Procedure |
|  | Scavenger Hunt Worksheet | For use during the outside activities. |

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| **Student Background Information Sheet – Watersheds**  |
| Source: https://www.epa.gov/hwp/basic-information-and-answers-frequent-questions**What is a Watershed?**A watershed – the land area that drains to streams, lakes and/or rivers – affects the water quality in the water body that it surrounds. Like water bodies (e.g., lakes, rivers, and streams), individual watersheds share similarities but also differ in many ways. Every inch of the United States is part of a watershed – in other words, all land drains into a lake, river, stream or other water body and directly affects its quality. Because we all live on the land, we all live in a watershed — thus watershed condition is important to everyone.**What is a Healthy Watershed?**A healthy watershed is one in which natural land cover supports:* dynamic hydrologic and geomorphologic processes within their natural range of variation,
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* **Water Use:** Uses of a stream might range from a few homeowners and businesses pumping small amounts of water to irrigate their lawns to large amounts of water withdrawals for irrigation, industries, mining, and to supply populations for drinking water.
 |
| **Student Vocabulary List** |
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| Name Date |
| **Watershed Scavenger Hunt Worksheet**School grounds are part of our watershed. You will perform a scavenger hunt to look at land use and pollution on school grounds. This information will be used to create a map of the school grounds showing problem areas with suggestions by students to minimize identified issues.In this scavenger hunt you will look for places on the grounds of the school where water flows, infiltrates or accumulates. You will also look at land use and places where changes to the quality of the water in our watershed can or do occur. You will also consider what future actions you could take to promote a healthy watershed.Note: You must remain on school grounds for the scavenger hunt, under supervision. Consider the following questions as you explore your school grounds watershed.* What land uses do you see on the school grounds? (List at least three and describe how they each affect water quality.)
* Where does the water collect or accumulate on the school grounds? Mark these areas on your map and describe their size, makeup etc.).
* Do you see signs of runoff? If so, mark them on the map.
* Is there an area of erosion showing? If so, mark them on the map.
* What areas have high water flow during a rain, and why? If it has not rained recently talk with your teacher and classmates to see if you remember where water runs or pools when it rains.
* What are some sources of pollution in this area of the watershedh? List at least three if possible.

Return to the classroom and as a teacher led group discuss the following questions:Where are problem areas in the watershed?How does human activity contribute to erosion and pollution transport? Give examples of where you saw this on your school grounds.What can be done to reduce the human contribution to the problems or erosion and pollution transport? |

**Project Assessment**

**Project Title:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Instructor/School/Grade: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_/\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_/\_\_\_\_\_\_\_\_**

**Instructor Contact Information: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date you assigned this project to your class: \_\_\_\_\_\_\_ Number of Students Participating \_\_\_\_\_\_**

The following questions are intended to help us understand your feelings regarding the presentation and materials. Your sincerity in answering these questions is appreciated. Please feel free to use the space at the end of the form for any additional comments that you may have. *This form has been left in Microsoft Word format so that you may fill it in electronically. Please fill out the form completely and email your assessment to* david.madore@maine.gov.

**Ranking System**

 1 ~ Excellent / Strongly agree

 2 ~ Good – Above average / Moderately agree

 3 ~ Average – ok / Neutral in agree or disagree

 4 ~ Poor – below average / Moderately disagree

 4 ~ Very poor – not acceptable / Strongly disagree

 NA / not applicable

*Please continue on the second pagee…*

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| --- | --- | --- | --- | --- | --- | --- |
| **1** | **2** | **3** | **4** | **5** | **NA** | **Questions** |
|  |  |  |  |  |  | **Course Content** |
|  |  |  |  |  |  | 1. Value of course content to you.
 |
|  |  |  |  |  |  | 1. Importance of course content given your teaching topic.
 |
|  |  |  |  |  |  | 1. Overall rating of course content.
 |
|  |  |  |  |  |  | 1. Ease of implementing materials into daily lessons.
 |
|  |  |  |  |  |  | **Materials/Project** |
|  |  |  |  |  |  | 1. Movie (if applicable) was easy to present.
 |
|  |  |  |  |  |  | 1. Student worksheet was useful and easy to follow.
 |
|  |  |  |  |  |  | 1. Student project stimulated thinking & conversation.
 |
|  |  |  |  |  |  | 1. The project put ideas across effectively.
 |
|  |  |  |  |  |  | 1. Teacher materials were useful and easy to follow.
 |
|  |  |  |  |  |  | 1. The method of material presentation encouraged students feel free to ask questions, disagree, express ideas, etc.
 |
|  |  |  |  |  |  | **Self-Evaluation (Instructor)** |
|  |  |  |  |  |  | 1. What was your level of knowledge concerning this topic prior to this presentation?
 |
| **Please share any recommendations you feel would be helpful.** |

**Thank you for providing your feedback!**

Please email your assessment to david.madore@maine.gov.