Youth & Education in Science (YES)

Lesson Title	Size and Occurrence of Floods
Grades	6 - 8
Length	one class period
Topics	floods, watersheds, probability

Materials Needed

- One hundred items the same size and shape, but five different colors. Suggestions for items include marbles, dried beans, or multi-colored macaroni. The items need to be organized according to color and number as follows:
    - One item its own color. This item represents a 100-year flood event, 100-year recurrence interval.
    - Two items their own color. These items represent a 50-year flood event, 50-year recurrence interval.
    - Ten items their own color. These items represent a 10-year flood event, 10-year recurrence interval.
    - Twenty items their own color. These items represent a 5-year flood event, 5-year recurrence interval.
    - Sixty-seven items their own color. These items represent no flooding.
- A small paper bag or large coffee an to contain the items. The opening at the top of the container must be large enough for the students to place their hand in for selection of an item
- Paper and pencil

NGSS Alignment

NGSS_flood occurrence lesson.pdf

Overview

The size or magnitude of a flood is described by the term "recurrence interval", which is determined by studying a long period of flow records for a stream. This activity demonstrates the occurrence of a particular flood event and shows that floods do not necessarily occur every 10, 50, or 100 years, as is commonly thought. In this activity, students use macaroni or beans to calculate the statistics of flood recurrence (see back side of poster).

Objectives

- Students will determine the occurrence of an event based on the random selection of different colored objects.
- Students will relate the occurrence of event to a 100-year, 50-year, 10-year, or 5-year flood.

Related Links

Watersheds: where we live (poster)

100 Year Flood - It's All About Chance (poster)

100-year-flood-handout

USGS Current Flood Info

How to Prepare for a Flood

Vocabulary

Recurrence interval, floodplain, watershed

Teacher Background

Floods happen irregularly and result from different circumstances. Scientists and engineers frequently use statistical probability (chance) to put a context to floods and their occurrence. If the probability of a particular flood magnitude being equaled or exceeded is known, then risk can be assessed. The "100-year flood" is an estimate of the

long-term average recurrence interval, which does not mean that we really have 100 years between each flood of greater or equal magnitude. This activity demonstrates the occurrence of a particular flood event and shows that floods do not necessarily occur every 10, 50, or 100 years, as is commonly thought.

Lesson Plans

Each group will need:

- One hundred items the same size and shape, but five different colors. Suggestions for items include marbles, dried beans, or multicolored macaroni. The items need to be organized according to color and number as follows:
    - One item its own color. This item represents a 100-year flood event, 100-year recurrence interval.
    - Two items their own color. These items represent a 50-year flood event, 50-year recurrence interval.
    - Ten items their own color. These items represent a 10-year flood event, 10-year recurrence interval.
    - Twenty items their own color. These items represent a 5-year flood event, 5-year recurrence interval.
    - Sixty-seven items their own color. These items represent no flooding.
- A small paper bag or large coffee an to contain the items. The opening at the top of he container must be large enough for the students to place their hand in for selection of an item
- Paper and pencil.

If sufficient material are available, divide the class into small groups. Provide each group with a container of 100 items. Explain to the students that each item in the container represents a flood event. The single items represents the 100-year flood event, the two items of the same color represent the 50-year flood event, the 10 items of the same color represent the 10-year flood event, the 20 items of the same color represent the 5-year flood event, and the 67 items of the same color represent no flooding. Student will be selecting 100 different items from the container, simulating 100 years of stream flow.

Identify one student in the group as the note keeper. The note keeper is to make a table with column headings of 100, 50, 10, 5, and 1. This individual needs to keep track of each item that is selected from the container. There will be a total of 100 items selected from the container.

Designate one student to hold the container above the heads of the other students in the group while they take turns selecting one item at a time from the container. After the note keeper has tallied the selection, the student should

return the item back to the container prior to selection of the next item. Students will make a total of 100 selections from the container, after the 100th selection, the note keeper is to total all the selections by individual flood events and make a grand total of all selections.

When all the groups have finished, make a master list of each groups' results on the chalkboard so all the students can share the results.

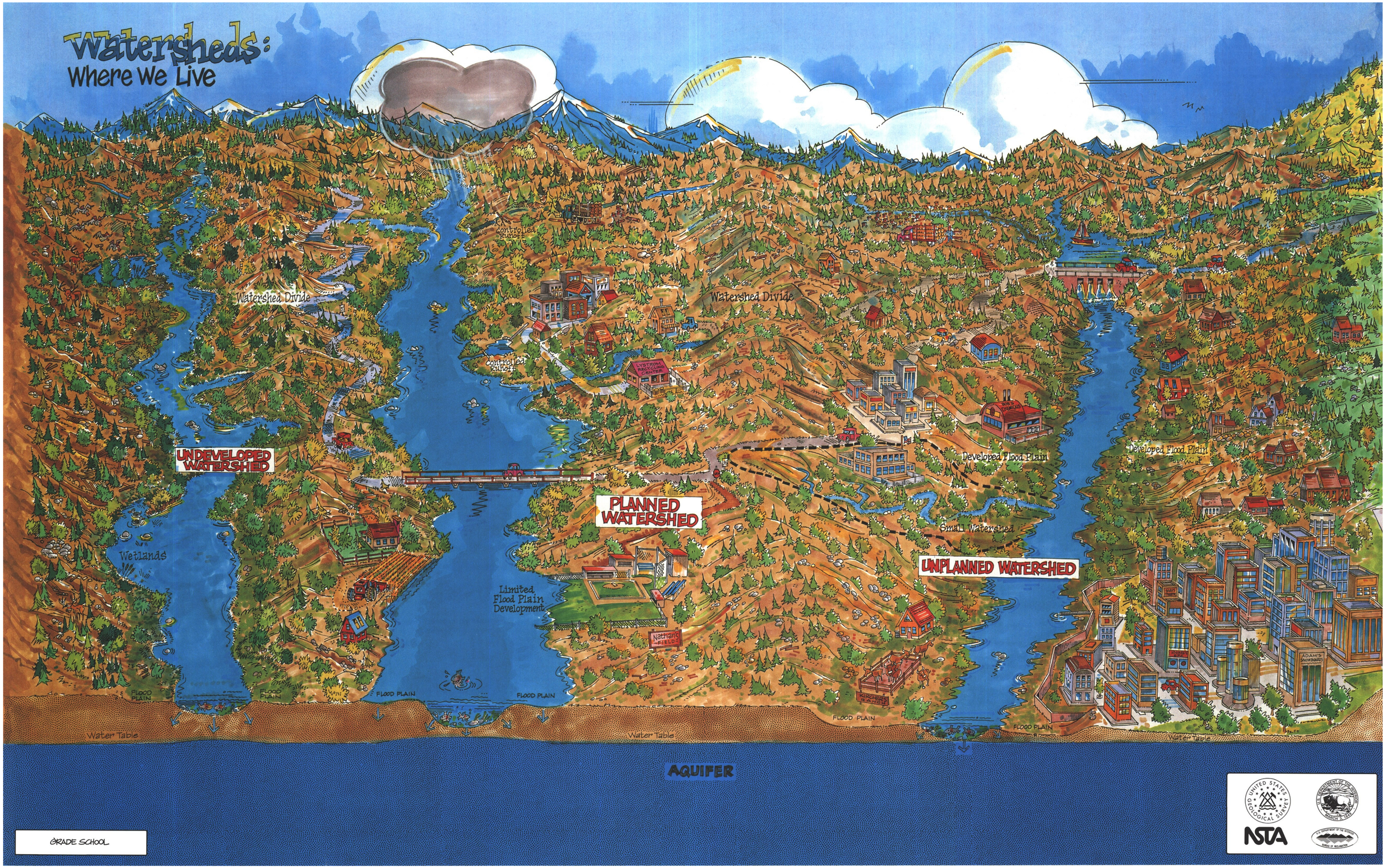
Interpretive Questions

1. How many times did the 100-year flood occur during the 100 selections? How many times did the 50-year, 10-year, or 5-year floods occur?

2. If the 100-year flood happened last year, what are the chances of it happening again this year?
    a. Answer: The same chance each year, one in 100.

3. What are several ways to protect individuals and property from floods?
    a. Possible Answers: Develop flood-warning systems to alert citizens when water in stream and rivers reaches a certain height. Limit development and land use in flood plains. Construction of flood control structures such as dams and levees.

Watersheds: Where We Live



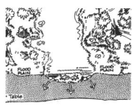
We all live in a watershed. Animals and plants all live there with us. Everyone affects what happens in a watershed by how we treat the natural resources. So what is a watershed? It is the land area that drains water to a stream, river, lake, or ocean. Water travels over the Earth's surface across forest land, farm fields, pastures, suburban lawns, and city streets, or it seeps into the soil and makes its way to a stream as local ground water. Watersheds come in many different shapes and sizes. Some contain mountains and hills, and others are nearly flat. A watershed can be affected by many different activities and events. Construction of cities and towns, farming, logging, and the application and disposal of many garden and household chemicals can affect the quantity and quality of water flowing from a watershed.

Floods are one of the major events in a watershed. Floods occur when the volume of water exceeds the ability of a water body (stream, river, or lake) to contain the water within its normal banks. Any stream, river, or lake can flood. The size or magnitude of a flood is described by a term called a recurrence interval. By studying a long period of flow records for a stream, it is possible to estimate the size of a flood that would, for example, have a 100-year recurrence interval (a 100-year flood). On the average, a 100-year flood would occur every 100 years. However, there is a 1-percent chance that a 100-year flood could happen any year. The severity of a flood is usually measured in terms of loss to human life or property, which is directly proportional to the amount of development in the flood plain surrounding the stream or river. A flood plain is a strip of relatively flat land bordering a stream, river, or lake that conveys the overflow of flood waters. Flood plains are Nature's way of carrying away flood waters. Because they are flat areas, flood plains are desirable locations for development.

This poster depicts many small watersheds within the three large watersheds, which are labeled in red on the poster. The large watersheds are separated by the two ridges that run from the top to the bottom of the poster. The large watershed labeled as undeveloped shows a watershed that has no development, the planned watershed has planned development, and the unplanned watershed has development that is unplanned. On the poster, a flood is shown in the planned watershed. The flood plains associated with the streams in each watershed are identified on the poster. One of the small watersheds is shown with a heavy dashed line within the larger unplanned watershed. The poster is folded into 8.5" x 11" panels; front and back panels can easily be photocopied.

Small Watershed

Watersheds come in many shapes and sizes. Larger watersheds are composed of many smaller watersheds. This watershed is a subwatershed of a larger watershed that has unplanned development. A watershed is determined by connecting the highest topographic points on a map between two adjacent areas. These points form a watershed boundary, similar to the edge of a bowl.



Flood Plain

Flood plains are relatively flat lands that border streams and rivers. Flood plains normally are dry but are covered with water during floods. Flood plains are created by floods and are indicators of the size of a flood produced by the upstream watershed. They are classified according to the flood events that created them. As with floods, the most common flood-plain delineations are 10, 50, 100, and 500 years.

WATERSHED MANAGEMENT

The quantity and quality of water draining from a watershed are dependent upon the climate, vegetation, soils, geology, and development within that watershed. Activities that change the vegetation and surface characteristics of some watersheds will affect the quantity and quality of water contributed to a stream. For example, a greater volume of water, perhaps of poorer quality, will flow from a parking lot than from a forest or pasture, which may result in increased flooding in a watershed because the greater volume exceeds the natural ability of the stream to transport the water.

Undeveloped Watershed

Undeveloped watersheds are drainage basins that have no development affecting the quality or quantity of water in that watershed. These watersheds are primarily on public-owned lands in national forests, national parks, and wilderness areas. Undeveloped watersheds provide scientists with areas to study the natural processes of a watershed and the movement of water within a watershed.

Planned Watershed

Planning the development within a watershed requires consideration of the entire drainage basin. Planned actions that consider the effect on the natural resources of the watershed will help preserve the quality and quantity of water flowing from a watershed. Actions such as controlling surface runoff from streets, providing recycling centers, farming along the contours, and logging practices that include controlling runoff and protecting stream channels help preserve the quality and quantity of water flowing from a watershed. Limiting the number and type of structures on a flood plain is one method of preventing loss of property from floods. Placing parks, golf courses, or farmland on a flood plain can reduce property loss caused by floods.

Unplanned Watershed

Unplanned development within a watershed has the potential for degradation of water quality and increased loss of property from flooding. Runoff from city streets, improper farming and logging techniques, and poor residential and industrial chemical-disposal practices all can affect water quality. Locating homes and businesses on flood plains greatly increases the chance of damage from flooding. In some places, flood-control structures such as dams and levees are required to protect development already located on the flood plain.

ACTIVITY
Watersheds, Floods, and Flood Plains

INTRODUCTION

A watershed is an area of land that drains water to a stream, river, lake, or ocean. It is a land surface feature that can be identified by connecting the highest elevations between two areas. For example, the pitched roof of a house or building is usually divided by a ridge. The back part of the roof is a separate watershed from the front part of the roof. During rainstorms, some water runs off both parts of the roof but meets in the street. Rain water from other houses in the neighborhood also flow to the street. Water from the street flows to a drain, ditch, or stream. Thus, the street is a larger watershed consisting of several smaller watersheds.

Floods occur when the level of a stream, river, or lake exceeds its normal height. Any stream or river can flood. During floods, water flows over the banks of a stream and into the surrounding low-lying areas called flood plains. During flooding, the threat to life and property damage most often occurs in the flood plain. Limiting the development within the flood plain is the best way to reduce damage associated with flooding.

The following activity is designed to demonstrate a watershed and the connection between small watersheds and larger watersheds. The activity also demonstrates property damage control during flooding through the placement of buildings in a flood plain.

OBJECTIVES—STUDENTS WILL:

1. Identify a watershed.
2. Observe how water flows from higher elevations to lower elevations in a watershed.
3. Observe the interconnection between watersheds.
4. Observe the importance of locating buildings within a watershed.
5. Experience a flood in a model watershed.

MATERIALS—EACH GROUP WILL NEED:

1. One container at least 22 cm wide, 33 cm long, and 6 cm deep. One possible container is a metal baking pan.
2. Two sheets of newspaper.
3. One sheet of thin (0.5 mils) plastic at least 30 cm larger in all dimensions than the container.
4. One waterproof marker.
5. One spray bottle.
6. Colored water to fill a spray bottle.
7. One book.
8. Two Styrofoam packing peanuts.

PROCEDURE

1. Divide the class into groups of three. Provide each group with a container, two sheets of newspaper, one sheet of plastic, one waterproof marker, one book, and one spray bottle filled with blue water.

2. Have one student in each group crumple both sheets of newspaper separately and place them next to each other at one end of the container. Drape the sheet of plastic over the crumpled newspaper, causing it to form hills over the high places and valleys in the low places. Put a book under one end of the container to allow water to flow down the valleys and pool at the front of the container. Place the sides of the plastic sheet down into the container to prevent water from overflowing the container.

3. Explain that the plastic sheet represents the ground surface covering the hills and valleys. Using the markers, have the students draw where they believe the main rivers will flow in their models. Have each student spray several pumps of water, using the spray bottle, on the model. Point out to students how water runs down one side or the other of the ridges and forms rivers in the valleys. The ridges divide individual watersheds. All the area from which water flows into a river is that river's watershed. Have the students count the number of small watersheds that drain into the main river they drew with the marker. All the watersheds should drain into a lake at the lower end of the container.

4. Discuss with the students that each small stream is formed by its own watershed. As streams join together, their combined watersheds and streamflow form larger watersheds and rivers.

5. Have each student place two of the Styrofoam peanuts (representing houses) on a flat location in the watershed. Have each student rapidly spray nine pumps of water on the upper portion of the watershed. Explain that rapidly spraying more water creates a flood in the watershed. Observe the houses during the rainstorm. Did the flood cause different amounts of damage (cause some to move) to the houses based on their location in the watershed?

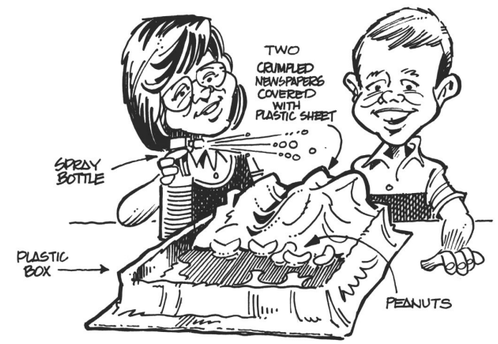
TEACHER PREPARATION

1. This activity is designed for students to work in groups of three.

2. Display a copy of the poster titled "Watersheds: Where We Live" on the classroom wall several days prior to conducting this activity.

3. Fill the spray bottles full of water and add several drops of blue food coloring so that the water can be easily identified.

4. Assemble one of the models as an example for the students.



INTERPRETIVE QUESTIONS

Have students examine other groups' models. How are they alike and how are they different?

1. How many watersheds are above the lake that forms at the bottom of model?
   Answer: The answer will vary from model to model, but students should be able to identify at least four. Have students look carefully because some of the watersheds may be hard to see.
2. What happens to the size of the stream as the watersheds get larger?
   Answer: The streams get larger.
3. What happens to the houses that the students placed on the level locations of the watershed? Were any houses washed away by the flood?
   Answer: The houses that were the closest to the river were the ones that were washed away by the flood.

EXTENSION

1. Have students write a short essay discussing what they learned about watersheds and floods. As part of the essay, have them draw a picture of a watershed including the stream and associated flood plains. Also have students discuss where the best place to build homes within their watershed would be in order to avoid flooding.

DEFINITIONS

Aquifer—An underground body of porous sand, gravel, or fractured rock filled with water and capable of supplying useful quantities of water to a well or a spring.

Drainage basin—Land area drained by a river.

Flood—Any relatively high flow of water that overflows natural or artificial banks of a stream, river, lake, or body of water.

Flood plain—A strip of relatively flat land bordering a stream, river, or lake that conveys the overflow of flood waters.

Ground water—Water found in pores or cracks in sand, gravel, and rock beneath the land surface.

Precipitation—Rain, snow, hail, or sleet.

Recurrence interval—The average interval of time within which the magnitude of a given event, such as a flood, will be equaled or exceeded one time.

Runoff—That part of precipitation that appears in surface-water bodies.

Watershed—The land area that drains water to a stream, river, lake, or ocean.

Poster Series

This poster is part of a series of water-resources education posters developed through the Water Resources Education Initiative. The Water Resources Education Initiative is a cooperative effort between public and private education interests. Partners in the program include the U.S. Geological Survey, U.S. Bureau of Reclamation, and the U.S. Fish and Wildlife Service of the U.S. Department of the Interior, the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, the Nebraska Groundwater Foundation, and the National Science Teachers Association.

The other completed posters in the series are entitled "Water: The Resource That Gets Used & Used & Used for Everything!", "How Do We Treat Our Wastewater?", "Wetlands: Water, Wildlife, Plants, & People!", "Ground Water: The Hidden Resource!", "Water Quality: Potential Sources of Pollution", "Navigation: Traveling the Water Highways!", and "Hazardous Waste: Cleanup and Prevention." The posters in the series are designed to be joined to create a wall mural. A schematic of the wall mural including the topics for the completed and planned posters is displayed on this panel. The light-shaded spaces indicate the completed posters. The dark-shaded space represents this poster.

OCEANS	WATERSHEDS	HAZARDOUS WASTE
WETLANDS	WATER USE	WASTEWATER TREATMENT
NAVIGATION	GROUND WATER	WATER QUALITY

Water-resources topics of the completed posters are drawn in a cartoon format by the same artist. Posters are available in color or black-and-white. The reverse sides of the color posters contain educational activities: one version for children in grades 3–5 and the other with activities for children in grades 6–8. The black-and-white posters are intended for coloring by children in grades K–2.

ORDERING INFORMATION

Copies of the completed posters in the series (see Poster Series panel) and the Watersheds poster (color for grades 3–5 and 6–8 or black-and-white) can be obtained at no cost from the U.S. Geological Survey. Write to the address below and specify the poster title(s) and grade level(s) desired. A limited number of color and black-and-white posters entitled "Water: The Resource That Gets Used & Used & Used for Everything" also are available in Spanish by writing to the address below.

U.S. Geological Survey
Branch of Information Services
Box 25286
Denver Federal Center
Denver, CO 80225
Telephone: 1–800–435–7627

ACKNOWLEDGMENTS

The following individuals contributed to the development of this poster:

Project Chief, Principal Author, and Layout:
Stephen Vandas, U.S. Geological Survey, Denver, Colorado.

Art Work:
Frank Farrar, Frank Farrar Graphics, Denver, Colorado, under contract to the National Science Teachers Association.

U.S. GEOLOGICAL SURVEY

As the Nation's largest earth-science information and research agency, the U.S. Geological Survey (USGS) maintains a long tradition of providing "Earth Science in the Public Service." As a Nation, we face serious questions concerning our global environment. Providing the scientific information necessary to answer these questions is the primary mission of the U.S. Geological Survey. Such information is essential for the public and its officials to make informed decisions concerning the wise use of our natural resources and the management of our global environment.

U.S. DEPARTMENT OF THE INTERIOR

As the Nation's principal conservation agency, the U.S. Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This responsibility includes fostering the wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing enjoyment through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The Department also has a major responsibility for Native American reservation communities and for people who live in island territories under United States administration.

Grade School

We all live in a watershed. Animals and plants all live there with us. Everyone affects what happens in a watershed by how we treat the natural resources. So what is a watershed? It is the land area that drains water to a stream, river, lake, or ocean. Water travels over the Earth's surface across forest land, farm fields, pastures, suburban lawns, and city streets, or it seeps into the soil and makes its way to a stream as local ground water. Watersheds come in many different shapes and sizes. Some contain mountains and hills, and others are nearly flat. A watershed can be affected by many different activities and events. Construction of cities and towns, farming, logging, and the application and disposal of many garden and household chemicals can affect the quantity and quality of water flowing from a watershed.

Floods are one of the major events in a watershed. Floods occur when the volume of water exceeds the ability of a water body (stream, river, or lake) to contain the water within its normal banks. Any stream, river, or lake can flood. The size or magnitude of a flood is described by a term called a recurrence interval. By studying a long period of flow records for a stream, it is possible to estimate the size of a flood that would, for example, have a 100-year recurrence interval (a 100-year flood). On the average, a 100-year flood would occur every 100 years. However, there is a 1-percent chance that a 100-year flood could happen any year. The severity of a flood is usually measured in terms of loss to human life or property, which is directly proportional to the amount of development in the flood plain surrounding the stream or river. A flood plain is a strip of relatively flat land bordering a stream, river, or lake that conveys the overflow of flood waters. Flood plains are Nature's way of carrying away flood waters. Because they are flat areas, flood plains are desirable locations for development.

This poster depicts many small watersheds within the three large watersheds, which are labeled in red on the poster. The large watersheds are separated by the two ridges that run from the top to the bottom of the poster. The large watershed labeled as undeveloped shows a watershed that has no development, the planned watershed has planned development, and the unplanned watershed has development that is unplanned. On the poster, a flood is shown in the planned watershed. The flood plains associated with the streams in each watershed are identified on the poster. One of the small watersheds is shown with a heavy dashed line within the larger unplanned watershed. The poster is folded into 8.5" x 11" panels; front and back panels can easily be photocopied.

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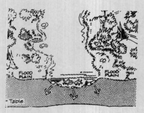
Watersheds come in many shapes and sizes. Larger watersheds are composed of many smaller watersheds. This watershed is a subwatershed of a larger watershed that has unplanned development. A watershed is determined by connecting the highest topographic points on a map between two adjacent areas. These points form a watershed boundary, similar to the edge of a bowl.



Flood Plain

Flood plains are relatively flat lands that border streams and rivers. Flood plains normally are dry but are covered with water during floods. Flood plains are created by floods and are indicators of the size of a flood produced by the upstream watershed. They are classified according to the flood events that created them. As with floods, the most common flood-plain delineations are 10, 50, 100, and 500 years.

WATERSHED MANAGEMENT

The quantity and quality of water draining from a watershed are dependent upon the climate, vegetation, soils, geology, and development within that watershed. Activities that change the vegetation and surface characteristics of some watersheds will affect the quantity and quality of water contributed to a stream. For example, a greater volume of water, perhaps of poorer quality, will flow from a parking lot than from a forest or pasture, which may result in increased flooding in a watershed because the greater volume exceeds the natural ability of the stream to transport the water.

Undeveloped Watershed

Undeveloped watersheds are drainage basins that have no development affecting the quality or quantity of water in that watershed. These watersheds are primarily on public-owned lands in national forests, national parks, and wilderness areas. Undeveloped watersheds provide scientists with areas to study the natural processes of a watershed and the movement of water within a watershed.

Planned Watershed

Planning the development within a watershed requires consideration of the entire drainage basin. Planned actions that consider the effect on the natural resources of the watershed will help preserve the quality and quantity of water flowing from a watershed. Actions such as controlling surface runoff from streets, providing recycling centers, farming along the contours, and logging practices that include controlling runoff and protecting stream channels help preserve the quality and quantity of water flowing from a watershed. Limiting the number and type of structures on a flood plain is one method of preventing loss of property from floods. Placing parks, golf courses, or farmland on a flood plain can reduce property loss caused by floods.

Unplanned Watershed

Unplanned development within a watershed has the potential for degradation of water quality and increased loss of property from flooding. Runoff from city streets, improper farming and logging techniques, and poor residential and industrial chemical-disposal practices all can affect water quality. Locating homes and businesses on flood plains greatly increases the chance of damage from flooding. In some places, flood-control structures such as dams and levees are required to protect development already located on the flood plain.

ACTIVITY
What is a Watershed?

INTRODUCTION

A watershed is the land area that drains water to a stream, river, or lake. It is a land surface feature that can be identified by tracing a line along the highest elevations between two areas on a map. Everyone lives within a watershed that drains to a local stream or river. Large watersheds, such as that of the Mississippi River, contain thousands of smaller watersheds. Changes in small watersheds can affect the river systems downstream. The following activity is designed to demonstrate a watershed and the connection between small watersheds and larger watersheds.

OBJECTIVES—STUDENTS WILL:

1. Identify a watershed.
2. Observe how water flows from higher elevations to lower elevations in a watershed.
3. Observe the interconnection between watersheds.

MATERIALS—EACH GROUP WILL NEED:

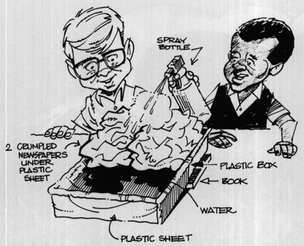
1. One container at least 22 cm wide, 33 cm long, and 6 cm deep. One possible container is a metal baking pan.
2. Two sheets of newspaper.
3. One sheet of thin (0.5 mils) plastic at least 30 cm larger in all dimensions than the container.
4. One waterproof marker.
5. One spray bottle.
6. Colored water to fill a spray bottle.
7. One book.

TEACHER PREPARATION

1. This activity is designed for students to work in groups of three.
2. Display a copy of the poster titled "Watersheds: Where We Live" on the classroom wall several days prior to conducting this activity.
3. Fill the spray bottles full of water and add several drops of blue food coloring so that the water can be easily identified.
4. Assemble one of the models as an example for the students.

PROCEDURE

1. Divide the class into groups of three. Provide each group with a container, two sheets of newspaper, one sheet of plastic, one waterproof marker, one book, and one spray bottle filled with blue water.
2. Have one student in each group crumple both sheets of newspaper separately and place them next to each other at one end of the container. Drape the sheet of plastic over the crumpled newspaper, causing it to form hills over the high places, and valleys in the low places. Put a book under one end of the container to allow water to flow down the valleys and pool at the front of the container. Place the sides of the plastic sheet down into the container to prevent water from overflowing the container.



3. Explain that the plastic sheet represents the ground surface covering the hills and valleys. Using the markers, have the students draw where they believe the main rivers will flow in their models. Have each student spray several pumps of water, using the spray bottle, on the model. Point out to students how water runs down one side or the other of the ridges and forms rivers in the valleys. The ridges divide individual watersheds. All the area from which water flows into a river is that river's watershed. Have the students count the number of small watersheds that drain into the main river they drew with the marker. All the watersheds should drain into a lake at the lower end of the container.

INTERPRETIVE QUESTIONS

Have students examine other groups' models. How are they alike and how are they different?

1. How many watersheds are above the lake that forms at the lower end of model?
   Answer: The answer will vary from model to model but will be at least four.
2. What happens to the size of the stream as the watersheds get larger?
   Answer: The streams get larger.

DEFINITIONS

Aquifer—An underground body of porous sand, gravel, or fractured rock filled with water and capable of supplying useful quantities of water to a well or a spring.
Drainage basin—Land area drained by a river.
Flood—Any relatively high flow of water that overflows natural or artificial banks of a stream, river, lake, or body of water.
Flood plain—A strip of relatively flat land bordering a stream, river, or lake that conveys the overflow of flood waters.
Ground water—Water found in pores or cracks in sand, gravel, and rock beneath the land surface.
Precipitation—Rain, snow, hail, or sleet.
Recurrence interval—The average interval of time within which the magnitude of a given event, such as a flood, will be equaled or exceeded one time.
Runoff—That part of precipitation that appears in surface-water bodies.
Watershed—The land area that drains water to a stream, river, lake, or ocean.

ACTIVITY
Size and Occurrence of Floods

INTRODUCTION

The size or magnitude of a flood is described by a term called a recurrence interval. By studying a long period of flow records for a stream, it is possible to estimate the size of a flood that would, for example, have a 100-year recurrence interval (a 100-year flood). On the average, a 100-year flood would occur every 100 years. However, there is a 1-percent chance that a 100-year flood could happen during any year. Many people have heard of the 10-year, 50-year, or 100-year flood. These year descriptors are the recurrence intervals for the floods.

The following activity is designed to demonstrate the occurrence of a particular flood event and to show that floods do not necessarily occur every 10, 50, or 100 years.

OBJECTIVES—STUDENTS WILL:

1. Determine the occurrence of an event based on the random selection of different colored items.
2. Relate the occurrence of events to 5-, 10-, 50-, and 100-year floods.

MATERIALS—EACH GROUP WILL NEED:

1. One hundred items the same size and shape, but of five different colors. Suggestions for items include marbles, dried beans, or multicolored macaroni. The items need to be organized according to color and number as follows:
   - One item its own color. This item represents a 100-year flood event, 100-year recurrence interval.
   - Two items their own color. These items represent a 50-year flood event, 50-year recurrence interval.
   - Ten items their own color. These Items represent a 10-year flood event, a 10-year recurrence interval.
   - Twenty items their own color. These items represent a 5-year flood event, a 5-year recurrence interval.
   - Sixty-seven items their own color. These items represent no flooding.
2. A small paper bag or large coffee can to contain the items. The opening at the top of the container must be large enough for the students to place their hand in for selection of an item.
3. Paper and pencil.

TEACHER PREPARATION

1. Display a copy of the poster titled "Watersheds: Where We Live" on the classroom wall several days prior to conducting this activity.
2. Organize the items according to the numbers and colors as described under the section, Materials.
3. Place each set of 100 items in a paper sack or other opaque container.

PROCEDURE

If sufficient materials are available, divide the class into small groups. Provide each group with a container of 100 items. Explain to the students that each item in the container represents a flood event. The single item represents the 100-year flood event, the two items of the same color represent the 50-year flood event, the 10 items of the same color represent the 10-year flood event, the 20 items of the same color represent the 5-year flood event, and the 67 items of the same color represent no flood. Students will be selecting 100 different items from the container, simulating 100 years of streamflow.

Identify one student in the group as the note keeper. The note keeper is to make a table with column headings of 100, 50, 10, 5, and 1. This individual needs to keep track of each item that is selected from the container. There will be a total of 100 items selected from the container.

Designate one student to hold the container above the heads of the other students in the group while they take turns selecting one item at a time from the container. After the note keeper has tallied the selection, the student should return the item back to the container prior to selection of the next item. Students will make a total of 100 selections from the container. After the 100th selection, the note keeper is to total all the selections by individual flood events and make a grand total of all selections.

When all the groups have finished, make a master list of each groups' results on the chalkboard so all the students can share the results.

INTERPRETIVE QUESTIONS

1. How many times did the 100-year flood occur during the 100 selections? How many times did the 50-year, 10-year, or 5-year floods occur?
2. If the 100-year flood happened last year, what are the chances of it happening again this year?
   Answer: The same chance each year, one chance in 100.
3. What are several ways to protect individuals and property from floods?
   Possible Answers: Develop flood-warning systems to alert citizens when water in streams and rivers reaches a certain height. Limit development and land use in flood plains. (Possible flood plain uses that are not severely impacted by flooding because of lack of structures include farming, parks, and golf courses.) Construction of flood control structures such as dams and levees.

Poster Series

This poster is part of a series of water-resources education posters developed through the U.S. Geological Survey's Water Resources Education Initiative, a cooperative effort between public and private education interests. Partners in the program include the U.S. Geological Survey, Bureau of Reclamation, and the U.S. Fish and Wildlife Service of the U.S. Department of the Interior; the National Oceanic and Atmospheric Administration; the U.S. Environmental Protection Agency; the U.S. Army Corps of Engineers; the Nebraska Groundwater Foundation; and the National Science Teachers Association.

The other posters in the series are entitled "Oceans--Coastal Hazards: Hurricanes, Tsunamis, Coastal Erosion", "Hazardous Waste: Cleanup and Prevention", "Wetlands: Water, Wildlife, Plants, & People!", "Water: The Resource That Gets Used & Used & Used for Everything!", "How Do We Treat Our Wastewater?", "Navigation: Traveling the Water Highways!", "Ground Water: The Hidden Resource!", and "Water Quality...Potential Sources of Pollution". The posters in the series are designed to be joined to create a large wall mural. A schematic of the wall mural is displayed on this panel. The gray shaded spaces represent the posters listed above. The black shaded space represents this poster.

OCEANS	WATERSHEDS	HAZARDOUS WASTE
WETLANDS	WATER USE	WASTEWATER TREATMENT
NAVIGATION	GROUND WATER	WATER QUALITY

Water-resources topics of the posters are drawn in a cartoon format by the same artist. All poster are available in color. The reverse sides of the color posters contain educational activities: one version for children in grades 3-5 and the other for children in grades 6-8.

ORDERING INFORMATION

Copies of all the posters in the series (see Poster Series Panel) can be obtained at no cost from the U.S. Geological Survey. Write to the address below and specify the poster title(s) listed on the Poster Series panel, and grade level(s) desired. The poster "Water: The Resource That Gets Used & Used & Used for Everything!" is also available in black-and-white, intended for coloring by children in grades K-2. In addition, the poster "Water: The Resource That Gets Used & Used & Used for Everything!" with activities intended for grades 3-5 is available in Spanish. There is a minimum shipping charge of $20.00 or actual cost if greater and $3.50 handling charge (total $23.50 in U.S. dollars) applying to ALL orders shipped to locations that are not a U.S. State or Territory.

U.S. Geological Survey
Branch of Information Services
Box 25286
Denver Federal Center
Denver, CO 80225
Telephone: 1-888-ASK-USGS

ACKNOWLEDGMENTS

The following individuals contributed to the development of this poster:

Project Chief, Principal Author, and Layout: Stephen Vandas, U.S. Geological Survey, Denver, Colorado

Art Work: Frank Farrar, Frank Farrar Graphics, Denver, Colorado, under contract to the National Science Teachers Association.

U.S. GEOLOGICAL SURVEY

As the Nation's largest water, earth, and biological science and civilian mapping agency, the USGS works in cooperation with more than 2,000 organizations across the country to provide reliable, impartial, scientific information to resource managers, planners, and other customers. This information is gathered in every state by USGS scientists to minimize the loss of life and property from natural disasters, to contribute to the conservation and the sound economic and physical development of the Nation's natural resources, and to enhance the quality of life by monitoring water, biological, energy, and mineral resources.

U.S. DEPARTMENT OF THE INTERIOR

As the Nation's principal conservation agency, the U.S. Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This responsibility includes fostering the wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing enjoyment through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The Department also has a major responsibility for Native American reservation communities and for people who live in island territories under United States administration.

U.S. Department of the Interior
U.S. Geological Survey

MIDDLE SCHOOL

MS.Earth's Systems

MS.Earth's Systems

Students who demonstrate understanding can:

MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. [Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.] [Assessment Boundary: Assessment does not include the identification and naming of minerals.]

MS-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]

MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop and use a model to describe phenomena. (MS-ESS2-1)
- Develop a model to describe unobservable mechanisms. (MS-ESS2-4)

Constructing Explanations and Designing Solutions
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.
- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS3-1)

Disciplinary Core Ideas

ESS2.A: Earth's Materials and Systems
- All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1)

ESS2.C: The Roles of Water in Earth's Surface Processes
- Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4)
- Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4)

ESS3.A: Natural Resources
- Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1)

Crosscutting Concepts

Cause and Effect
- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1)

Energy and Matter
- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4)

Stability and Change
- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. (MS-ESS2-1)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World
- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ESS3-1)

Connections to other DCIs in this grade-band: **MS.PS1.A** (MS-ESS2-1),(MS-ESS2-4),(MS-ESS3-1); **MS.PS1.B** (MS-ESS2-1),(MS-ESS3-1); **MS.PS2.B** (MS-ESS2-4); **MS.PS3.A** (MS-ESS2-4); **MS.PS3.B** (MS-ESS2-1); **MS.PS3.D** (MS-ESS2-4); **MS.LS2.B** (MS-ESS2-1); **MS.LS2.C** (MS-ESS2-1); **MS.ESS1.B** (MS-ESS2-1); **MS.ESS2.D** (MS-ESS3-1); **MS.ESS3.C** (MS-ESS2-1)

Articulation of DCIs across grade-bands: **3.PS2.A** (MS-ESS2-4); **4.PS3.B** (MS-ESS2-1),(MS-ESS2-4); **4.PS3.D** (MS-ESS3-1); **4.ESS2.A** (MS-ESS2-1); **4.ESS3.A** (MS-ESS3-1); **5.PS2.B** (MS-ESS2-4); **5.ESS2.A** (MS-ESS2-1); **5.ESS2.C** (MS-ESS2-4); **HS.PS1.B** (MS-ESS2-1); **HS.PS2.B** (MS-ESS2-4); **HS.PS3.B** (MS-ESS2-1),(MS-ESS2-4),(MS-ESS3-1); **HS.PS4.B** (MS-ESS2-4); **HS.LS1.C** (MS-ESS2-1),(MS-ESS3-1); **HS.LS2.B** (MS-ESS2-1); **HS.ESS2.A** (MS-ESS2-1),(MS-ESS2-4),(MS-ESS3-1); **HS.ESS2.B** (MS-ESS3-1); **HS.ESS2.C** (MS-ESS2-1),(MS-ESS2-4),(MS-ESS3-1); **HS.ESS2.D** (MS-ESS2-4); **HS.ESS2.E** (MS-ESS2-1); **HS.ESS3.A** (MS-ESS3-1)

Common Core State Standards Connections:

ELA/Literacy –

RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-1)
WHST.6-8.2	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS3-1)
WHST.6-8.9	Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-1)
SL.8.5	Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-ESS2-1)*

Mathematics –

6.EE.B.6	Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. *(MS-ESS3-1)*
7.EE.B.4	Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. *(MS-ESS3-1)*

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

MS.Weather and Climate

MS.Weather and Climate

Students who demonstrate understanding can:

MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions. [Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).] [Assessment Boundary: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.]

MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. [Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]

MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.
- Ask questions to identify and clarify evidence of an argument. (MS-ESS3-5)

Developing and Using Models
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop and use a model to describe phenomena. (MS-ESS2-6)

Planning and Carrying Out Investigations
Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.
- Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-ESS2-5)

Disciplinary Core Ideas

ESS2.C: The Roles of Water in Earth's Surface Processes
- The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5)
- Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6)

ESS2.D: Weather and Climate
- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6)
- Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)
- The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6)

ESS3.D: Global Climate Change
- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)

Crosscutting Concepts

Cause and Effect
- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5)

Systems and System Models
- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (MS-ESS2-6)

Stability and Change
- Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3-5)

Connections to other DCIs in this grade-band: **MS.PS1.A** (MS-ESS2-5); **MS.PS2.A** (MS-ESS2-5),(MS-ESS2-6); **MS.PS3.A** (MS-ESS2-5),(MS-ESS3-5); **MS.PS3.B** (MS-ESS2-5),(MS-ESS2-6); **MS.PS4.B** (MS-ESS2-6)

Articulation of DCIs across grade-bands: **3.PS2.A** (MS-ESS2-6); **3.ESS2.D** (MS-ESS2-5),(MS-ESS2-6); **5.ESS2.A** (MS-ESS2-5),(MS-ESS2-6); **HS.PS2.B** (MS-ESS2-6); **HS.PS3.B** (MS-ESS2-6),(MS-ESS3-5); **HS.PS3.D** (MS-ESS2-6); **HS.PS4.B** (MS-ESS3-5); **HS.ESS1.B** (MS-ESS2-6); **HS.ESS2.A** (MS-ESS2-6),(MS-ESS3-5); **HS.ESS2.C** (MS-ESS2-5); **HS.ESS2.D** (MS-ESS2-5),(MS-ESS2-6),(MS-ESS3-5); **HS.ESS3.C** (MS-ESS3-5); **HS.ESS3.D** (MS-ESS3-5)

Common Core State Standards Connections:

ELA/Literacy –

RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-5),(MS-ESS3-5)
RST.6-8.9	Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ESS2-5)
WHST.6-8.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. *(MS-ESS2-5)*
SL.8.5	Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-ESS2-6)*

Mathematics –

MP.2	Reason abstractly and quantitatively. (MS-ESS2-5),*(MS-ESS3-5)*
6.NS.C.5	Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-ESS2-5)
6.EE.B.6	Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. *(MS-ESS3-5)*
7.EE.B.4	Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. *(MS-ESS3-5)*

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

