AN INTRODUCTION TO THE HUDSON-RARITAN ESTUARY

The Hudson-Raritan Estuary, a system of interconnected waterways, is the most prominent natural feature of northern New Jersey. The watershed of the Hudson-Raritan Estuary includes Upper and Lower New York Harbor, the Hudson River, the East River, Newark Bay, the lower Hackensack River, the lower Passaic River, the Kill Van Kull, the Arthur Kill, Raritan Bay, the Raritan River, Sandy Hook Bay, and the Shrewsbury and Navesink Rivers.

The Hudson-Raritan Estuary is one of the greatest natural harbors in the world and one of the busiest ports in the nation, playing a crucial role in regional economy. During the past 100 years, the Estuary has been subject to serious pollution and other modifications resulting in deleterious changes to the environment and biota.

Wide-scale shoreline development, discharges of industrial wastes and sewage and destruction of tidal marshes have had a serious effect on the aquatic resources of the area. This long history of environmental degradation suggests that there is little left in the Estuary.

Despite this, the area continues to provide important habitat for diverse marine and estuarine species. Among these species are striped bass, bluefish, weakfish, white perch, winter flounder, and summer flounder. Other marine resources of importance include blue claw crabs, lobsters, hard clams, soft clams, and fish such as shad, herring and tomcod. All utilize portions of the Estuary for nursery or feeding grounds.

The land boundaries of the Hudson-Raritan Estuary region are the meeting place of three geologic formations; the rock-based New England Terrain represented by Manhattan, Bronx, Westchester, and Northern New Jersey, the glacial Till/Oak Pinelands represented by Long Island including Brooklyn and Staten Island and the coastal plain/Pine Barrens vegetation represented by southern New Jersey. The shoreline of the area is categorized by two distinct configurations; rocky shores to the north and sand and gravel beaches to the south. The region outside of New York Harbor is classified as a coastal plain.
NAUTICAL CHARTS

A nautical chart can be viewed as a map of the marine environment. They are designed to provide information needed by mariners to make proper piloting decisions. The general shape and nature of the sea floor are important to mariners and a good chart will have a high density of bottom information. They also include information about tides, currents, depth, navigation channels, obstructions and other hazards to navigation, the location and description of local aids to navigation, and other information of interest. Most nautical charts are of the Mercator type, meaning that they are a graphic representation on a flat, two dimensional surface of a navigable portion of the surface of the earth on which latitude and longitude lines are at right angles to one another. Distances are measured on charts either from printed scales or from bordering meridians and are scaled in minutes of latitude or nautical miles.

Nautical charts are also extremely useful for studying the features of waterways and the relation of waterways to adjacent land areas. In addition to portraying the physical characteristics of a water body, nautical charts portray land areas in detail including shoreline configuration, topographic landmarks, harbor facilities and prominent natural and manufactured features of interest. Charts are commonly termed large-scale or small-scale. A chart covering a relatively small area is called a large-scale chart. In other words, a certain small expanse on the earth is represented by a relatively large distance on a large-scale chart. A chart requiring less detail and covering a relatively large area, such as an ocean chart, would have the same expanse represented by a comparatively small distance on the chart and, thus, this chart would be termed a small-scale chart.

Charts of the United States waters are prepared and published by the National Oceanic Service (NOS) of the National Oceanic and Atmospheric Administration (NOAA). The scale of a chart is represented by a ratio of a given distance on the chart to the actual distance it represents on Earth. Not unlike topographic maps, a scale of 1:200,000 on a nautical chart indicates that 1 inch on the chart represents 200,000 inches, or about 2.74 nautical miles on earth. One nautical mile equals 6,080.2 ft.

CHART CATEGORIES

Conventional flat nautical charts are published in the following categories:

1. Sailing charts- Utilizing the smallest scale (under 1:600,000), they cover long stretches of coastline and are used for plotting a course in offshore waters between distant ports and for approaching the coast from open ocean waters. The shoreline and topography are generalized
## NEW JERSEY QUADRANGLE MAPS

### 7.5 Minute Series

<table>
<thead>
<tr>
<th>MAP TITLE</th>
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<td>Coney Island (NY)</td>
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<tr>
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<td>South Amboy</td>
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<td>1:24,000</td>
</tr>
<tr>
<td>Long Branch</td>
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All of the topographic maps for the Hudson-Raritan Estuary are on the scale of 1:24,000.
and only offshore soundings, principal navigational aids, and landmarks visible at considerable distances are shown.

2. **General charts**- These charts use scales of 1:150,000 to 1:160,000 and are used for navigation well offshore with vessel position fixed by landmarks, characteristic soundings, and navigational aids such as lights and buoys.

3. **Coast charts**- Coast charts are large scale charts with scales of 1:50,000 to 1500,000. They are used for nearshore coastwise navigation, entering and leaving bays and harbors of considerable size, and navigating certain inland waterways.

4. **Harbor charts**- Harbor charts are the most detailed with scales from 1:5,000 to 1:50,000 and may include larger scale inserts. They are intended for navigation and anchorage in harbors or smaller waterways. They contain detailed land features as well as navigational information.
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<thead>
<tr>
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<tr>
<td>12326</td>
<td>Approaches to New York Fire Island to Sea Girt</td>
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<td>12327</td>
<td>New York Harbor</td>
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<tr>
<td>12331</td>
<td>Raritan Bay and southern Arthur Kill</td>
<td>1:15,000</td>
</tr>
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<td>12332</td>
<td>Raritan River - Raritan Bay to New Brunswick</td>
<td>1:20,000</td>
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<td>12333</td>
<td>Kill Van Kull and northern Arthur Kill</td>
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<td>12334</td>
<td>New York Harbor - Upper Bay and Narrows</td>
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<td>12335</td>
<td>Hudson and East Rivers - Governors Island to 67 St</td>
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<tr>
<td>12337</td>
<td>Passaic and Hackensack Rivers</td>
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<td>12338</td>
<td>Newtown Creek, East River</td>
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<td>12339</td>
<td>East River - Tallman Island to Queensboro Bridge</td>
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<td>12341</td>
<td>Days Point to George Washington Bridge</td>
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<td>12342</td>
<td>Harlem River</td>
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<td>12343</td>
<td>Hudson River - New York to Wappinger Creek</td>
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<td>12345</td>
<td>Hudson River - George Washington Bridge to Yonkers</td>
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<td>Hudson River - Yonkers to Piermont</td>
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<td>12347</td>
<td>Hudson River - Wappinger Creek to Hudson</td>
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<td>12348</td>
<td>Hudson River - Coxsackie to Troy</td>
<td>1:40,000</td>
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<td>12350</td>
<td>Jamaica Bay and Rockaway Inlet</td>
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<tr>
<td>12401</td>
<td>New York Lower Bay - southern portion</td>
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<td>12402</td>
<td>New York Lower Bay - northern portion</td>
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GEOGRAPHIC POINTS OF INTEREST
IN THE HUDSON - RARITAN ESTUARY

COMPONENT WATERBODIES OF THE WATERSHED

Hackensack River
Passaic River
Newark Bay
Arthur Kill
Kill Van Kull
Raritan Bay
Raritan River
Shrewsbury River
Navesink River
Sandy Hook Bay
Hudson River
East River
Harlem River
Hell’s Gate
The Narrows
Jamaica Bay
Gravesend Bay
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<th>COORDINATES</th>
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<tr>
<td>Old Orchard Shoal</td>
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<tr>
<td></td>
<td>Long. 74° 07'.2 W</td>
</tr>
<tr>
<td>Flynns Knoll</td>
<td>Lat. 40° 29'.4 N</td>
</tr>
<tr>
<td></td>
<td>Long. 74° 01'.4 W</td>
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<tr>
<td>Romer Shoal</td>
<td>Lat. 40° 30'.5 N</td>
</tr>
<tr>
<td></td>
<td>Long. 74° 00'.0 W</td>
</tr>
<tr>
<td>Upper Harbor/Upper Bay</td>
<td>Lat. 40° 35'.5 N</td>
</tr>
<tr>
<td></td>
<td>Long. 74° 02'.2 W</td>
</tr>
<tr>
<td>Lower Harbor/Lower Bay</td>
<td>Lat. 40° 29'.4 N</td>
</tr>
<tr>
<td></td>
<td>Long. 74° 04'.7 W</td>
</tr>
<tr>
<td>Verrazano Narrows</td>
<td>Lat. 40° 36'.4 N</td>
</tr>
<tr>
<td></td>
<td>Long. 74° 02'.6 W</td>
</tr>
<tr>
<td>Robins Reef</td>
<td>Lat. 40 39'.4 N</td>
</tr>
<tr>
<td></td>
<td>Long. 74 03'.9 W</td>
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<tr>
<td>LAND FEATURE</td>
<td>COORDINATES</td>
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<tr>
<td>Sandy Hook</td>
<td>Lat. 40° 27'.0 N</td>
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<td>Rockaway Point</td>
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<td>Crookes Point</td>
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<td>Long. 74° 08'.23 W</td>
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<td>Ward Point</td>
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<td></td>
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<td>Governors Island</td>
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<td></td>
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<tr>
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<td></td>
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<tr>
<td>Swinburne Island</td>
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<td>Long. 74° 03'.02 W</td>
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<tr>
<td>Port Newark</td>
<td>Lat. 40° 41'.1 N</td>
</tr>
<tr>
<td></td>
<td>Long. 74° 07'.9 W</td>
</tr>
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</table>
Getting Your Bearings

Words to Know:
Bearings
Latitude
Longitude

Materials:
One magnetic compass to each group of five (5) students. Note: Magnetic compasses can be purchased from boat catalogs, lab supply catalogs, or a Ben Meadow Company catalog. Price range $7.50-$20.00.

Activity:
Set up your classroom to represent a portion of the Hudson-Raritan Estuary with three points of interest (e.g. Sandy Hook Lighthouse, Statue of Liberty and South Street Seaport). The relative positions of points of interest can be found on the activity sheet. In this activity students learn how to use a compass and work with navigational bearings, locating the major waterbodies of the Hudson-Raritan Estuary watershed and points of interest along the way.

How High is High? How Deep is Deep?

Words to Know:
Fathom
Latitude
Longitude
Nautical
Navigate
Topography

Materials:
For this activity you will need nautical charts of the Hudson-Raritan Estuary, topographic map of the Hudson-Raritan Estuary, a road map of the area surrounding the Hudson-Raritan Estuary, a map of the continents, corrugated cardboard, tracing paper, construction paper, pencils, scissors, glue, and string.

Activity:
Observe the differences of each map. Have the students think about situations in which each map would be most useful. In this activity students read, interpret and discover the differences between nautical charts and topographic maps, then design a three-dimensional map of an area they choose, using the nautical charts and topographic maps as reference.
Where Does the Water Go?

Words to Know:
Aquifer
Basin
Drainage Basin
Hydrology
Hydrologic Cycle
Watershed

Materials:
For this activity you will need a shallow pan, aluminum foil, the three-dimensional map created for the “How High is High? How Deep is Deep?” activity or a few paper cups, a watering can, topographical maps and nautical charts for the Hudson-Raritan Estuary, and drink mix or other powdery substance.

Activity:
You can use the same groups of students as for the other activities or choose new ones. In this activity students will learn about the hydrologic cycle and be able to define it, construct a model of a watershed, and understand how the watershed affects marine pollution.

Mapping the Ocean Floor

Words to Know:
Contour map
Sonar
Topography

Materials:
For this activity you will need large, watertight Styrofoam coolers, dark plastic garbage bags, waterproof markers, water to fill the coolers, dark food coloring (blue or green), bricks, rocks, sand or gravel, two strings, two metal nuts or washers, two meter sticks, data sheets for each pair of students and a bucket or pan to bail out the coolers.

Activity:
In this activity students use a cooler to build a simulated underwater terrain and take depth readings to accomplish mapping by using the method of lowering weighted ropes into the water to measure the depths. The figures are placed on the corresponding coordinates on the worksheet.
Getting Your Bearings

Objectives: 1) You will learn how to use a compass and work with navigational bearings. 2) You will locate geographic points of interest along the Hudson-Raritan Estuary.

Background: When people first started traveling on the ocean, they would calculate their approximate location using a magnetic compass to determine direction. If a navigator wanted to travel northwest for 100 miles and then directly west for 200 miles to reach his destination and his ship only went 10 mph, he would travel northwest for 10 hours then turn to travel directly west. Twenty hours later he should reach his destination, making his total trip 30 hours long. This method was not highly accurate. It does not consider changes in speed and location due to wind, ocean currents or tides. Today we use advanced technology that can tell you your exact longitude and latitude location.

Words to Know:
Bearings
Latitude
Longitude

Materials:
Magnetic compasses with moveable bearings (Magnetic compasses can be purchased from boat catalogs or lab supply catalogs. Price range $7.50-$20.00)
Nautical charts of the Hudson-Raritan Estuary
Topographic maps of the Hudson-Raritan Estuary
A road map of the surrounding area

Activity One:
1) Using maps and nautical charts set up your classroom to represent a portion of the Hudson-Raritan Estuary including three points of interest (eg. Sandy Hook Lighthouse, Statue of Liberty and South Street Seaport).
2) Set the bearings on your compasses. Let the needle on the compass find north, then set the drawn arrow on the plate of the compass over the needle. This establishes magnetic north. Next, set the bearings to 200 degrees. After moving the dial so that 200 degrees is on the line that says “read bearing here”, move the compass until the needle and the arrow line up again. Then position yourself to face in the direction of the arrow that says “read bearing here.” You are now bearing 200 degrees. Move five even paces bearing 200 degrees. Keep an even pace. Everyone should attempt to standardize their pace.
3) Start at one point in the estuary you have set up, and figure out your bearings and distance (paces) as you go from one point to another.
4) Divide into small groups. Each group should set up a series of three bearings with distances (paces) which represent actual locations in the Estuary according to their relative position and distance from each other. Each group will then give its directions to another group to follow to test their accuracy. At the end of the activity, a complete set of Hudson-Raritan Estuary courses will be accumulated.

Activity Two:
1) Charts included in the text of this section give the location of various points of interest within our Estuary. Use these charts to locate the approximate position of your three points of interest from Activity One.
2) As a group, brainstorm to determine the importance of each point of interest listed.
How High is High? How Deep is Deep?

Objectives: 1) You will read, interpret and recognize nautical charts and topographic maps.
2) You will design a three-dimensional map based on nautical charts and topographic maps.

Background: A topographic map depicts the height of the land and land features. Topographic maps express land height in feet above sea level. This is indicated with contour lines. Contour lines are imaginary lines that, in the case of topographic maps, indicate land of the same height above sea level. Topographic maps also indicate the location of railroads, pipelines, points of interest, and other information pertaining to landforms.

A nautical chart indicates the shape and depth of the ocean floor. They relate water depth in feet or fathoms, with one fathom equaling six feet. Like a topographical map, nautical charts use contour lines. In the case of a nautical chart these lines indicate depths that are the same distance below sea level. Nautical charts also provide mariners with information on lighthouses, submerged structures, channel markers, and points of interest.

Words to Know:
- Fathom
- Nautical
- Navigate
- Topography

Materials:
- Nautical charts of the Hudson-Raritan Estuary
- Topographic maps of the Hudson-Raritan Estuary
- A road map of surrounding area
- A map of the continents
- Corrugated cardboard
- Tracing paper, Construction paper
- Pencils, Scissors, Glue, String

Activity One:
1) Observe the differences of each map. Think about in what situations each map would be most useful.
2) Using tracing paper, trace the contour lines of a nautical chart and a topographic map of the same scale for the Hudson-Raritan Estuary. Cut out the traced contours, and retrace onto the corrugated cardboard. Cut the contours out of the cardboard. Place the cut cardboard contours onto a flat surface to recreate the section of the Hudson-Raritan Estuary being represented. The deepest section is flat surface, the first cut pieces set in place should represent the next highest section, and so forth. The highest land elevation should be placed on last. Let the thickness of each cardboard piece represent 6 feet or one fathom.
3) Add colored construction paper to the surfaces of contours to distinguish between shallow water, deep water, sea level and land forms. Label landforms and bodies of water. Glue the contours in place.
4) Add at least 10 symbols that indicate land and water features. Use the key of your maps and charts to recreate these symbols.

Activity Two:
1) Imagine you are the captain of an oil tanker, navigating a full load of crude fuel oil to a refinery in Perth Amboy. Your ship sits 25 feet deep in the water. Using a nautical chart, plot a course to safely navigate from the Atlantic Ocean to Perth Amboy.
2) Note the various symbols on the chart. Create an imaginary log of your voyage from the ocean to Perth Amboy. Make a list of dangers encountered and how they were they safely avoided. List the locations of points of interest. Record each observation in your log book as if you were seeing it from the ship.
Discussion:
1. Discuss the difference between nautical charts, topographic maps, road maps, and world maps.
2. Describe the situations each map would be most useful for and why.

Extension:
Each student constructs a 3-dimensional representation of a different part of the Hudson-Raritan Estuary and watershed. All maps are constructed to the same scale. As each map is completed, they are assembled to represent a larger portion of the Estuary and watershed.
GEOGRAPHY STUDENT ACTIVITY

Where Does the Water Go?

Objectives:
1) You will be able to define and understand the hydrologic cycle.
2) You will be able to define and construct a watershed.
3) You will understand how the watershed affects marine pollution.

Background: Approximately 70% of the earth is covered by water and the amount of water in the earth’s system changes very little over time. Where does water come from and where does it go? The answer to this question begins with understanding the hydrologic cycle, also known as the water cycle. We recycle paper, cans and bottles and the earth’s ecosystem recycles water. Water evaporates from the earth’s surface, rises into the atmosphere, condenses, and falls to the earth as rain. Once back on the earth’s surface, the water may be taken up by plants or animals, sink into the ground, or flow into the nearest body of water (stream, lake, sewer, aquifer). Eventually, the water evaporates and condenses, falling to earth as rain in an ongoing cycle called the hydrologic cycle. Just as gravity causes rain drops to fall to earth, gravity causes water to flow downhill. A water droplet that falls on land will move downward into and through the soil or along the ground until it reaches a stream, river, estuary or the ocean. The waterbody is a basin. The section of land which drains into a given body of water is that basin’s watershed. The size of a watershed is related to the size of the drainage basin. A stream has a smaller watershed than an estuary. The watersheds of larger drainage basins like estuaries are made up of many smaller watersheds, and these smaller watersheds feed the streams and rivers that empty into the estuary. Water that flows over the land into a drainage basin is called runoff. During its downhill trip over the land into streams, rivers, estuaries, and eventually the oceans, water droplet pick up pollutants. Thus, human activities on land affect surrounding bodies of water.

Words to Know:
Aquifer
Basin
Drainage Basin
Hydrology
Hydrologic Cycle
Watershed

Materials:
A shallow pan
Aluminum foil
A three-dimensional map created for the “How High is High? How Deep is Deep?” activity and blocks or a few paper cups and blocks
A watering can
Topographic maps and nautical charts for the Hudson-Raritan Estuary
Drink mix or other powdery substance
Food coloring

Activity:
1) If you divided into groups for the activity “How High is High? How Deep is Deep?” and constructed three-dimensional maps of the Hudson-Raritan Estuary, divide into those same groups to use the map your group constructed. Otherwise, divide into groups as directed. If you did not build the 3-D map you will be using paper cups and blocks for this activity.
2) Tear off a piece of aluminum foil the size of the pan being used. Place it over your 3-D model and mold the foil to conform to the contours of your map. Place this in the shallow pan and support it with the blocks so it does not fall over. If you did not construct a model, place paper cups and blocks in a shallow pan to represent the high and low points of a portion of the Hudson-Raritan Estuary. Place the foil over the blocks and use your hands to create valleys in a shape that represents the form of the portion of the Hudson-Raritan Estuary you chose to represent. When you are finished, you will have a model of a watershed.
3) Make it rain over your model with the watering can. Observe where the water goes. Sprinkle some
drink mix, a drop of food coloring or a powdery substance over the model to represent pollutants. Make it rain again, and observe what happens.

4) Place all models next to each other to represent a larger portion of the Hudson-Raritan Estuary. If possible, place all the models in the same pan or take them outside and staple them together so that one continuous model is formed. Sprinkle different colors of drink mix over the different parts of the model and make it rain again.

**Discussion:**
Discuss the direction in which the water runs when it rains on your model. Consider the following questions:
1. How do gravity and topography influence where water goes;
2. Discuss the role of the hydrologic cycle in the pollution of streams, rivers, and estuaries;
3. What happens to pollutants on land when it rains;
4. How is the size of a watershed related to the size of a drainage basin;
5. Which is larger, the watershed for the Raritan River or the watershed for the Raritan Bay, and
6. Is the Raritan River watershed part of the Hudson River watershed?

**Extension:**
Create a diagram indicating which watersheds of the Hudson-Raritan Estuary are part of other watersheds. Start with the largest watershed and work your way backwards to show which smaller watersheds are part of each larger watershed and how they are all connected.
Mapping the Ocean Floor

Objectives: 1) You will be able to develop a better understanding of how scientists once mapped the bottom structure of underwater habitats.
2) You will understand that it is possible to describe something you cannot see through the collection and correlation of accurate data.
3) You will simulate how water body contours were mapped.

Background: Despite the fact that it is underwater, the ocean floor can be mapped by scientists. This activity demonstrates the old fashioned method of measuring depth by the use of a weighted, marked line. People lowered these lines into rivers, lakes and coastal waters to test depths. Presently depth sounders and sonar accomplish the same task more accurately and efficiently. Sonar sends impulses of sound downward and measurements of depth are determined by the length of time it takes the sound impulse to travel to the water body bottom and bounce back again.

Words to Know:
Contour Map
Sonar
Topography

Materials:
Large watertight Styrofoam coolers
Dark plastic garbage bag
Waterproof marker
Water (to fill the cooler)
Dark food coloring (blue or green)
Bricks, rocks, sand or gravel
Two strings
Two metal nuts or washers
Two meter sticks
Data sheets for each pair of students
Bucket or pan to bail out coolers

Activity:
1) Write north, south, east and west on the sides of the coolers so maps will have the same orientation.
2) Using the magic marker, draw lines one centimeter apart around the top of the cooler. Label with a, b, c’s going north and south and 1, 2, 3’s east to west across the coolers.
3) Modify and copy the attached data sheet to correspond to the size of your coolers.
4) Line the cooler with a dark plastic garbage bag and place a variety of objects (rocks, bricks, sand or gravel) inside the cooler to simulate a varied underwater terrain.
5) Once prepared, place the cooler on a table and fill with water and add food coloring.
6) Using a length of string weighted with a washer at one end, take depth readings at predetermined coordinates by lowering the weighted string into the cooler until it touches the bottom surface. Coordinates are determined by laying the meter sticks across the marked cooler, perpendicular to one another.
7) After the string hits bottom, it is then measured and the resulting figure is placed at the corresponding coordinate on the work sheet. Take at least 15 measurements, entering the data on the work sheet as it is gathered.

Discussion:
1. Make predictions about your cooler bottom topography based on your 15 readings.
2. Create your own nautical chart by connecting the points of common depth.
3. After everyone’s predictions have been made, empty the coolers. Compare the cooler’s bottom to your own predictions.
4. How might you have made more accurate predictions? a more accurate contour map?
Write depth (in cm) next to the position where lines cross.
TOPOGRAPHIC MAPS

Just as a globe is a model of the earth, maps are models of the places they represent. A topographic map is a line and symbol representation of natural and manufactured features on the Earth’s surface plotted to a definite scale.

Map scale defines the relationship between distance on a map and the corresponding distance on the Earth. Scale is generally stated as a ratio in which the numerator (first number) represents map distance and the denominator (second number) represents a horizontal ground distance. Scale is graphically depicted on topographic maps by bar scales marked in feet and miles or in meters and kilometers. For example, a scale of 1:24,000 would mean that one inch on the map would represent 24,000 inches on earth (or 2,000 ft.).

Large-scale maps cover small geographic areas and are useful when detailed information on a particular location is needed. An example of a scale for a large-scale map would be 1:24,000. Small-scale maps cover very large areas and are useful for comprehensive views of a particular region. Examples of map scales on small-scale maps include 1:250,000, 1:500,000, or 1:1,000,000.

The National Mapping Program of the United States Department of Interior Geological Survey produces the standard topographic map series. Each map in the U.S. Geological Survey series conforms to established specifications for size, scale, content, and symbolization. The unit of survey for standard topographic maps is the quadrangle. Each quadrangle is defined by parallels of latitude and meridians of longitude. Quadrangles are named after a city, town, or prominent natural feature within the area mapped. Standard edition topographic maps produced for New Jersey are published at a scale of 1:24,000 (1 inch = 24,000 inches or 2,000 feet) in a 7.5 x 7.5 minute format. This means that these quadrangles cover 7.5 minutes of latitude and longitude. Other quadrangles covering 15 minutes of latitude and longitude are published at a scale of 1:62,500 (1 inch = 62,500 inches or 1 mile). In addition, a few special maps are published at other scales.

Topographic maps give as complete a picture of the terrain as can be legibly produced in mapped form. Topographic maps show the location and shape of mountains, valleys, and plains, the networks of streams and rivers, and the principal manufactured features of the area depicted. A distinguishing characteristic of a topographic map is the portrayal of the shape and elevation of the terrain by contours. Contours are imaginary lines which follow the land surface or the ocean bottom at a constant elevation above or below sea level. The contour interval is the elevation difference between adjacent contour lines. The contour interval is chosen on the basis of the map scale and the local relief. Contour intervals differ with the scale of the map and the relief of the area mapped. For example, a small contour interval is
used for flat areas whereas larger intervals are used for mountainous terrain.

The physical and cultural characteristics of an area depicted on a particular topographic map are determined by engineering surveys and field inspections. These features are recorded on topographic maps in a convenient, readable format using standardized symbols. Color helps distinguish categories of features. Manufactured features are printed in black, water features are printed in blue, road classifications, urban areas, and U.S. land lines are red, woodlands and other vegetated areas are shown in green, and contour lines are printed in brown.

Topographic maps have many uses. They are an essential part of terrestrial ecological studies, geologic research and water quantity and quality studies. They may also be used in flood control, soil conservation, and reforestation projects. Topographic maps are extremely useful for studying marine environments. They depict details about shorelines including the extent of wetlands or shoreline development and the approximate mean high water line. They also provide the types and locations of prominent coastal features like seawalls, breakwaters, jetties, piers, or wharves. In addition, topographic maps reflect local bathymetry including water depth depicted by depth curves based on soundings and other bathymetric features like areas exposed at low tide, the locations of channels, sunken rocks, rocks awash and exposed wrecks.