Texas Stream Team
Caring for Our Waters

8th – 12th – Designing a Monitoring Plan – Mapping & Analysis
(Activities 1 – 2)

Objectives for All Activities
- To be able to define and describe the purpose and uses of topographic maps.
- To define rules of interpreting topographic maps and the symbols used for features.
- To comprehend calculations for determining latitude and longitude of a location on a topographic map.
- To identify important features on topographic maps.
- To determine primary land uses in watershed.
- To identify potential hazards to water quality in the watershed.
- To establish goals for monitoring the water quality at a given site.

Materials Activity 1-2
- As many different 1:24,000, "7 ½ Minute Series" topographic maps as your can locate. You may obtain topographic maps from several different sources.
    + The Texas Natural Resources Information System in Austin, Texas offers topographic maps for education. The only cost is shipping, which is $5 per tube of 25 maps. To order, visit them on the web at http://www.tnris.org or call at 512-463-8337.
    + The United States Geological Survey, USGS, provides information for ordering maps and for finding other map suppliers. Their web site is http://www.usgs.gov
    + The local public library may have topographic maps on file.
    + Private mapping companies also have topographic maps. The USGS web site gives a list of these companies.
- Several topographic map legends, found on the web at http://www.usgs.gov or http://www.topozone.com.
- 1 Topographic Map of Local Area per group
- Cardboard
- Plastic Sheets (or several overheads) per group
- Dry Erase Markers
- Thumb Tacks

Alternative setup for maps - If unable to obtain topographic maps, students may use copies of topographic maps or maps printed from the web, as long as students are allowed to write on the maps.

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Background

Many environmental and human factors exist that influence measurements of the water quality parameters of depth, temperature, pH, conductivity, and dissolved oxygen. Important factors to consider include: 1) size of watershed 2) topography, or land features 3) stream location 4) cultural features, such as buildings, roads, pipelines, etc. 5) the number and size of towns, and 6) the types of land use within the watershed.

TOPOGRAPHIC MAPS

Topographic maps provide one method of analyzing factors that influence water quality parameters and of mapping a watershed. Topographic maps, a type of contour map, project a flat, 2-D representation of the shape of earth's surface. These maps also identify other important physical and cultural features, such as vegetation, streams, lakes, caves, towns, buildings, roads, pipelines, and bridges.

Topographic maps serve many purposes for a diversity of professionals including, city planners, urban developers, hydrologists, flood plain managers, hazards researchers, and physical geographers to name a few. In their jobs, topographic maps are used to identify areas for potential growth, assess future problems related to growth issues, determine threats to the local environment, locate boundaries of flood plains, find areas prone to damage from disasters, and study the physical landscape.

Latitude and Longitude

Latitude and longitude is one of the coordinate systems represented on topographic maps. Latitude lines measure north and south and run east and west. Longitude lines measure east and west and run north and south. When writing and reading latitude and longitude, latitude always comes first. Each corner of the topographic map displays the latitude and longitude of that corner. These are the boundaries of the topographic map. Latitude and longitude readings in between these corners, or boundaries, are shown on the side of the map. Latitude readings can be found on the vertical axes of the map, while longitude readings are on the horizontal axes of the map.

On topographic maps, latitude and longitude are given in degrees, minutes, and seconds. These units measure distance. One degree consists of 60 minutes and one minute consists of 60 seconds. The symbol for minutes is one apostrophe and seconds is two apostrophes. For example, a location at 29° 52' 30'' N, 97° 45' 0'' W is at 29 degrees, 52 minutes, and 30 seconds north latitude and 97 degrees, 45 minutes, and zero seconds west longitude.

Classifying Topographic Maps

One way of classifying topographic maps is by the scale of the map. The scale is a ratio between distance on the map and distance on the earth's surface. For example,

one of the most common types of topographic maps is the 7 ½ minute quadrangle. This map depicts an area of 7 ½ minutes latitude and 7 ½ minutes longitude, thus making it the "7 ½ Minute Series." For this map, the scale is usually 1:24,000. This means that one inch on the map equals 24,000 inches on the earth's surface, and one foot on the map represents 24,000 feet of the earth's surface. Topographic maps also come in scales of 1:100,000 and 1:250,000. This lesson requires the 1:24,000, "7 ½ Minute Series" topographic maps.

Activity 1: Introduction to Topographic Maps

1. Gather materials.

2. In a class discussion, generate a definition for topographic maps and make a list of people in society who might use them. Write the list on the board or overhead. As students provide names of professions that use topographic maps, have them describe how these professionals use the maps.

Activity 2: Mapping Your Watershed

1. Gather materials.

2. To mount plastic over the topographic map:
   a) Place the topographic map on the cardboard.
   b) Place sheet of plastic on top of topographic map.
   c) Tape plastic and map to cardboard. (May also use thumbtacks to fasten plastic and map to cardboard).

***Topographic maps may be laminated instead of covering them with plastic**

3. Divide students into groups of two or three for Mapping Your Watershed Activity.

4. Distribute Watershed Mapping Survey worksheet (6.1) for students to complete. The end result should resemble the mapped watershed of the topographic map in **Appendix 1**.

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8th – 12th – Designing a Monitoring Plan – Mapping & Analysis (Activities 3 and 4)

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Materials Activity 3-4

- Rulers (with centimeters)
- Calculators for each group
- Local Area Topographic Maps with Marked Watersheds from Activity 2

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Activity 3: Locating Your Monitoring Site

1. Gather materials.

2. On the topographic map, locate a monitoring site on a waterway.

3. Have students use Site Location Calculations worksheet (6.2) to find the latitude and longitude of their monitoring site.

NOTE: Topographic maps printed from the web do not display latitude and longitude coordinates on the map and are not suitable for calculating the latitude and longitude of the monitoring site.

Activity 4: Creating a Monitoring Plan

1. Gather materials.

2. Divide students into the same groups as for the previous activity, Mapping Your Watershed.

3. Provide each group with Monitoring Plan Activity worksheet (6.3).

4. Have students review the topographic maps and discuss their findings.

5. Using the information from their Watershed Survey, have each group design a Monitoring Plan around their watershed on their map.

6. After completing their Monitoring Plans, have each group discuss their findings and conclusion.

Assessment/Evaluation

1. Lead a class discussion defining topographic maps, describing the purpose and uses of topographic maps, and explaining topographic map rules and symbols to introduce students to topographic maps and determine their comprehension of basic topographic map terminology.

2. The Watershed Mapping Activity will assess students' understanding of topographic map rules, calculating latitude and longitude on a topographic map, watershed-mapping procedures, meanings of topographic map symbols, and identification of land uses.

3. The Monitoring Plan Activity measures student mastery of calculating map location and of developing a monitoring site plan.

TEKS

Science 8.1A, 8.2A, 8.2B, 8.2C, 8.2D, 8.2E, 8.3A, 8.4A, 8.4B, 8.11B, 8.11C
Aquatic Science 1A,2A, 2B, 2C, 2D, 2E, 2F, 2G, 2H, 2I, 2J, 3A, 4A, 5B, 5D, 6A, 9C, 11B, 12A
Biology 1A, 2E, 2F, 2G, 2H, 3A, 11B, 12F
Chemistry 1A, 2E, 2F, 2G, 2H, 2I, 3A, 10A, 10B
Earth and Space Science 1A, 2E, 2H, 2I, 3A
Environmental Systems 1A, 2E, 2F, 2G, 2H, 2I, 2J, 2K, 3A, 4E, 5B, 9B, 9C

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Resources

ESRI – topographic maps and digital data
http://www.esri.com/
This ESRI site allows you to make and print a topographic map from their site. You may also obtain digital data for developing your own topographic map with GIS.

Geographic Information Systems Data Depot – Topographic map digital data
http://www.gisdatadepot.com
This website provides digital data to create your own topographic map in GIS programs.

Texas Center for Policy Studies - Texas Environmental Atlas
http://www.Texascenter.org
The Texas Environmental Almanac displays facts and figures concerning environmental issues in Texas, including water quantity and water quality. The 1995 edition is available on-line at the above site.

Texas Natural Resources Information System – Paper topographic maps
http://www.tnris.org
The Texas Natural Resources Information System (TNRIS) in Austin, Texas offers topographic maps for education. The only cost to you is shipping, which is $5 per tube of 25 maps. To order, visit them on the web at http://www.tnris.org or call at 512-463-8337.

Texas Parks and Wildlife - River basin and stream gauge identification and discharge
http://www.tpwd.state.tx.us/texaswater/rivers/index.htm
Information about river basins and stream discharge is available at this site.

Topozone - topographic maps
http://www.topozone.com
This website offers free topographic maps that may be printed from their site.

United States Geological Survey
http://www.usgs.gov
This site provides stream discharge data for specific gauging stations located in the United States.

NAME: _____ DATE: _____ Worksheet 6.1

WATERSHED MAPPING SURVEY

As you map your watershed, it is important to remember the following rules of contour maps:

- Contour lines depict areas of equal elevation. Elevations on one side are higher than elevations on the opposing side.
- Contour lines spaced close together show a steep slope, or steep hills and ridges. Conversely, areas having contour lines spaced widely apart display a gentle slope.
- The contour interval is constant for the entire map, unless indicated otherwise.
- Contour lines are continuous and will always close, even though they may run off the map before closing.
- Contour lines will never split or intersect.
- Contour lines that form circles on the map indicate a hilltop, or a place of higher elevation.
- Contour lines that form circles on the map and have hachured mark within the circles indicate a depression, or points of lower elevation.
- Contour lines bend upstream when crossing streams.
- Contour lines bend downslope when crossing ridges.

Mapping Your Watershed

1. Obtain a topographic map or a copy of a map for your stream site and determine the following:

   Map Title _____

   Contour Interval _____

   Highest Elevation _____

   Lowest Elevation _____

   Stream Flow Direction _____

2. To map your watershed, follow these steps:

   a. Locate and mark your study site on the topographic map. A road map may help you.

   b. Identify streams, lakes, oceans, and rivers closest to your site and mark them in blue.

   c. For the streams and rivers on your map, indicate the direction of water flow by drawing an arrow next to the stream. Make sure the arrow points downstream.

   d. Find the highest points around your site. Write "X" on all the hilltops.

   e. For each hilltop, or "X," draw arrows on your map showing the direction that runoff flows.

   f. Draw a line connecting the highest points (all the Xs) around your stream, including its mouth. The line should follow the tops of hills or ridges and should make a boundary between water bodies included in your watershed and those that are not.

You have just mapped your watershed. Write the name of your watershed on your map. The next section will help you identify important land characteristics of your watershed.

Land Characteristics of Your Watershed

Use the map legend and your outlined watershed to answer the following questions.

1. According to the map legend, what do the following colors represent?
   - Black _____
   - Blue _____
   - Brown _____
   - Red _____
   - Green _____
   - Purple _____

2. Which of these colors are dominant in your watershed?

   _____

3. What type of roads do you see close to your monitoring site?

   _____

4. List the type of buildings located in your watershed.

   _____

5. Do you see any pipelines or transmission lines in your watershed? YES NO
   If so, what kind are they?

   _____

6. Based on the above information, what would you say is the primary land use in your watershed?

   _____

7. What potential environmental hazards exist in your watershed?

   _____

NAME: _____ DATE: _____ Worksheet 6.2

SITE LOCATION CALCULATIONS

Calculating Latitude and Longitude of Monitoring Sites.
Using your 7 ½ Minute Topographic Map, choose a site location along the water body within your delineated watershed.

Step 1. Determine the starting latitude and longitude. The base readings are in the bottom right hand corner of the map.

Beginning latitude _____° _____' _____" N

Beginning longitude _____° _____' _____" W

Step 2. Find out how far away your monitoring site is from the starting latitude and longitude. It will take two simple procedures to finish this step: draw and measure. (Measurements need to be in centimeters.)

a. Draw

Draw a line from the monitoring site straight down to the bottom edge of the map. Do not include the map border. The line must meet the edge of the map at a right angle.

Draw a line from the monitoring site to the right edge of the map. Do not include the map border. The line must meet the edge of the map at a right angle.

b. Measure both lines.

Centimeters of line east to west (to measure difference in longitude)_____

Centimeters of line north to south (to measure difference in latitude)_____

Step 3. Convert the measurements by finding the conversion factor. Use your measurements from Step 2 part b. To convert the measurement of the monitoring site your measurements will need to be converted into degrees, minutes, and seconds. Remember that one degree has 60 minutes and one minute has 60 seconds.

Finding the conversion factor.

Latitude

a. Measure the entire length of the map north to south in centimeters.

b. Divide this measurement (in centimeters) by 450 seconds to get the conversion factor.
Latitude conversion factor is _____ seconds/centimeter.

Longitude

a. Measure the length of the map east to west (in centimeters).

b. Divide this measurement (in centimeters) by 450 seconds to get the conversion factor.
Longitude conversion factor is_____ seconds/centimeter.

Converting your measurements. **(Use your measurements from Step 2 part b.)**

Latitude

_____ sec/cm X _____ cm = _____ seconds
Latitude conversion factor multiplied by north/south cm measured from site equals number of seconds away.

Longitude

_____ sec/cm X_____ cm = _____ seconds
Longitude conversion factor multiplied by east/west cm measured from site equals number of seconds away.

Step 4. Finally, add the converted measurements to the starting latitude and longitude readings and then simplify.

Adding.

	Latitude	Longitude
Starting location	_____° _____′ _____″ N	_____° _____′ _____″ W
Seconds to site:	+ _____″ to the north	+ _____″ to the west
Added Values:	_____° _____′ _____″ N	_____° _____′ _____″ W

Simplifying.
Does your reading for seconds exceed 60? NO YES

If NO, then you have the correct latitude and longitude and do not need to simplify further.
If YES, then you must simply. Remember, one minute has 60 seconds and one degree has 60 minutes.

To simplify, divide the seconds by 60. The whole number is your minutes and your remainder is the seconds. For example, if you have 216 seconds, divide it by 60. This gives you 3 and a remainder of 36. So, you will add 3 minutes to the minutes of latitude/longitude and have 36 seconds left.

Site Location =

_____° _____′ _____″ **N** _____° _____′ _____″ **W**

NAME: _____ DATE: _____ Worksheet 6.3

MONITORING PLAN ACTIVITY

Potential Monitoring Group Name:

_____

MONITORING SITE INFORMATION

Location Description _____

_____

Latitude/Longitude for site:_____ **LAT** _____ **LONG**

County where site is located:_____

Potential Safety Hazards for site:_____

_____

_____

Nearest town or city to your Monitoring Site: _____

List several factors that could influence water quality data in your watershed

1. _____
2. _____
3. _____

What goals do you want to achieve as a monitoring group?
(How do you think your water quality data may be used for the greater good of the community)

1. _____
2. _____
3. _____

List the names and addresses to whom you will send your data and why (i.e. Texas Watch Partner, local business, school, local newspaper, etc): _____

_____

_____

_____

Who are you going to contact if you see a problem and why? _____

_____

_____

_____

Teachers Guide 6.2

TEACHER'S GUIDE
SITE LOCATION CALCULATIONS

These calculations require 7 ½ Minute Topographic Map with the site location. The four main steps are: 1) find the starting latitude and longitude; 2) draw and measure; 3) convert to degrees, minutes, and seconds; and 4) add values to starting latitude and longitude. Before beginning this exercise, students need to mark their monitoring site location with a dot that is easy to see. An example has been included with the directions below.

Step 1. Determine the starting latitude and longitude. The base readings are in the bottom right hand corner of the map.

Beginning latitude 28 ° 52 ′ 30 ″ N
Beginning longitude 97 ° 52 ′ 30 ″ W

Step 2. Find out how far away your monitoring site is from the starting latitude and longitude. It will take two simple procedures to finish this step: draw and measure. (Measurements need to be in centimeters.)

a. Draw
Draw a line from the monitoring site straight down to the bottom edge of the map. Do not include the map border. The line must meet the edge of the map at a right angle.

Draw a line from the monitoring site to the right edge of the map. Do not include the map border. The line must meet the edge of the map at a right angle.

b. Measure both lines.
Centimeters of line east to west (to measure difference in longitude) 6

Centimeters of line north to south (to measure difference in latitude) 12

Step 3. Convert the measurements by finding the conversion factor. Use your measurements from Step 2 part b. To convert the measurement of the monitoring site your measurements will need to be converted into degrees, minutes, and seconds. Remember that one degree has 60 minutes and one minute has 60 seconds.

Finding the conversion factor.
Latitude
a. Measure the entire length of the map north to south in centimeters.

b. Divide this measurement (in centimeters) by 450 seconds to get the conversion factor.
Example: Student measures 25 cm north to south.
and divides 450 by 25.

Latitude conversion factor is 18 seconds/centimeter.

Longitude
a. Measure the length of the map east to west (in centimeters).

b. Divide this measurement (in centimeters) by 450 seconds to get the conversion factor.
Example: Student measures 30 cm east to west and divides 450 by 30.

Longitude conversion factor is 15 seconds/centimeter.

Converting your measurements. **(Use your measurements from Step 2 part b.)**

Latitude
18 sec/cm X 12 cm = 216 seconds
Latitude conversion factor multiplied by north/south cm measured from site equals number of seconds away.

Longitude
15 sec/cm X 6 cm = 90 seconds
Longitude conversion factor multiplied by east/west cm of measured from site equals number of seconds away.

Step 4. Finally, add the converted measurements to the starting latitude and longitude readings and then simplify.

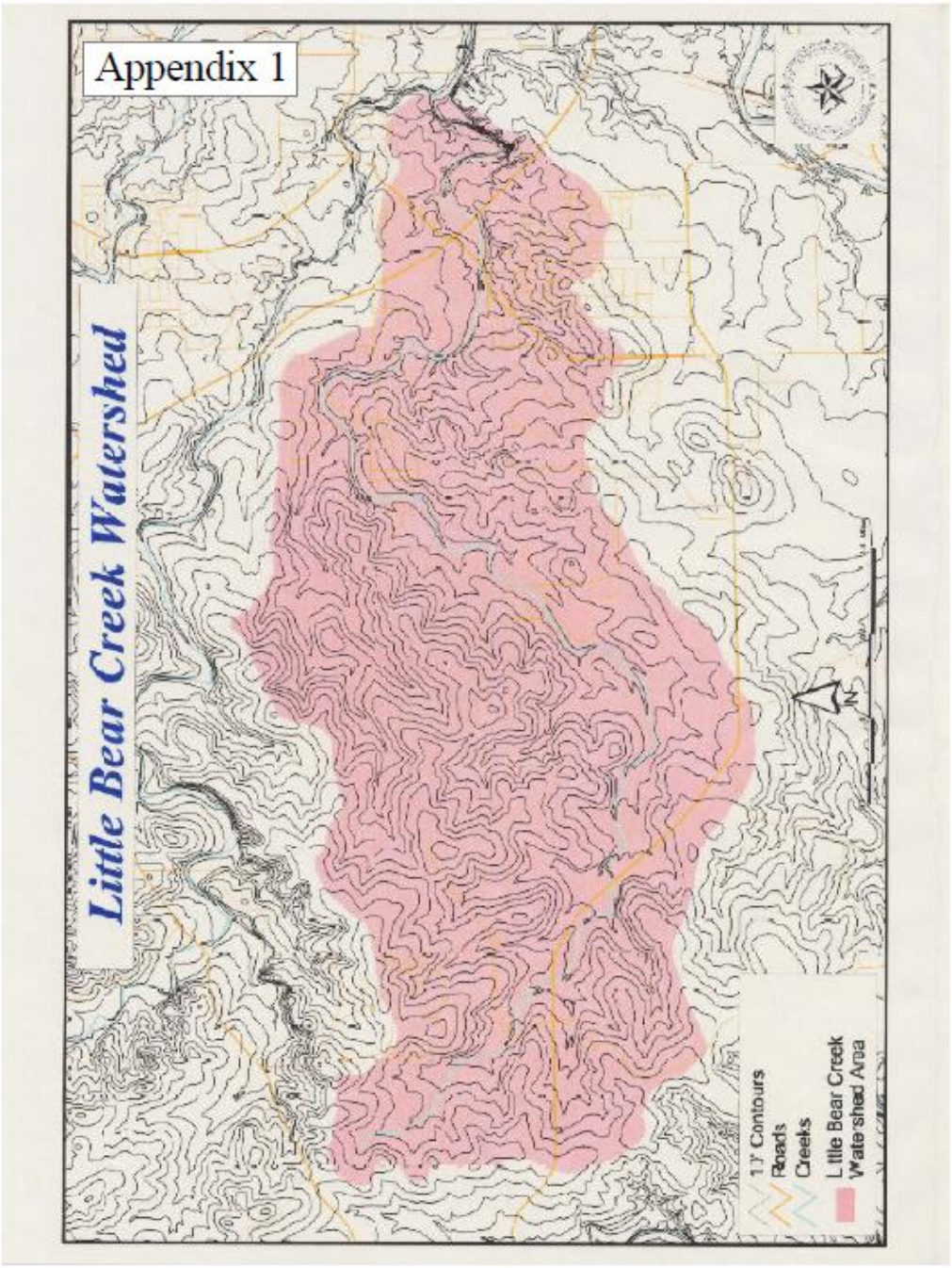
Adding.

	Latitude	Longitude
Starting location	28 ° 52 ′ 30 ″ N	97 ° 52 ′ 30″ W
Seconds to site	+ 216″ to the north	+ 90 ″ to the west
Added values	28 ° 52 ′ 246 ″ N	97 ° 52 ′ 120 ″ W

Simplifying.

Does your reading for seconds exceed 60? NO (YES)

If NO, then you have the correct latitude and longitude and do not need to simplify further.
If YES, then you must simply. Remember, one minute has 60 seconds and one degree has 60 minutes.
To simplify, divide the seconds by 60. The whole number is your minutes and your remainder is the seconds. For example, if you have 216 seconds, divide it by 60. This gives you 3 and a remainder of 36. So, you will add 3 minutes to the minutes of latitude/longitude and have 36 seconds left.
Example: Latitude – 246/60 = 4 remainder of 6
Longitude – 120/60 = 2 remainder of 0


Appendix 1
Little Bear Creek Watershed
N
10' Contours
Roads
Creeks
Little Bear Creek
Watershed Area