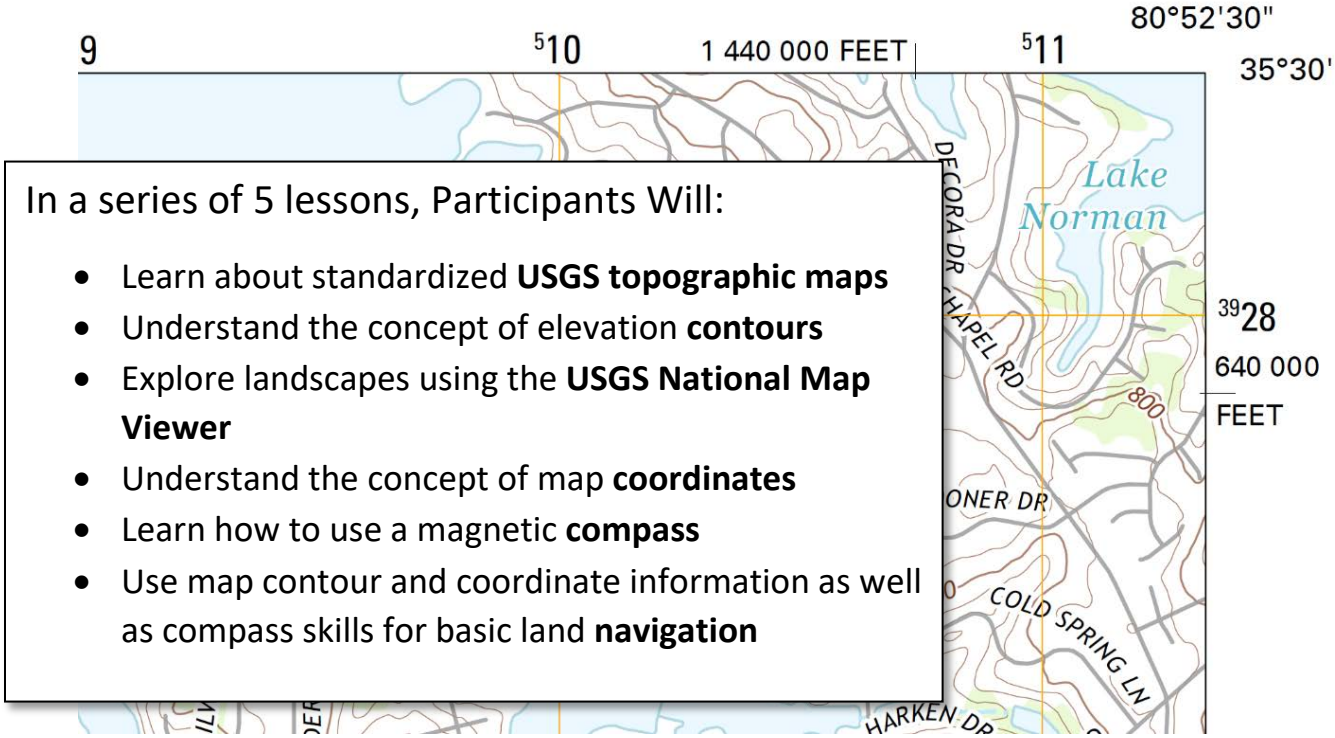
2021 Edition

Teaching Topos

Leader's Guide

Understanding Topographic Maps & Contours



In a series of 5 lessons, Participants Will:

- Learn about standardized **USGS topographic maps**
- Understand the concept of elevation **contours**
- Explore landscapes using the **USGS National Map Viewer**
- Understand the concept of map **coordinates**
- Learn how to use a magnetic **compass**
- Use map contour and coordinate information as well as compass skills for basic land **navigation**

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Teaching Topos: Leader's Guide

Lesson 1: Topographic maps

Key Concepts:

- What is a topographic map?
- Parts of a topographic map
- Standard topographic symbols and colors
- Where to find topographic maps – paper and digital

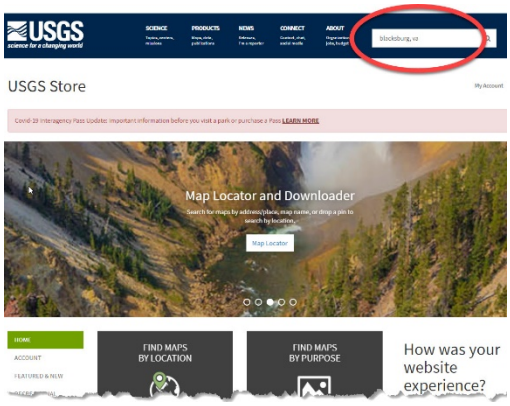
Activities:

- Activity 1: Exploring topographic maps
- Activity 2: Exploring landscapes using the USGS National Map Viewer (*Optional* [Device such as an ipad, Chromebook, or laptop] & Internet required)
- Activity 3: Mobile Connect (*Optional* [SmartPhone or similar device required]): Exploring topographic maps on a mobile device

Activity 1: Exploring Topographic Maps- Materials & Preparation

1. This is an indoor/covered area activity. Become familiar with the terms and concepts being covered by reading through the participant's handbook.
2. Obtain topographic maps of your location (outlined below) as well as topographic maps for areas with different types of landforms: mountainous, coastal, hills, glaciated features. Historic topographic maps of your location are also interesting to look at and compare changes over time.
    a. To order topographic maps or download for free and print from a plotter, first go to the USGS map store (store.usgs.gov) : map locator & downloader: https://store.usgs.gov/ ,

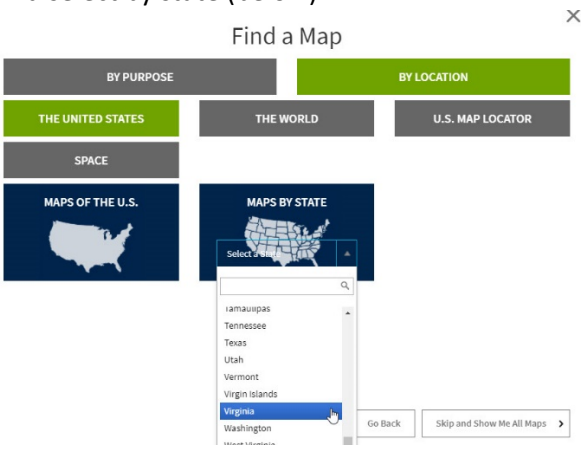
    b. You can search for topos of your area entering the name of your town (or county) and using the "search" box and *By Location.*



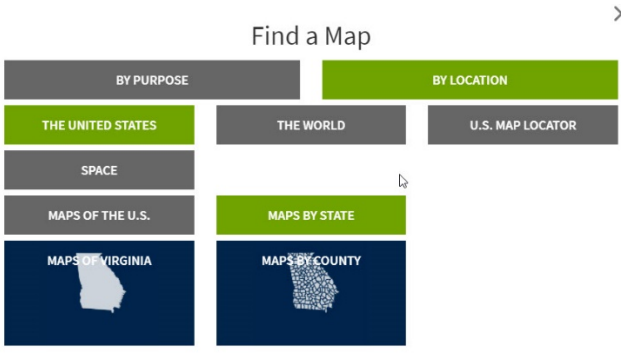
Or…

    c. You can search by selecting the "Find Maps by Location" option (below), and selecting the United States (below left and right).

d. And select by state (below)

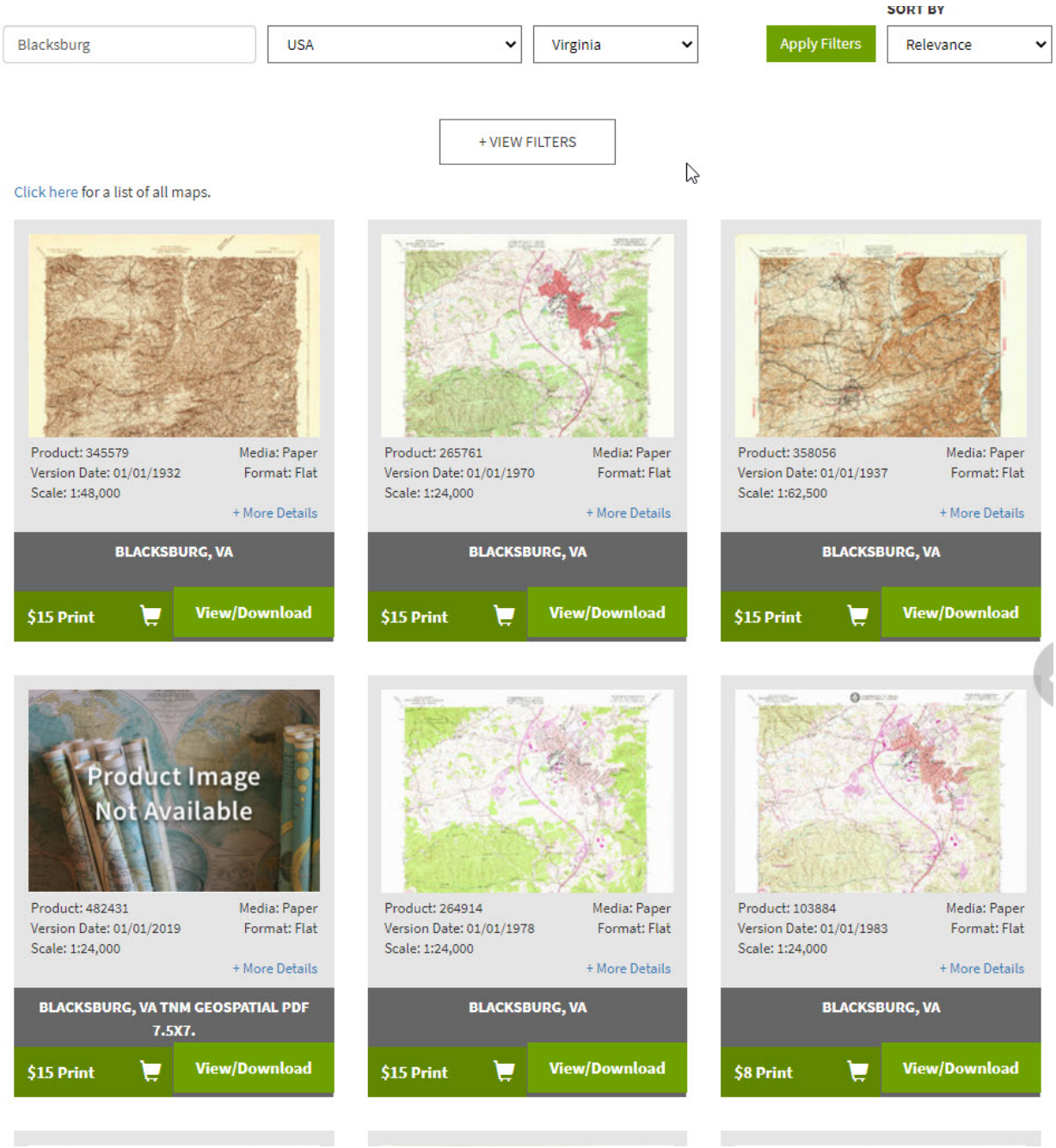


e. You can select by state, or maps by county. Note that finest resolution county maps are at a 1:50,000 scale and the topo quad maps are 1:24,000 scale maps. So in this case, you can select by county.



f. Explore the map options. If you do not see what you are looking for, you can always enter the name of your town / locality in the search box at the top of the window. By selecting the View/Download option, you can save the topo to your local hard drive.

Then you will be able to print the topo on a local plotter or other printer. If you do not have a plotter then you can project the topo on the screen (note that you might want to try this ahead of time just to make sure that your projector shows the map details clearly). You can also order prints from the USGS by adding products to your cart.



g. If you decide to download and save the file using your browser's instructions. The file will be saved as a geo.pdf file. These files are 'considered to be 'mapping files" because the maps are georeferenced. This means that these digital maps have latitude and

longitude associated with them. Not only can students easily obtain the the latitude and longitude locations of points on a map, but they can also measure area and perimeter. You may want to consider holding off on providing this information to then until after they have worked with written (along the corners and sides of the map) coordinate systems, and until they have estimated their own area and perimeter (using the scale bar to estimate).

h. If you intend to print them map, it will be saved as a PDF file type. Open the PDF in Adobe Reader and print to your plotter. Most topo maps will require a print area of 22" wide by 27" long. Be sure to print in full color.

i. To buy topographic maps from USGS: select the <$15Print> option – be sure to check the dates and the scale (preferably 1:24,000), as they may display out of order. Also be sure you are getting at least one map that is "contours" only – the US Topo maps are more up-to-date, but it is helpful to have an older contour map to examine as well. Enter the quantity and click the cart button. You can then check out using the upper-right hand menu from this page.

j. Be sure to obtain not only a map or two for your location, but also for areas with different types of land forms. Some suggestions for quad names to order or print for different land forms:
   - Mountain Glaciated – Quad name: Logan Pass, MT
   - Mountainous – Quad name: Trail Ridge, CO
   - Coastal – Quad name: Yorktown, VA

3. Print at least one copy of USGS Topo map symbols found at http://pubs.usgs.gov/gip/TopographicMapSymbols/topomapsymbols.pdf and Appendix A (topo map definitions) for each group or participant.

Leading Activity 1: Exploring Topographic maps

Have participants work in groups, pulling out full size paper topographic maps and identifying the following key features on each map. Try to have each group look at two or more maps from various parts of the country (or different time periods), giving time to explore each map. Use the Standard USGS Topo symbols chart (available from https://pubs.usgs.gov/gip/TopographicMapSymbols/topomapsymbols.pdf) and the definitions (Appendix A) for this activity. See Appendix B for additional information for of each map element. You may want to cover each of the definitions in Appendix A as you go through the different parts of the topo map together for the first map.

1. Have participants Identify the following key features on a USGS topographic map, searching the map margins and using Appendix B for more information:
   a. Agency or author of map
   b. Map title (quadrangle name)
   c. Road classification

d. Revision date
e. Quadrangle location
f. Quadrangle legend
g. Map scale: fractional and bar/graphic scale
h. Contour interval
i. North arrow
j. Declination
k. Map production information
l. Datum and UTM zone
m. Latitude and Longitude (map edges)
n. UTM coordinates
o. Section, Township, and Range

2. Compare two topographic maps of different terrain types side-by-side (for example, one map from a flat, coastal area with one map from a hilly, mountainous region). Use the following questions to compare the two:
    a. Are the contour intervals used on each map the same? If they are different, why might this be?
    b. How are the symbols used on each map the same? How are they different?
    c. What patterns of development (roads, buildings, houses) do you notice in each of the terrain types?

USING THE MOBILE CONNECT (MC) EXERCISES?

We highly recommend completing these exercises (in all five chapters) using the traditional methods first. Digital maps, apps, and GPS navigation are part of our modern world – but we would do well to impart manual map handling, reading, and navigation skills to the next generation of map users. By building a solid foundation of map skills, digital map and mapping technology users will have a better understanding of the far-reaching uses as well as the limitations of this technology.

If your group has time, using both the traditional activities and the mobile connect activities will broaden their understanding of maps and navigation. But if you're short on time, or don't have access to devices – skip the mobile connect option.

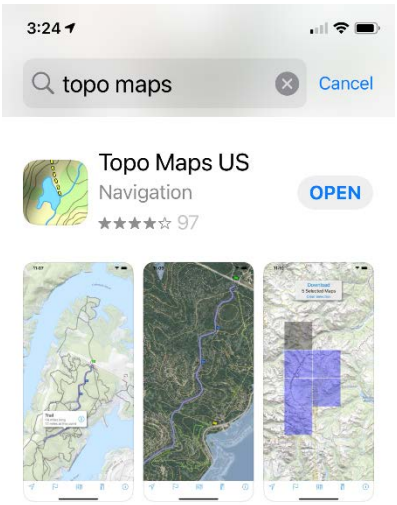
Activity 2: Exploring landscapes using the USGS National Map Viewer

1. In order to conduct this exercise, participants must have access to a device (Chromebook, iPad, etc.) and the Internet
2. Walk students through basics of the National Map. Show them how to search for locations (i.e. Blacksburg, VA or their own towns) using the search bar. Demonstrate that they can also enter lat./long. coordinates into the search bar. Open and explore various basemaps of the same area.

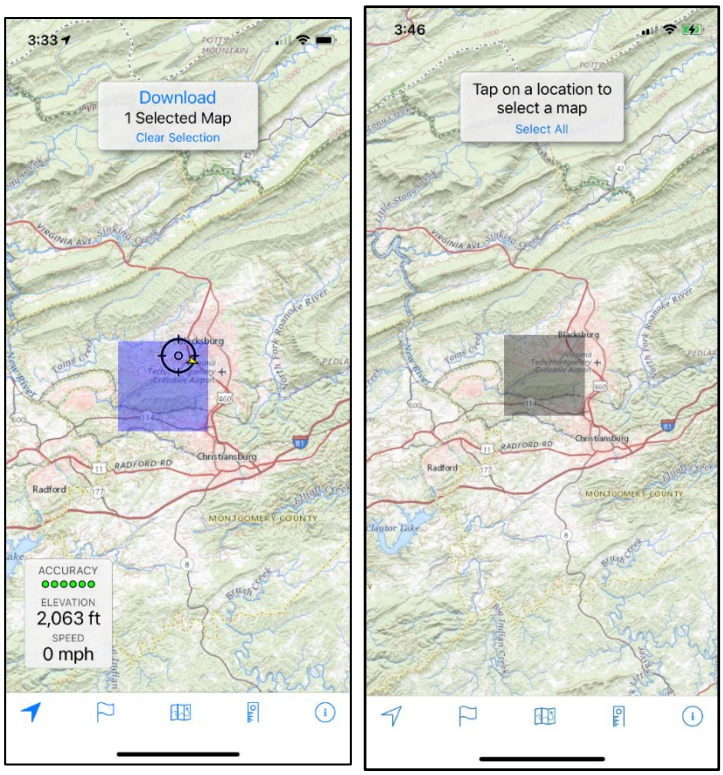
3. You may also want to assign them a geographic area and ask them to learn more about the landscapes of this particular area based on what they can discern on the USGS National Map. Students could work in groups of 2. Examples might include:
    a. The Grand Canyon
    b. Washington, DC
    c. Acadia, ME
    d. Lake Drummond, VA
    e. Burke's Garden, VA
    f. Yellowstone National Park
    g. Compare Washington DC with New Orleans
    h. Mt Rainer, WA
    i. Accomack, VA

Activity 3 (MC): Topographic Maps on a Mobile App - Materials & Preparation

1. This is an indoor or outdoor activity.
2. Load your devices with the Topo Maps USA App (you can also use other topomap App, such as Avenza)
    a. Download the app, or help participants download on personal devices, for each device you plan on using.
3. Mobile connect option: We recommend completing this part of the exercise with at least one paper map, as well as exploring these map elements on your downloaded maps on Topo Maps USA. Maps aren't pre-loaded (but they are free), so it is important that you download the topo maps from the Topo Maps USA app.



    a. Navigate to the region where you want to explore (the Town of Blacksburg for example)
    b. You will notice that if you zoom too far in to the map on Topo Maps USA, the map data disappears all together. This is because only cursory level data has been included with the Topo Maps USA app. You will need to download a more detailed topographic map for your area.
    c. To download more detailed topographic maps, use your finger to select different areas on the map. These areas are then highlighted in blue. Then hit the "Download" button on the screen. Warning: Do not download too many topographic maps, as they are kind of large and will take time to download. You should only download 1 map (see image below).



Leading Activity 2 (Mobile Connect): Topographic Maps on a Mobile App

1. We recommend completing this part of the exercise with at least one paper map, as well as exploring these map elements on your downloaded maps on Topo Maps USA. Have participants become familiar with the app by opening Topo Maps USA and opening the map you've downloaded for your region (step-by-step instructions and screen shots for all the exercises are included in the participant handbook).

2. With the map open, have participants practice zooming in and out, panning to map margins, and exploring the other icons at the bottom of the screen.

3. Discussion question: What would be some advantages to using this mobile app to view and work with topographic maps? What would be some disadvantages?

Lesson 2: Contours

Key Concepts:

- What is a contour line?
- Understanding contour intervals
- Identifying key relief features on maps and in field

Activities:

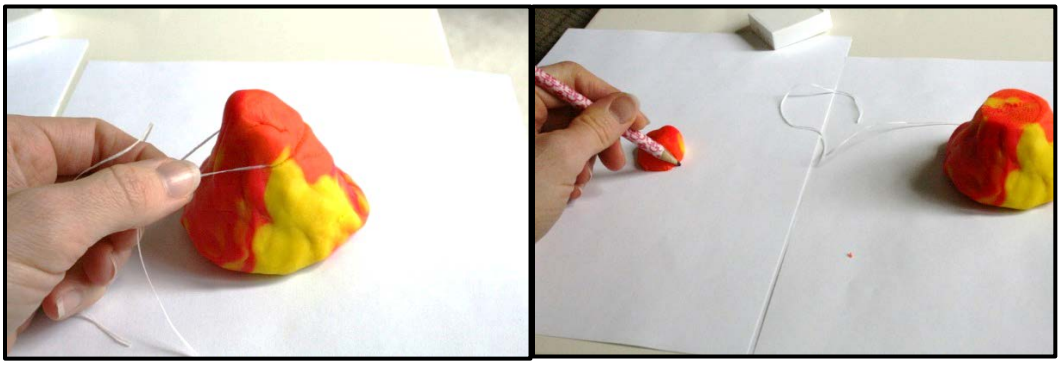
- Activity 4: Modeling and mapping elevation activity with play dough
- Activity 5: (Mobile connect option): Outdoors walk with Topo Maps USA using local topo map to identify topographic features both on the map and in the field

Activity 4: Contour Modeling - Materials & Preparation

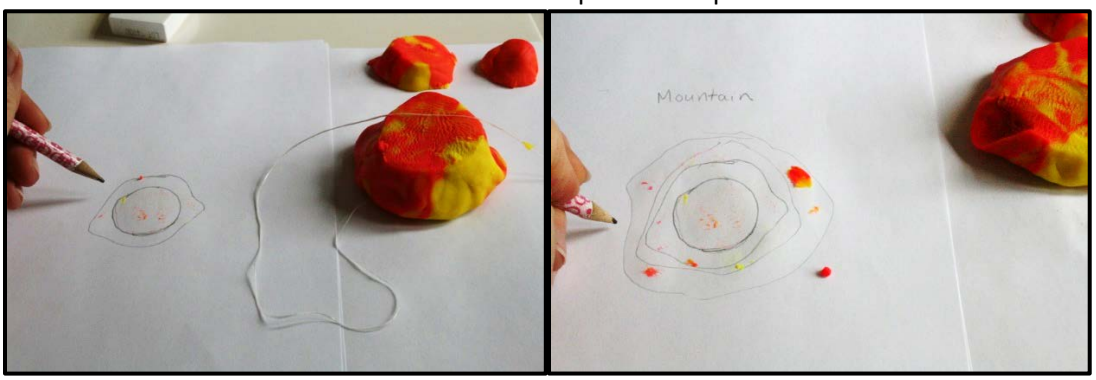
1. This is an indoor/covered area activity. Tables are very helpful.
2. Gather the following supplies:
    a. One full-size can of play dough for at least every two participants. Have participants work either as individuals or pairs.
    b. Dental floss – about two feet per group
    c. 2-3 sheets plain paper per group
    d. One pencil per group
    e. Topographic maps used in Activity 1
3. The purpose of this exercise is to help participants understand the concept of a contour line in a hands-on way, then apply that concept to topographic maps

Leading Activity 4: Contour Modeling

1. Have the participants create a mountain with their dough – just a simple shape for the first exercise.
2. Using the dental floss, have them cut evenly-spaced slices of the mountain, starting at the top. Every time they take a slice, have them trace its shape onto a piece of paper. The slices should be “nested” as they trace them.



3. Explain that the even spacing between slices is the ***contour interval***, and the traced outlines are the ***contours***. Show how each contour traces all points of equal elevation.



4. Have them label their contour map (the traced slices) “mountain”.
5. Now have the participants make another mountain, this time with a stream channel running

down one or more sides.

6. Repeat the slicing and tracing on another sheet of paper. Label this contour map “streams”.
7. Have participants discuss the shape of these contours – how can you tell where the stream is on the contour map? What shape does it make? Does this shape point uphill or downhill?
8. If time allows, have participants make other terrain shapes – a pond, a cliff, or multiple little hills. Discuss the results.
9. As a group, compare what you’ve learned about the way contour maps of hills and stream channels look with the topographic map of your area. What terrain features can you now identify? How might you use this to help you find your way? Focus especially on stream channels as a way to identify what is “uphill” and what is “downhill” when reading topographic maps.

Activity 5 (Mobile Connect required): Identifying contours in the field - Materials and Preparation

1. This is an outdoor activity.
2. You will need mobile devices loaded Topo Maps USA, and the topographic map for your current area downloaded on each device (see materials and preparation: Activity 2).

Leading Activity 5: Identifying contours in the field

1. Have participants open the Topo Maps USA app and then open the downloaded topographic map for your current location.
2. Click the navigation arrow icon to locate yourself on the map.
3. Take note of the contour lines around where you are currently standing, remembering what you learned about contours in activity 3. Scan the horizon - can you see any hills or other terrain features around you? Locate them on the map and help participants connect the shape of the contours on the map with what you see in front of you. Leaders - Be sure to spend some time with this part of the activity. If you need to, lead your group to a location for a better view of the local terrain – even a window from a high building can help as you point out terrain features and look at them on the map.
4. Create a new GPS track by going to the Map icon (at the bottom of the screen) and "Start Recording a Trail" (at the bottom of the screen). Have participants try to walk along a contour (unless you are in a very hilly area, you won't be able to connect). See if you can follow between two contour lines without crossing them. Be sure to click Stop when you are finished. Leaders - Be sure to set limits on how long participants should walk along a contour, where/when to regroup, and to follow common safety rules (Heads up!)
5. Discussion questions: What did you notice about trying to follow a contour? Was your walk perfectly flat? If not, why do you think this is the case? (hint: look at the contour interval for your map – are all changes in elevation going to be recorded?)
    a. This might be a good time to review how GNSS works, since this technology is the foundation for location and route navigation. Most smartphones, for example, have a recreational-grade GNSS receiver. The associated error with a recreation grade GNSS receiver is higher than a 'mappging grade' or 'survey grade' GNSS receiver. You may also want to explain that GNSS Signals can bounce off of trees, large boulders, mountainsides, buildings. All of these can introduce error. You can supplement this exercise with the "Introduction to GNSS" PowerPoint presentation (available through the VAView Website (http://www.virginiaview.net) that shows how GNSS works, and some associated applications.

Lesson 3: Coordinates

Key Concepts:

- Types of Coordinate systems represented on USGS topos
- How to find coordinates for a point on a map
- How to plot points based on given coordinates

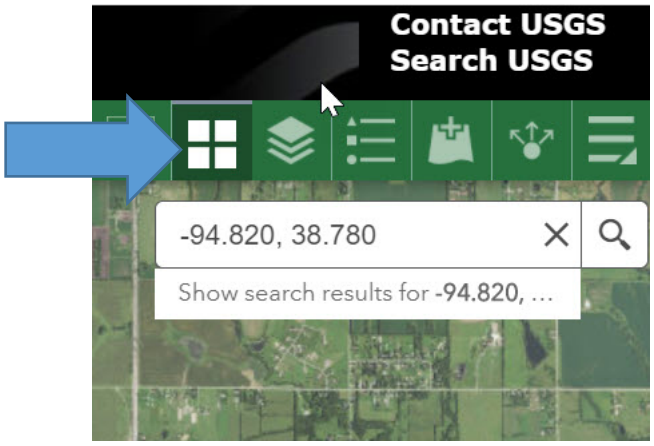
Activities:

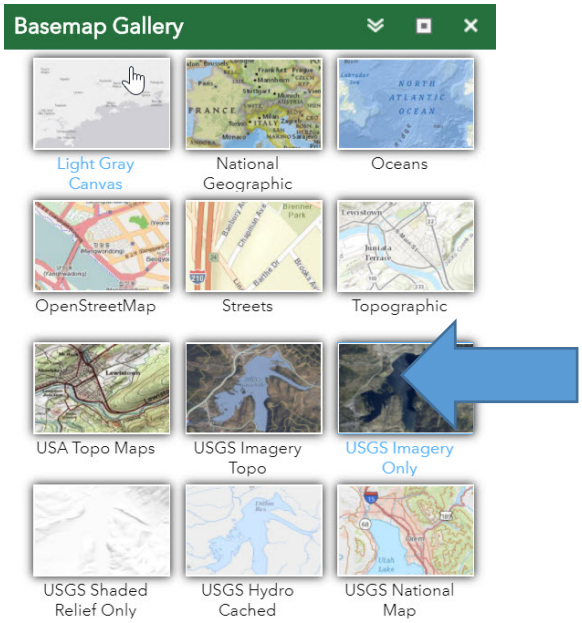
- Activity 6: Exploring the Public Land Survey System
- Activity 7 Coordinate scavenger hunt
- Activity 8 (Mobile connect option): Setting Waypoints and finding coordinates

Activity 6: Exploring the Public Land Survey System

For this activity, participants will require access to the USGS National Map Viewer (https://viewer.nationalmap.gov/advanced-viewer), They will require access to the Internet, and will need a Chromebook, laptop, or table of some kind. You may need to walk them through the National Map Viewer as a group, to demonstrate the different basemap options, and other basic functions.

Additional data layers can be turned on to continue our exploration of the PLSS and the National Map Viewer. Navigate to the icons at the top of the viewer and select the *Basemap* icon (refer to the left image below) to open the Basemap Gallery window. There are 12 different basemaps to choose from.





Activity 7: Coordinate Scavenger Hunt - Materials & Preparation

1. This is an indoor/covered area activity
2. Each group or pair of participants will need:
    a. Paper topographic map of your region
    b. Ruler, yard stick, or long straight edge
    c. Pencil and eraser
    d. Coordinate scavenger hunt worksheet (below)
3. As the leader, you will need to prepare a coordinate scavenger hunt worksheet ***prior to starting*** this activity. A template you can fill out is included. Be sure to fill out two copies – one with all columns filled out (this will be your key), and another with either location name or coordinates left blank for the participants to fill in.
4. If you are not sure how to read coordinates prior to starting this activity, refer to the participants guide introduction information in Lesson 3.

Leader Key: Coordinate scavenger hunt

Leaders:

1. Identify 6-8 locations on the topographic map you will be using for Activity 3 (if you are using a variety of maps, prepare a separate hide and seek worksheet for each one). Write the name of the locations in the first column of the table below. Choose locations that are easily distinguishable from other features (i.e., have a name printed on the map, or a noteable terrain or development feature)
2. For the first two features (A and B), record the latitude and longitude, in the second and third columns. If you are unsure of how to do this or read any of the following coordinate pairs, refer to the instructions in Activity 5.
3. For features C and D, record the coordinate pair using UTM coordinates – Easting and Northing, in meters.
4. For features E and F, record the coordinate pair using state plane coordinates (usually in feet).
5. For features G and H, if working with a map that uses township, range, section (typically western states), record that information in the first column.

Location name or feature name		
A.	Long:	Lat:
B.	Long:	Lat:
C.	E:	N:
D.	E:	N:
E.	X:	Y:
F.	X:	Y:
G.	TRS:	
H.	TRS:	

6. The above table is your answer key for your specific map. Record the location names or coordinates in the worksheet on the next page. For each row (line), leave either the name of the feature or both of the coordinate columns blank. Have participants fill in the missing information. An example is included for the first two lines. If you are not using Township, Range, Section on your map, cross out those lines. Copy the worksheet for your participants.

Coordinate scavenger hunt

Participants: Fill in the missing information.

Location name or feature name	X Coordinate	Y Coordinate
Example 1: Round lake	*Long: _____ (have participants fill in)*	*Lat: _____*
Example 2: _____ (have participants fill in)	*Long: -116^{0}30'14"*	*Lat: 48^{0}15'34"*
A.	Long:	Lat:
B.	Long:	Lat:
C.	E:	N:
D.	E:	N:
E.	X:	Y:
F.	X:	Y:
G.	TRS:	
H.	TRS:	

Leading Activity 7: Coordinate scavenger hunt

Have your group answer the following questions for the topographic map of your region. Help them search the map margins to make sense of the coordinate tick marks and grids for your particular map.

i. What coordinate systems are represented on your map?

ii. How is each coordinate system symbolized?

iii. How are the units of measurement abbreviated?

iv. Which coordinate system do you think would be easiest to use to communicate specific locations when you are in the field? Why?

2. Have the participants fill out the missing information in the coordinate hide-and-seek worksheet and check answers against your key.

Activity 8 (Mobile Connect required): Setting waypoints and finding coordinates - Materials& Preparation

1. This is an indoor or outdoor activity.
2. You will need mobile devices loaded with the Topo Maps USA maps and your topographic map as outlined in Activity 2.

Leading Activity 8: Setting waypoints and finding coordinates

1. Leaders: For this activity, have the participants add 3 to 5 points of interest as waypoints/placemarks, using the directions and screen shots in the participant's guide.
2. Leaders: Give your group 3 coordinate pairs of items that fall within your map boundary. Have the participants enter the coordinates and give the name of the landmark or feature at each coordinate pair.
    a. Feature name: _____ coordinates: _____
    b. Feature name: _____ coordinates: _____
    c. Feature name: _____ coordinates: _____

3. To discuss: What are the benefits of using an app like Avenza to find and give coordinates? What are the limitations, when comparing to use of a standard paper topo map?

Lesson 4: Compass

Key Concepts:

- Parts of a compass
- How a compass works
- Adjusting for declination
- Taking a bearing in the field and plotting it on a map
- Taking a bearing from a map and following it in the field

Activities:

- Activity 9: Using a compass and taking and giving bearings
- Activity 10: (Mobile connect option): Magnetic declination app

Activity 9: Using a compass - Materials & Preparation

1. Compasses: you will need a compass for each participant or pair. Compasses with mirrors or sights and adjustable declination are best, but simple baseplate compasses can also be used.
2. You will need a Topographic map of your area for each participant or pair.
3. If you are unfamiliar with using a compass, review and practice the information in the Introduction section of Lesson 4 of the participant's guide.

Leading Activity 9: Get familiar with the Compass; reading and following bearings

Prior to starting the activity: Go over each of the parts of the compass with your group. Make sure everyone knows the direction of travel arrow, the orienting arrow, the magnetic needle, and to read the red end of the needle. Also, discuss magnetic declination for your area and have the group set their compasses for the correct declination if possible.

If your group's compasses do not have adjustable declination: use a small piece of electrical tape on the back of the compass, setting it to the declination for your area. When taking or following a **field** bearing, simply use this tape arrow instead of the orienting arrow.

1. Orient the map. Using the topographic map of your area and a compass, have the group orient the map. All the maps in the group should be angled the same way and pointing the same direction when they are finished.
2. Taking a bearing on the map: give your group two points of interest on the map (from "here" to "there"): Point 1: _____ Point 2: _____ Have them find the bearing if traveling from 1 to 2: _____. Be sure to cover that the magnetic arrow and orienting arrow are not used when working with the map.
3. Following a bearing on a map: Point 1: _____ Bearing given: _____
4. Taking a bearing in the field (practice several times with different points of interest): Point 1: _____ Point 2: _____ Point 3: _____

5. Following a bearing in the field: Have everyone in the group attempt to follow the same bearing. Once they have themselves oriented in the proper direction, practice following the line of travel as a group. Discuss strategies for getting around obstacles, or getting back on the track of the proper bearing when needing to re-route due to a large obstacle or boundary. Bearing given: _____ Starting point: _____

Activity 10: Looking at Magnetic Declination - Materials & Preparation

- This is a short indoor or outdoor activity
- Requires an internet connection and mobile devices or computers

Leading Activity 8: Looking at Magnetic declination

Have the participants direct the browsers of their device or computer to http://maps.ngdc.noaa.gov/viewers/historical_declination/ by searching for "NOAA declination viewer"

Allow the participants 5-10 minutes to play around with the settings on this map viewer, and discuss what you see. Explain that the line of **zero declination** is the line where magnetic north and geographic north are the same.

Part 5: Navigation

Key Concepts:

- Putting it all together: reading map contours, map information, and coordinate pairs to reach hidden points in the field.

Activities:

- Activity 11: Mini orienteering course

Activity 11: Mini Orienteering Course - Materials & Preparation

You will need:

- Flagging or other means of marking points in the field, permanent marker
- Topographic map of the area you will use – a smaller, photocopied section of the area you'll be using often works well and allows you to make notes for the course.
- Compasses and topographic maps for each pair or participants
- Worksheet for each pair of participants to fill out (see following for creating your own worksheet)
- A suitable area for practicing orienteering – preferably an area with noteable terrain features on the map and a combination of wooded and open areas. However, even an area as simple as a soccer field could be used for basic practice.
- (Mobile connect option): Make the first two checkpoints mobile-ok: using Avenza (or other) app, notice location on the map and in the field to help navigate. Make a map note in Avenza when control point is located (control might have a secret code or pattern to log).

Setting up Activity 11:

To create an example exercise like the one on the following page:

1. Find and mark control points in the field with flags or flagging, writing numbers on the flags and a letter that will form a "secret" word when all the flags are found. Be sure to account for the fitness level, outdoor readiness, and map reading abilities of your group when setting out points. If you can place them along a path or other linear feature, use that to your advantage.
2. As you mark the control points in the field, mark their location on your map as well.
3. After you have your points marked on the map, write the course directions so that participants have to do one of each:
    a. Sketch the location and direction of a linear feature, such as a trail, boundary or fence line on the map.
    b. Follow a given bearing from one point to another. To make this more difficult, leave the second point off the participant's map and have them sketch it in.
    c. Take a bearing in the field.
    d. Plot the location of a point given coordinates, and find it.
    e. Mobile connect (optional): set two additional points that must be found using USA TOPO Maps or similar app (AVENZA). PDF maps and a map downloaded for your area. Flag the points, and give the participants the coordinates only, but do not mark them on the map. Have participants mark these flag locations both on the paper map and in USA Topo Maps.
4. Print out copies of the map with flag locations (except the ones they must plot!) and the instructions for the course, one for each pair or group of participants.

Example Orienteering course instructions:

Entry point to Flag 1: From the entrance to the cross-country course, follow the mown path (starting by heading South at the initial bend). As you follow the path, **sketch the path's location** on your map, paying attention to the contours.

Flag 1 (at the gate): **Continue to sketch the path's location**. From Flag 1 to Flag 2, as you come into the large open area, take the path at the bottom of the hill that heads West, past the stadium area. After you pass between two (very small) knolls, you will come to Flag 2.

Flag 2 (backside of the small knolls): From Flag 2, you will follow a **bearing of _38 degress_ to find Flag 3**, about 250 feet from Flag 2.

Flag 4: From Flag 3, face the trash can at the southeast corner of the large field (just past the stadium) where Flag 4 is located. **What is the bearing from Flag 3 to Flag 4? _____**

Flag 5: To locate flag 5, navigate to $37^{O}13.7'$, $-80^{0}24.8'$. Mark this location on your map.

LETTERS: Flag 1____ 2____ 3____4_____5_____

Leading Activity 11: Mini Orienteering Course

Leader's notes:

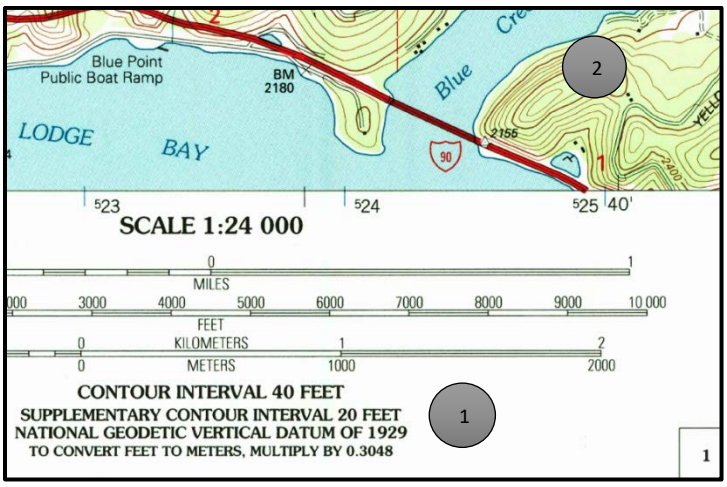
- Have participants set out in groups of two or three with maps of the area where you have set up the course, compasses, and mobile devices loaded with USA Topo Maps and the downloaded map for your area (optional).
- If you set your flags in brushy areas, be sure to alert participants about any potential hazards such as poison ivy or ticks.
- Set a meeting time and place for when the course is completed.
- You may want to stagger groups leaving every few minutes so they don't follow one another instead of truly navigating.
- Wander the course to help participants as they find their way around.

Appendix A

Appendix A: USGS topo map terms

Contour line: A contour line on a map connects all points that have the same elevation.

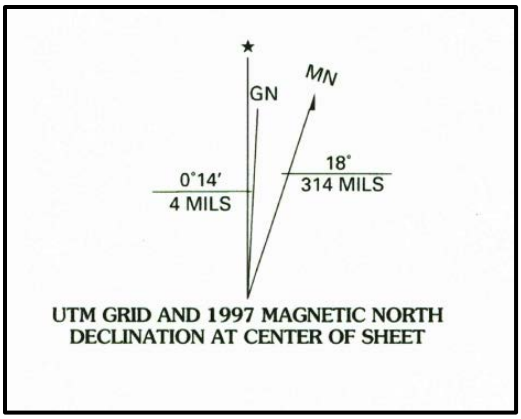
Contour interval: The contour interval is the difference in elevation between two contour lines next to each other on the map. This interval can be found on the map margin (1) and will vary depending on the terrain. In this example, there is a 40 foot elevation change between contour intervals (symbolized with brown lines), with some areas having supplementary lines showing 20 feet of elevation change (usually a dashed brown line), (2).



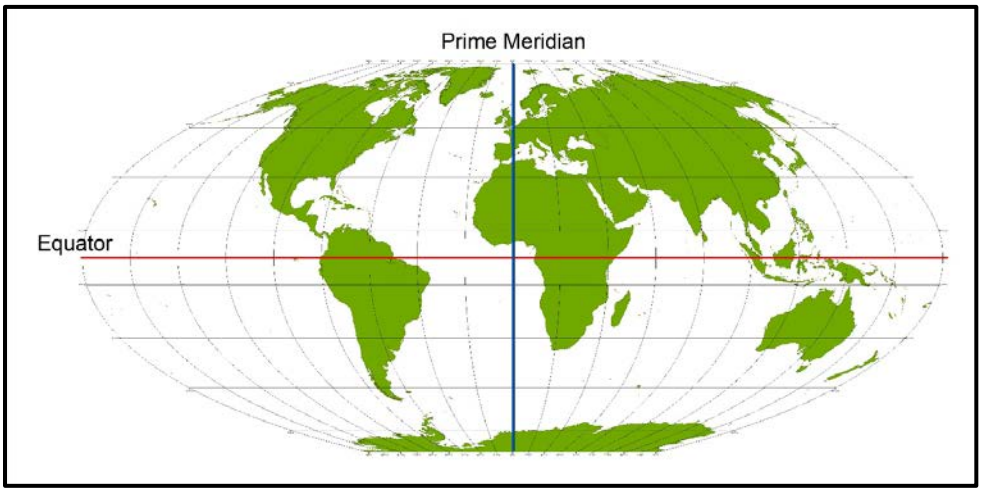
Datum: A datum is a basis of measurement for the earth's surface. This information is necessary to know when using a GPS to find coordinates. Some common datums are NAD83, WGS84, and NAD27.

Declination: There is a difference between true North (geographic North) and magnetic North. Magnetic north is the direction that the red arrow on a compass will point. Magnetic north differs from true north because of magnetic fields on the earth. Declination changes from location to location, and it also changes over time. When navigating using a compass, declination must be accounted for. USGS topographic maps will show the amount of declination for the date of map production in the map margin.

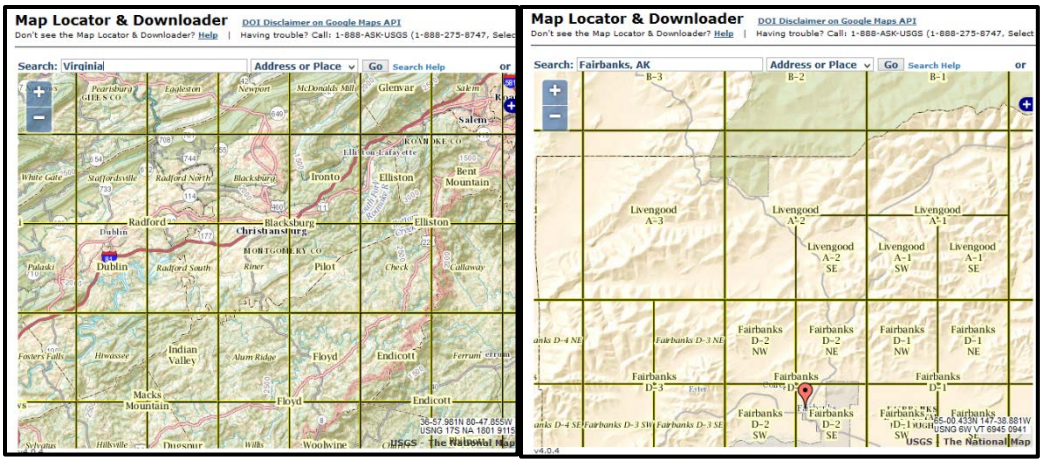
For more information on magnetic declination, including a historical map viewer and place to get up-to-date adjustments for declination, visit http://www.ngdc.noaa.gov/geomag/declination.shtml



Latitude and Longitude: A familiar coordinate system that we use to describe location. Latitude is the Y coordinate (North/South), measured as an angle from the equator; Longitude is the X coordinate (East/West), measured as an angle from the prime meridian.



Quadrangle: Standard USGS topographic maps are arranged in tiles, or quadrangles (commonly called quads). Each quad has a name. A standard topographic map covers a 7.5 minute area of latitude at a 1:24,000 scale. There are also standard topo maps that cover a 15 minute area of latitude at a 1:63,360 scale, typically in areas of Alaska.

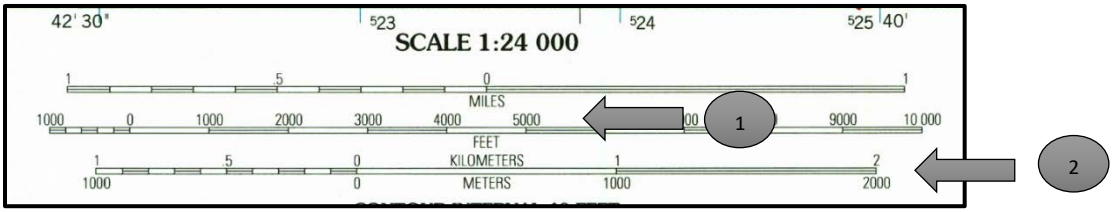


The yellow lines outline 7.5 minute quadrangle tiles (left) in Virginia and 15 minute quadrangle tiles (larger tiles, right) in Alaska. Source: USGS The National Map.

Public Land Survey System: This is a system of land surveying used in the Western United States. Areas were divided into Sections, Ranges, and Townships when initially surveyed, and this system is still occasionally used today to share the location of a parcel of land. Section numbers are typically printed in Red on the map, with Township or Range information shown along margins or red lines.

Scale: There are two types of scale on a standard USGS topographic map: Fractional scale and Bar scale. Scale is the ratio of distance measured on a map to the distance of the same area measured on the ground (in "real life"), using the same units.

A fractional scale (1) is expressed as a ratio (such as 1:24,000): which means that for every 1 inch we measure on the map, that same area is 24,000 inches on the ground (or "in real life"). A bar scale (2) helps us compare measurements on the map to measurements in the real world, but using different units– for example, showing that 1 inch on the map is equal to one mile of real world measurement. A bar scale can be useful for taking quick measurements from a map and converting to ground units.



USGS: United States Geological Service, an agency of the Department of the Interior. Publishes standardized topographic maps for the United States.

UTM Zone: UTM stands for Universal Transverse Mercator, which is a type of projection (mathematically making the round earth "fit" into two dimensions) and also a coordinate system (giving us position information). UTM is built as a series of zones along the earth's surface, so it may be important to know your current UTM zone when using a GPS or finding coordinates.

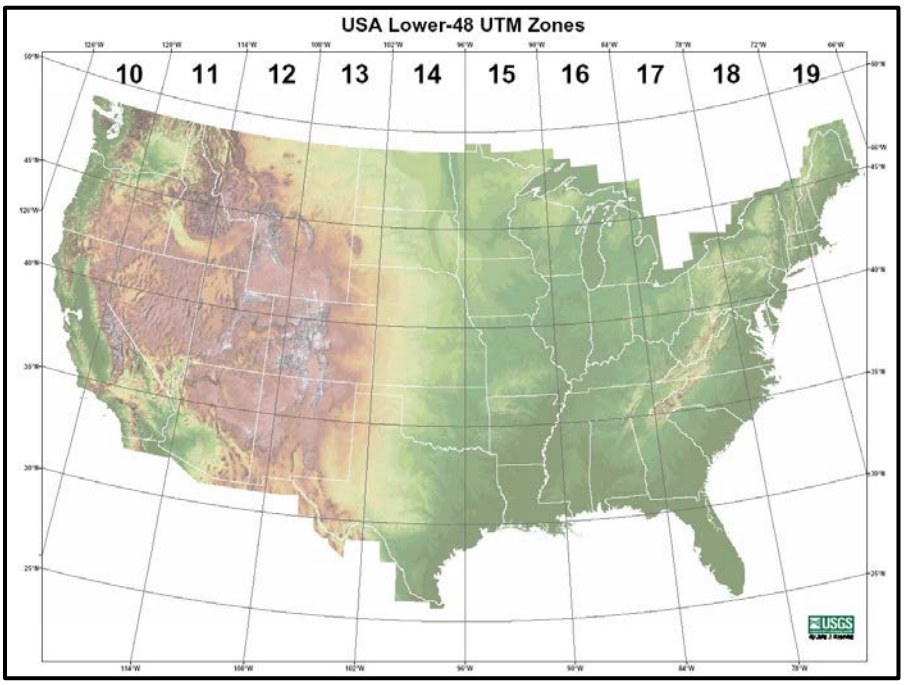
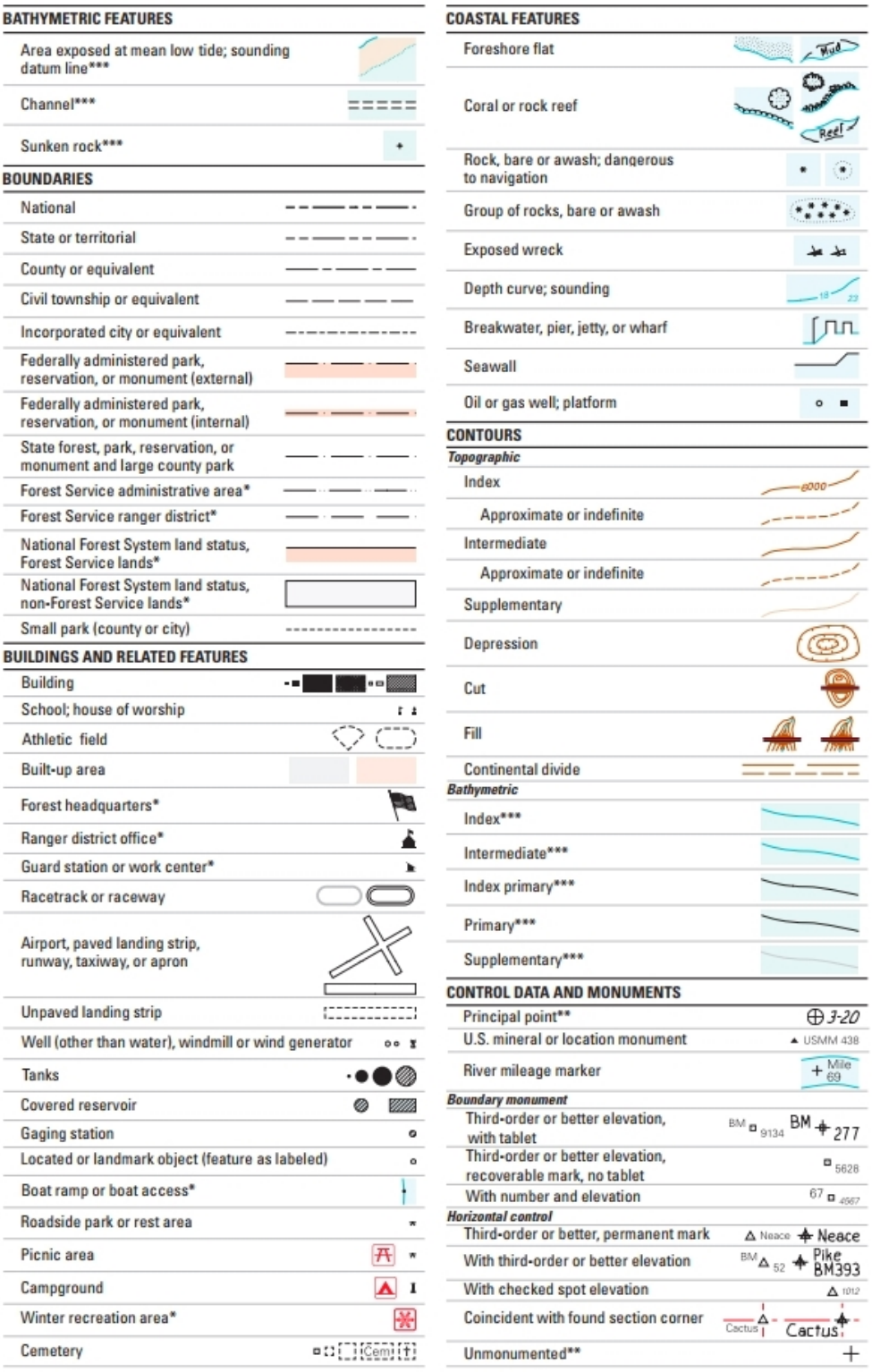


Image retrieved from http://www.nps.gov/gis/gps/UTM_Zones_USA48.jpg

UTM coordinates: When using the UTM coordinate system, coordinate pairs are given in meters as an Easting (distance in meters from the origin point for that zone) and a Northing. UTM coordinate pairs are commonly used by the military as well as surveyors. Knowing ground coordinates in meters (rather than degrees of latitude and longitude) makes land measurements and navigation simpler.

Appendix B



BATHYMETRIC FEATURES

- Area exposed at mean low tide; sounding datum line***
- Channel***
- Sunken rock***

BOUNDARIES

- National
- State or territorial
- County or equivalent
- Civil township or equivalent
- Incorporated city or equivalent
- Federally administered park, reservation, or monument (external)
- Federally administered park, reservation, or monument (internal)
- State forest, park, reservation, or monument and large county park
- Forest Service administrative area*
- Forest Service ranger district*
- National Forest System land status, Forest Service lands*
- National Forest System land status, non-Forest Service lands*
- Small park (county or city)

BUILDINGS AND RELATED FEATURES

- Building
- School; house of worship
- Athletic field
- Built-up area
- Forest headquarters*
- Ranger district office*
- Guard station or work center*
- Racetrack or raceway
- Airport, paved landing strip, runway, taxiway, or apron
- Unpaved landing strip
- Well (other than water), windmill or wind generator
- Tanks
- Covered reservoir
- Gaging station
- Located or landmark object (feature as labeled)
- Boat ramp or boat access*
- Roadside park or rest area
- Picnic area
- Campground
- Winter recreation area*
- Cemetery

COASTAL FEATURES

- Foreshore flat
- Coral or rock reef
- Rock, bare or awash; dangerous to navigation
- Group of rocks, bare or awash
- Exposed wreck
- Depth curve; sounding
- Breakwater, pier, jetty, or wharf
- Seawall
- Oil or gas well; platform

CONTOURS

Topographic

- Index
- Approximate or indefinite
- Intermediate
- Approximate or indefinite
- Supplementary
- Depression
- Cut
- Fill
- Continental divide

Bathymetric

- Index***
- Intermediate***
- Index primary***
- Primary***
- Supplementary***

CONTROL DATA AND MONUMENTS

- Principal point**
- U.S. mineral or location monument
- River mileage marker

Boundary monument

- Third-order or better elevation, with tablet
- Third-order or better elevation, recoverable mark, no tablet
- With number and elevation

Horizontal control

- Third-order or better, permanent mark
- With third-order or better elevation
- With checked spot elevation
- Coincident with found section corner
- Unmonumented**

Additional Resources for Leaders

Boga, Steven. *Orienteering: The Sport of Navigating with Map & Compass*. Mechanicsburg, PA: Stackpole Books, 1997.

A great resource for students interested in the sport of orienteering and also has an entire chapter on short games and activities to enhance map and terrain reading skills. These would make nice supplemental activities to the ones in this guide.

Cox, Steven M. and Kris Fulsaas. *Mountaineering: The Freedom of the Hills, 7th edition*. Seattle, WA: The Mountaineers Books, 2007.

Has a detailed chapter on map reading and compass use. While geared towards climbing and mountaineering, it also contains useful background information on backcountry navigation and safety.

Kjellstrom, Bjorn and Carina Knellstrom Elgin. *Be Expert with Map and Compass.* Hoboken, NJ: John Wiley and Sons, Inc., 2009.

A classic in-depth guide on map and compass use. A great reference and resource for leading these exercises.