CHAPTER 13

PO 322 – PLOT LOCATION ON A TOPOGRAPHICAL MAP USING A GLOBAL POSITIONING SYSTEM RECEIVER

ROYAL CANADIAN ARMY CADETS

SILVER STAR

INSTRUCTIONAL GUIDE

SECTION 1

EO M322.01 – REVIEW RED STAR NAVIGATION

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-703/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

PRE-LESSON ASSIGNMENT

Mark off 100 m for pacing.

APPROACH

An interactive lecture was chosen for this lesson to review the basic and background material covered during Red Star navigation.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have reviewed Red Star navigation, to include:

- describing bearings;
- identifying compass parts;
- setting declination;
- determining distance on a map;
- determining individual pace;
- orienting a map using a compass; and
- taking a magnetic bearing using a compass.

IMPORTANCE

It is important for cadets to participate in a review of Red Star navigation as it is a foundation for building subsequent navigation skills. The review will clarify any areas in question, providing an opportunity for cadets to work on their skills and retard progressive skill decay. Red Star navigation is an important aspect of expedition training and before learning new skills, the skills already taught should be reviewed. All cadets should take every opportunity to practice and refine these skills.

Teaching Point 1	**Conduct a Review of Red Star Navigation**
Time: 25 min	Method: Interactive Lecture

Briefly review Red Star navigation without spending too much time on any one point.

POINTS OF THE COMPASS ROSE

Four Cardinal Points. Measured at right angles clockwise, they are:

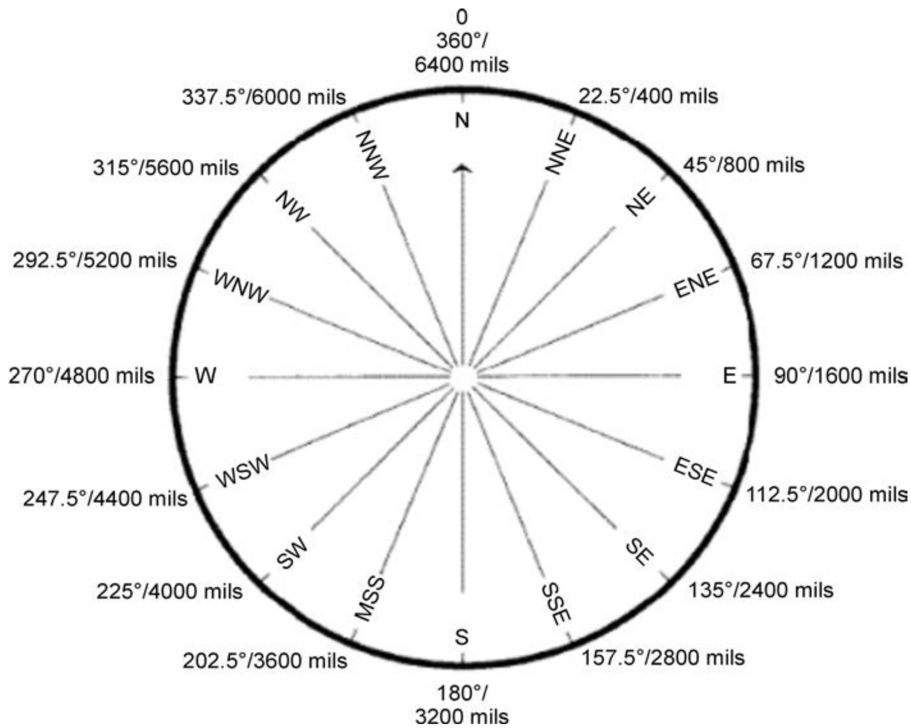
1. north (N),
2. east (E),
3. south (S), and
4. west (W).

Four Inter-Cardinal Points. Located halfway between each of the cardinal points. Measured clockwise, they are:

1. northeast (NE),
2. southeast (SE),
3. southwest (SW), and
4. northwest (NW).

Eight Intermediate Points. Located halfway between each cardinal point and inter-cardinal point. Measured clockwise, they are:

1. north-northeast (NNE),
2. east-northeast (ENE),
3. east-southeast (ESE),
4. south-southeast (SSE),
5. south-southwest (SSW),
6. west-southwest (WSW),
7. west-northwest (WNW), and
8. north-northwest (NNW).



Director Cadets 3, 2007, Ottawa, ON: Department of National Defence

Figure 13-1-1 Compass Rose

SCALES ON A COMPASS

To express direction in an accurate and precise method, the full circle of the compass rose is divided into equal measures of angle. This measurement starts and ends at north (top) and always moves in a clockwise rotation. There are two main scales used to measure a circle – degrees and metric milli-radian (mils).

Degrees. The most common method of dividing a circle. There are 360 equal angles in a complete circle and they are represented by the degree symbol (eg, 360°). On the compass rose, north is located at 0 and 360 degrees, east is located at 90 degrees, south is located at 180 degrees and west is located at 270 degrees.

Mils. When a more accurate division of the same circle is required, the mils method is used. The mils method has a military background and is based on the metric system with 6400 equal angles in a complete circle. On the compass rose, north is located at 0 and 6400 mils, east is located at 1600 mils, south is located at 3200 mils and west is located at 4800 mils.

> There are 22.5 degrees or 400 mils between each point on a compass rose.

DEFINITION OF A BEARING

Bearing. An angle that is measured clockwise, from a fixed zero line; north is always this zero line. Simply, a bearing is just another name for an angle.

TYPES OF BEARINGS

Bearings are divided into three different types:

Grid Bearing. A bearing that is measured between two points on a map. The ability to measure a bearing from a map allows a map user to plan routes or activities before going into the field, and provides an easy method of communicating location or movement.

Magnetic Bearing. A bearing that is measured between two points using a compass. A magnetic bearing is a quick and efficient method of describing a route to take. The bearing alone is usually not enough information to navigate with and must also have distance or a target object.

Back Bearing. A bearing that is in the exact opposite direction of the bearing that has been measured. A back bearing can be useful for different reasons; to return to the start location after a hike, or to calculate the bearing from an object to one's current location. Depending on the compass being used, the steps to calculate a back bearing are:

1. When the bearing is less than 3200 mils or 180 degrees, add 3200 mils or 180 degrees.
2. When the bearing is greater than 3200 mils or 180 degrees, subtract 3200 mils or 180 degrees.

COMPASS PARTS

Refer to Figure 13-1-2 or an actual compass to identify the parts of a compass with the cadets.

A - Sight. Located at the top of the compass cover, used to align an objective or bearing.

B - Compass Cover. Protects the compass dial and houses the sighting mirror.

C - Sighting Mirror. Used to see the compass dial while setting a bearing.

D - Sighting Line. Used when aligning the objective or bearing.

E - Luminous Index Point. Located at the top of the compass dial and is where a bearing is set and read from.

F - Compass Dial. Houses the magnetic needle, the orienting arrow and the declination scale on the inside and the dial graduations on the outside.

G - Dial Graduations. The compass dial is graduated in 50 mil divisions from 0 to 6400 mils, or two degree divisions from 0 to 360 degrees. The dial is rotated by hand.

H - Orienting Arrow. The red orienting arrow is located inside the compass dial and is used to line up the magnetic needle. The orienting arrow is always set at 00 mils/degrees.

I - Romer 1 : 25 000. Used to measure a grid reference (GR) on a map with a 1 : 25 000 scale.

J - Compass Base Plate. Clear piece of flat plastic, to which the cover, dial and lanyard are attached.

K - Declination Scale. Used to compensate for the variation of magnetic declination between the compass and the map being used.

L - Compass Meridian Lines. Black or red lines inside the compass dial and are used to line up the compass dial with the grid lines on a map.

M - Magnetic Needle. Spins freely and points to magnetic north. The south end of the compass needle is black and the north end, with a luminous patch, is red. When the magnetic needle is lined up with the red orienting arrows, the mnemonic "Red in the Bed" is used to remember which end of the needle belongs between the arrows.

N - Luminous Orienting Points. There are two luminous orienting points located on either side of the orienting arrow.

O - Luminous Index Point. The luminous orienting point at the bottom of the compass dial, where a back bearing is read from.

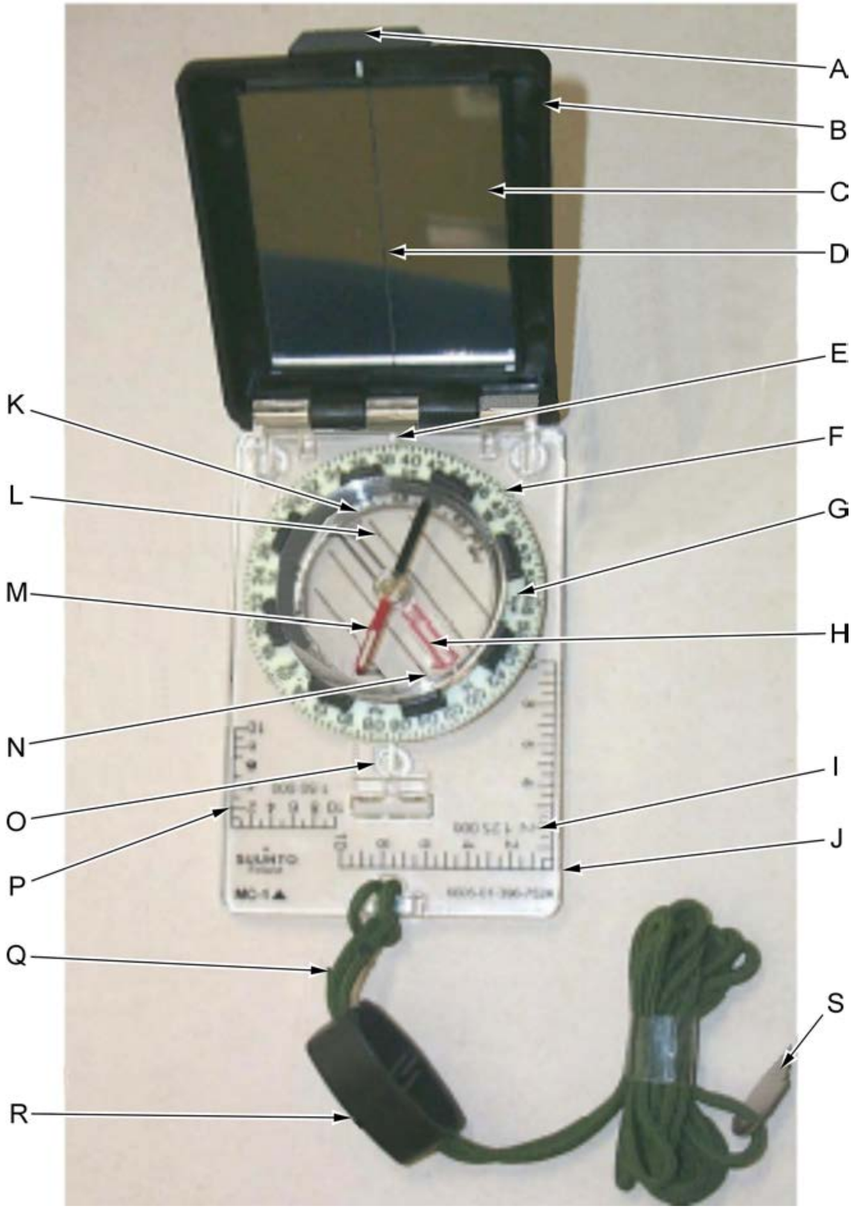
P - Romer 1 : 50 000. Used to measure a GR on a map with a 1 : 50 000 scale.

Q - Safety Cord or Lanyard. Used to fasten the compass to the body.

R - Adjustable Wrist Lock. Used to attach the compass to the wrist.

S - Screwdriver. The tiny screwdriver at the end of the safety cord is used to turn the screw to adjust the declination scale.

T - Declination Adjustment Screw. Located on the back side of the compass dial and is used to adjust the declination scale (not shown).



A-CR-CCP-121/PT-001, Royal Canadian Army Cadet Reference Book (p. 5-33)

Figure 13-1-2 Compass

SET DECLINATION ON A COMPASS

The compass's declination scale must be set to compensate for the difference between true north and magnetic north. To set declination on a compass the amount of declination adjustment in degrees east or west is needed. Turn the compass over and look at the back of the dial.

From the zero point, use the screwdriver on the end of the safety cord and turn the declination screw to the right for west and to the left for east declination. Each small black line is two degrees.

When setting declination on a compass, it is easier to hold the screwdriver and turn the compass, especially in cold weather. The declination shall never be turned past 90 degrees on the declination scale.

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Figure 13-1-3 Declination Screw

DETERMINE DISTANCE

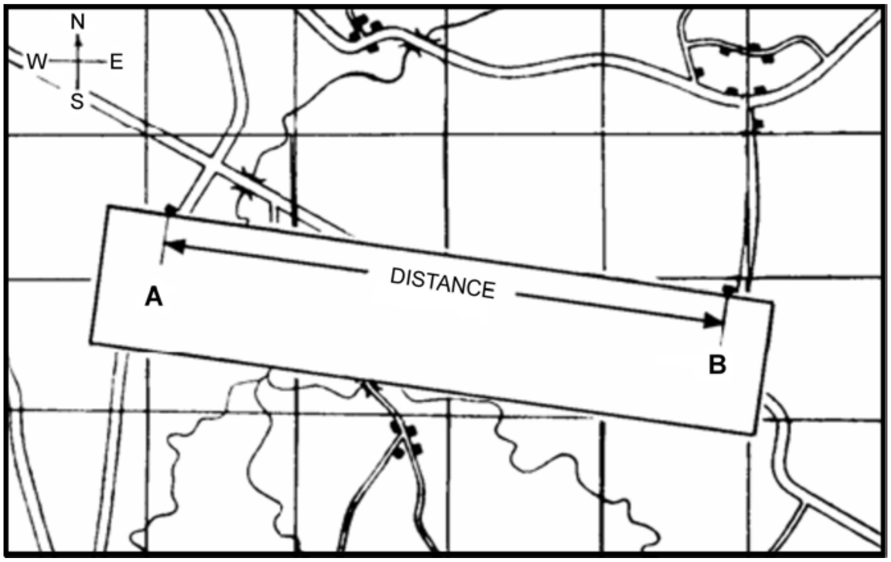
Determining Distance on a Map

Cadets can use their maps to measure the distance between two points on the ground. All maps are drawn to scale; therefore, a specified distance on a map equals a specified distance on the ground. The scale of a map is printed at the top and bottom of each map (eg, Scale 1 : 50 000). This means that 1 cm on the map equals 50 000 cm (500 m) on the ground.

There are two ways to determine distance on a topographical map – point-to-point and along a route.

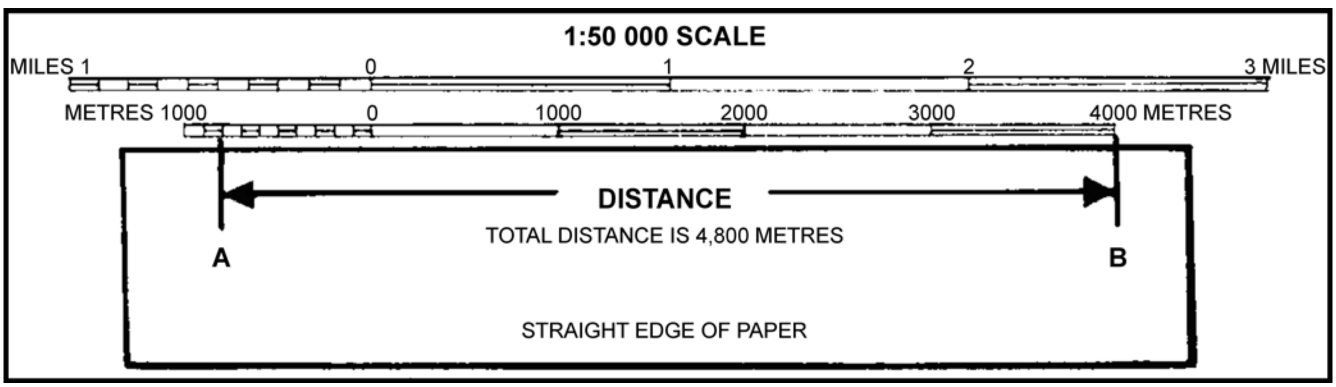
Measuring Point-to-Point. To measure a distance point-to-point:

1. Lay the straight edge of a piece of paper against the two points.
2. With a sharp pencil, mark the paper at the A (start) and B (finish) points.
3. Lay the paper just under the scale bar (metres) and move the B mark backwards to each thousands mark until the A mark falls within the subdivided thousands (hundreds) to the left of the zero.
4. To calculate the total distance, add the number of thousands where the B mark is, plus the number of subdivided thousands where the A mark is to the left of the zero.



A-CR-CCP-121/PT-001 (p. 5-24)

Figure 13-1-4 Measuring Distance Point-to-Point



A-CR-CCP-121/PT-001 (p. 5-25)

Figure 13-1-5 Calculating Distance

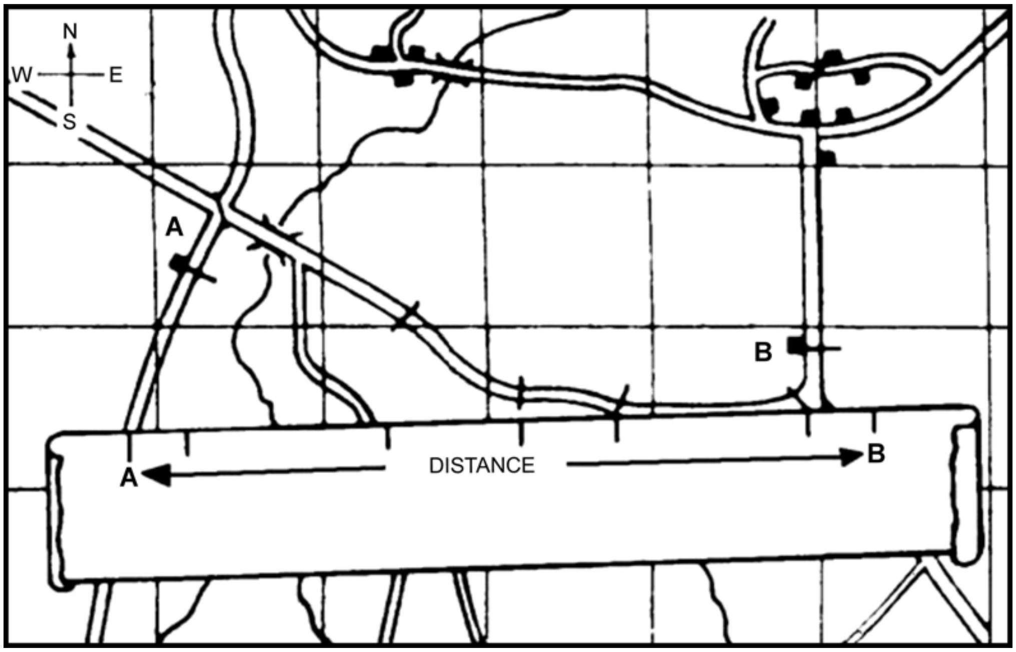
For a distance that is longer than 5 000 m, measure the first 5 000 m and mark the paper with a new line and label it ‘5 000 m’. Place the new mark at the zero or thousands mark until the A mark fits within the subdivided thousands bar. Add the total of that distance to the 5 000 m and that will be the total distance.

Measuring Along a Route. Sometimes the cadets need to find the distance between A and B around curves in a road or along a planned route. To measure a distance along a route between two points:

1. Lay the straight edge of a piece of paper against point A.
2. With a sharp pencil, mark point A on the paper and the map.
3. Line up the paper with the edge of the road until you come to a curve and make another mark on the paper and on the map.
4. Pivot the paper so that it continues to follow the road edge. Repeat until you reach point B.
5. Mark your paper and the map at point B.

6. Lay the paper just under the scale bar (metres) and move the B mark backwards to each thousands mark until the A mark falls within the subdivided thousands to the left of the zero.

7. Adding the number of thousands where the B mark is, plus the number of subdivided thousands where the A mark is to the left of the zero, will determine the total distance.



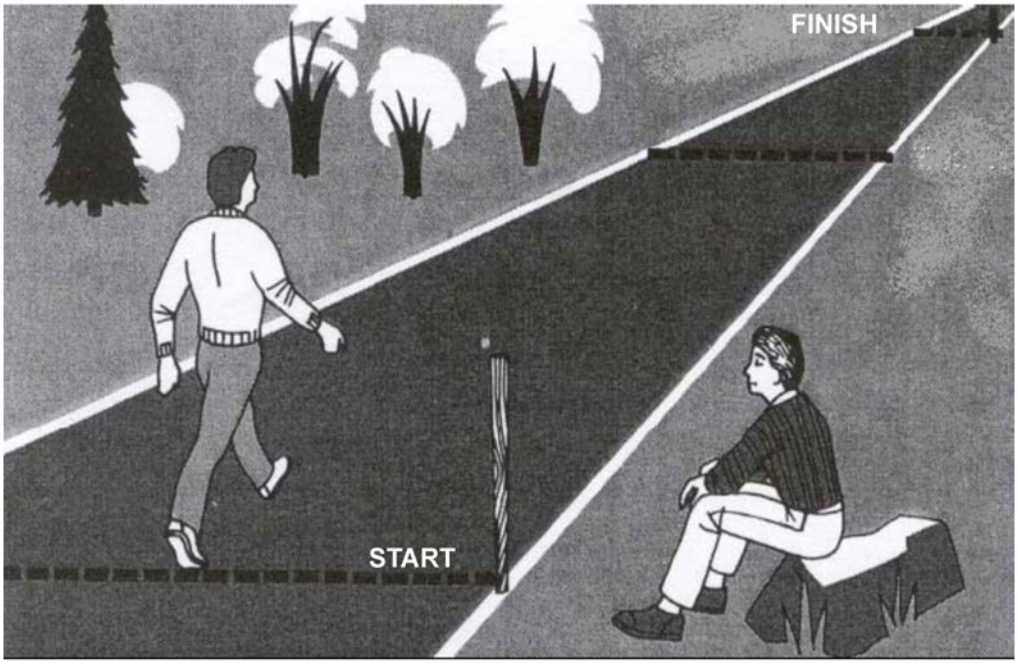
A-CR-CCP-121/PT-001 (p. 5-25)

Figure 13-1-6 Measuring Distance Along a Route

Determining Individual Pace

Pace Counting Method (Pacing). Used for measuring a given distance by counting every other step. Two steps equal one pace. Pacing is a very important skill in navigation, as each person has a different pace and needs to establish their pace before it can become a useful measurement tool. Pacing varies between individuals as it uses a natural stride – an average adult will pace about 60–70 paces in 100 m.

To determine an individual pace, practice taking uniform, comfortable steps over a measured distance (100 m) counting every second step of the dominant foot. Do this three to five times to get an average. This will be the individual's pace number and should be remembered.



B. Kjellstrom, Be Expert with Map & Compass, Hungry Minds, Inc. (p. 53)

Figure 13-1-7 Determining Distance Using Pacing

Remember, pacing is an approximation. A margin of error of 1–2 percent is considered reasonable (eg, 10–20 m for every 1 km walked).

Factors That Affect Pacing

Pacing can be affected by different factors and the count may vary. Some of the factors and the affect on individual pacing are:

- **Topography.** This is the most common factor. Walking through mud, thick bush and tall vegetation can shorten the paces.
- **Slopes.** Walking uphill will shorten paces, while walking downhill can lengthen paces.
- **Fatigue.** Pacing may change from natural in the morning, when cadets are rested, to shorter in the afternoon as they start to get tired.
- **Equipment.** Equipment could affect pacing, such as the wrong type of footwear. Too much or too little clothing and the amount of equipment being carried can shorten the paces.
- **Weather.** Heavy rain, wind velocity, temperature and snow can shorten the paces.

Pacing beads can be used to keep track of the distance walked. One bead is moved for every 100 m walked. If pacing beads are not available, stones can be used by moving them from one pocket to another to count every 100 m.

ORIENT A MAP USING A COMPASS

To orient a map using a compass:

1. set the current declination on the compass;

2. set the compass dial to read 00 (zero) mils or 0 degrees (north);
3. lay the compass flat on the map with the cover open;
4. point the mirror to north (top of the map);
5. align one side of the base plate with an easting line; and
6. turn the map and compass together until the red end of the magnetic needle is over the orienting arrow.

> The mnemonic used to remember putting the magnetic needle over the orienting arrow is "Red in the Bed".

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Figure 13-1-8 Set Declination

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Figure 13-1-9 Set Compass to 00

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Figure 13-1-10 Turn Until Red is in the Bed

TAKE A MAGNETIC BEARING

A compass can be used to identify the cardinal points such as north and south, the direction of travel and the bearing from one's current location to a prominent object. However, the ability to take a magnetic bearing of a prominent object and to use that information to help identifying one's general location can save hours when trekking. A magnetic bearing is a quick method for determining the direction of travel.

There are two ways to determine a magnetic bearing.

To determine the magnetic bearing of a prominent object:

1. Check and set the predetermined declination on the compass.
2. Hold the compass at eye level, at arms length, and face the prominent object.

3. Aim at the object using the compass sight, ensuring the sighting line is in line with the index pointer.
4. Adjust the compass cover so the compass dial is seen in the sighting mirror.
5. Look in the mirror and turn the compass dial until the magnetic needle is over the orienting arrow (red in the bed).
6. Read the number on the compass dial at the luminous index pointer. The magnetic bearing of the prominent object is read at the luminous index pointer.

A-CR-CCP-121/PT-001 (p. 5-42)

Figure 13-1-11 Taking a Magnetic Bearing

To determine a magnetic bearing on a map:

1. Set the predetermined declination on the compass.
2. Identify and mark the start (point A) and finish (point B) points on a map.
3. Draw a plotting line from point A to point B.
4. Lay the fully opened compass with the edge of the compass base plate along the plotting ray, in the direction of travel (point A to point B).
5. Hold the compass in place, rotate the compass dial so that the compass meridian lines align with the easting lines on the map, ensuring north on the dial indicates north on the map.
6. Read the number on the compass dial at the luminous index pointer.

Prior to determining a magnetic bearing on a map, it is good practice to first estimate the bearing by drawing a quick compass rose and looking at where the bearing would be on the compass rose. This serves as a good check to ensure the cadet has not accidentally measured the back bearing.

If the bearing is taken from point B to point A, the compass will be pointing 180 degrees or 3200 mils in the exact opposite direction of travel wanted. This is also called a back bearing.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the review will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in the review will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Map-reading skills take a great deal of practice in order for a person to become efficient using them in the field. Throughout expeditions, cadets will always be required to navigate routes. Take each and every opportunity to practice map and compass skills, whether it is navigating a route or even riding a bike. The skills learned in Green and Red Star navigation are building blocks. There are still many more navigation skills to acquire.

INSTRUCTOR NOTES/REMARKS

Assistant instructors may be required for this lesson.

REFERENCES

A2-041 B-GL-382-005/PT-001 Canadian Forces. (2006). *Maps, Field Sketching, Compasses and the Global Positioning System*. Ottawa, ON: Department of National Defence.

C0-011 Canadian Orienteering Federation. (1985). *Orienteering Level Two Coaching Certification*. Ottawa, ON: Canadian Orienteering Federation.

C2-041 (ISBN 0-07-136110-3) Seidman, D., & Cleveland, P. (1995). *The Essential Wilderness Navigator*. Camden, ME: Ragged Mountain Press.

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ROYAL CANADIAN ARMY CADETS

SILVER STAR

INSTRUCTIONAL GUIDE

SECTION 2

EO M322.02 – CALCULATE MAGNETIC DECLINATION

Total Time:	60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-703/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Photocopy the handout located at Annex A for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP 1 to orient the cadet to calculating magnetic declination and to present basic material.

Demonstration and performance was chosen for TP 2 as it allows the instructor to explain and demonstrate calculating magnetic declination while providing an opportunity for the cadets to practice calculating magnetic declination under supervision.

An in-class activity was chosen for TP 3 as it is an interactive way to reinforce calculating magnetic declination.

INTRODUCTION

OBJECTIVES

By the end of this lesson the cadet shall have calculated magnetic declination.

IMPORTANCE

It is important for cadets to know how to calculate magnetic declination and set it on a compass as it provides the cadet with confidence that they will arrive at their destination when navigating on a bearing. Not accounting for declination may affect navigation, as the cadet may travel off route. For every one degree of error in declination setting, a person would be approximately 52 m off of for every km travelled.

Teaching Point 1	**IAW M222.02 (Describe Bearings) Review Magnetic Declination and the Three Norths**
Time: 5 min	Method: Interactive Lecture

> Magnetic declination was identified in M222.03 (Identify Compass Parts, A-CR-CCP-702/PF-001, Chapter 12, Section 3) however, it must be discussed again to support calculating magnetic declination.

Magnetic Declination

Magnetic declination is the difference between true north (map) and magnetic north (compass). It is caused by the different locations of the geographic north pole and the magnetic north pole plus any local anomalies such as iron deposits.

Map users will identify the declination in the marginal information through a declination diagram depicting the true, grid, and magnetic bearing of any line within the area of the map sheet.

Declination will change annually due to the shifting magnetic pole. There are only two lines in the northern hemisphere where magnetic and true north line up equalling declination of zero degrees. One line runs through central Canada and the other through Russia.

Grid Magnetic Angle

Grid magnetic angle is the horizontal angular difference between grid north and magnetic north. This is the number that is applied when converting from magnetic to grid bearings.

Annual Magnetic Change

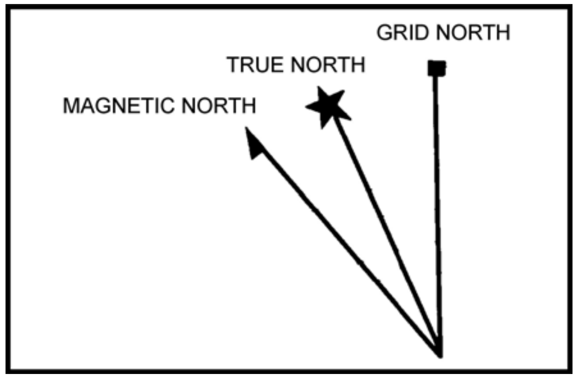
Due to the dynamic forces on the earth, magnetic north continually migrates. Subsequently an annual adjustment/calculation must be made to obtain the correct grid angle at the date of use. The amount of adjustment, to be made, is provided in the declination diagram.

This change is significant as adjustments to a compass may be required. This is known as “setting the declination.” Bearings and directions taken from the map would not be accurate if the magnetic change is not taken into account. All maps have the required information to calculate the declination and this information is found in the margin of the map.

> Review the three norths. This material was covered in M222.02 (Describe Bearings, A-CR-CCP-702/PF-001, Chapter 12, Section 2).

In navigation, there are three different norths – true north, grid north and magnetic north. Each north varies from each other and must be known for navigation. A diagram representing the three norths can be found in the margin of the map being used.

> Draw Figure 13-2-1 on a visual aid and draw the symbol for each north as it is explained to the cadets.



B-GL-382-005/PT-001, Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System (p. 51)

Figure 13-2-1 Three Norths

True North. True north is located at the top of the earth where the geographic North Pole is found. It is the point at which the earth rotates on its axis and is where all lines of longitude meet. In the diagram on the map, true north is represented by a star (Polaris).

Grid North. Grid north is the north indicated by the grid lines (eastings) on a topographical map. Eastings are lines that run parallel to each other and will never meet at the North Pole; because of this, grid north points off slightly from true north. Grid north is symbolized by a square on the declination diagram.

Magnetic North. Magnetic north is the direction in which the compass needle points. This direction is to the magnetic pole which is located in the Canadian arctic and is slightly different from true north (North Pole). Magnetic north is symbolized by an arrow or half arrow head on the declination diagram.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Explain true north.

Q2. What symbol on a declination diagram represents magnetic north?

Q3. What is annual magnetic change?

ANTICIPATED ANSWERS

A1. It is the point at which the earth rotates on its axis. The geographic north pole or true north is located at the top of the earth where the lines of longitude converge. On a map, the direction of true north is shown by the lines of longitude. True north is symbolized by a star on the declination diagram.

A2. Magnetic north is represented by an arrow.

A3. Due to the dynamic forces on the Earth magnetic north continually migrates. Subsequently an annual adjustment/calculation must be made to obtain the correct grid angle at the date of use.

Teaching Point 2 — **Demonstrate, Explain and Have the Cadet Practice Calculating Magnetic Declination**

Time: 20 min — Method: Interactive Lecture

Provide guidance to the cadets when learning to calculate magnetic declination. Use the provided steps and follow the sample calculations provided below.

CALCULATE THE MAGNETIC DECLINATION

Locate the Declination Diagram and Information

Calculating current declination uses the information provided by the declination diagram on a map and the information printed directly underneath. This diagram is most often found, on the right side of the map in the marginal information.

Calculate Declination

To calculate declination use the angle between magnetic north and grid north – ignoring true north. This is because bearings taken from a map use grid north as their point of reference. The annual change noted under the diagram will be either "increasing" (the declination is getting larger), or "decreasing" (getting smaller). The total annual change will then be added or subtracted from the declination printed on the map, to get the current declination.

The degree system of bearings shares some structure and terminology with units of time. There are:

- 360 degrees in a circle, written as **360°**,
- 60 minutes in a degree, written as **60'**, and
- 60 seconds in a minute, written as **60"**.

It is common to divide degrees into minutes, instead of seconds (eg, 1.5' instead of 1'30").

The steps to calculate magnetic declination are:

Step 1. Identify how long it has been since the map information was current by:

1. **Identifying the Current Year**. This is the actual current calendar year.

2. **Identifying Year of Declination Information**. This date is found under the declination diagram defined as the "approximate mean declination".

3. **Recording the Difference in Years**. Subtract the approximate mean declination year from the current year.

Step 2. Determine how much declination has changed since the map was current by:

4. **Multiplying the Difference in Years by the Annual Change**. Take the difference in years and multiply it by the annual change.

Step 3. Update the map declination with the amount of change calculated by:

5. **Determining if the Annual Change is Increasing or Decreasing**. The annual change found under the declination diagram also indicates whether the annual change is increasing or decreasing in degrees and minutes.

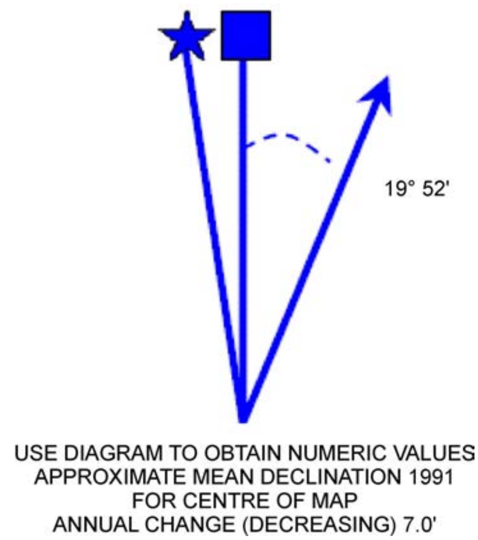
6. **Adding or Subtracting the Annual Change from the Original Declination**. The original declination is found on the declination diagram. It is the numbers represented in minutes and degrees between grid north and magnetic north. Were the change is increasing add to the map declination, if the change is decreasing subtract from the map declination.

Step 4. Set the current declination on the compass by:

7. **Determining if Declination is East or West**. This determines what direction the declination must be set on a compass. East or west is determined by looking at the declination diagram and identifying true north and magnetic north. The side magnetic north falls on represents east or west declination. Right side is east, left side is west.

8. **Setting the Calculated Declination on a Compass**. On the back side of the compass there is a declination adjusting screw, adjust the declination adjusting screw to the calculated declination east or west.

The zero declination line (agonic line) runs west of Hudson Bay, near Churchill, Manitoba. Therefore, maps east of here can assume a declination to the west and maps west will assume a declination to the east.



Department of National Defence, Instructional Guide (IG) DP1–Cadet Instructors Cadre (CIC) Environmental Performance Requirements–Land, Department of National Defence (p. 84)

Figure 13-2-2 Declination Diagram Sample

When the declination is recorded in writing, it is written in degrees and minutes. Degrees is represented by a number followed by a small circular symbol (eg, 19°) The same is true for minutes as the number is followed by an apostrophe (eg, 52').

Example With East Declination (Figure 13-2-2). The declination as of 1991 is 19° 52' East and the annual change is decreasing 7.0'. The magnetic declination is calculated as:

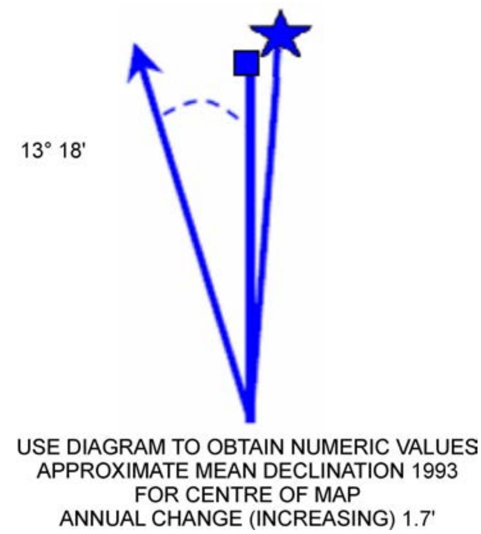
Current year:	2010
Year of declination information:	- 1991
Difference in years:	19
Difference in years:	19
Annual change:	x 7.0'
Total change:	133' or 2°13'

The total change is converted from 133' minutes to 2°13' because there are 60' in a degree.

Annual change is decreasing so it is subtracted from the original declination:

Original declination:	E 19° 52'
Total change:	- 2° 13'
Current declination:	E 17° 39'

This tells us that the magnetic needle on a compass will point to the east of grid north by 17 degrees and 39 minutes, for the area depicted on this map in 2010.



Department of National Defence, Instructional Guide (IG) DP1–Cadet Instructors Cadre (CIC) Environmental Performance Requirements–Land, Department of National Defence (p. 84)

Figure 13-2-3 Declination Diagram Sample

Convert to degrees and minutes when there are 60' (minutes) or more.

Example With West Declination (Figure 13-2-3). The declination as of 1993 is 13° 18' West and the annual change increasing 1.7'. The magnetic declination is calculated as:

Current year:	2010
Year of declination information:	- 1993
Difference in years:	17

Difference in years:	17
Annual change:	x 1.7'
Total change:	28.9'

Annual change is increasing so it is added to the original declination:

Original declination:	W 13° 18'	
Total change:	+ 28.9'	
Current declination:	W 13° 46.9'	(rounded to 47)

Round minutes up or down as required during calculations. (eg, at or over 0.5 minutes round up, under 0.5 minutes round down).

This tells us that the magnetic needle on a compass will point to the west of grid north by 13 degrees and 47 minutes, for the area depicted by this map in 2010.

It is possible to have a very small original declination and a larger total annual change, so that when calculated the current declination actually changed from what was originally a West declination to an East declination, or vice versa.

When subtracting, there are times when the equation cannot be completed without borrowing from the next figure in the line.

13° 12'
- 45'

To complete this equation, one degree (sixty minutes) must be borrowed from 13° to allow subtraction from 12'. When borrowing a degree (1° equals 60') reduce the degree portion by one and add 60' to the minute numbers.

12° 72'
- 45'
= 12° 27'

The equation can now be completed as seen above.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. Where is the declination diagram found on a topographical map?

Q2. How many minutes are in a degree?

Q3. When the annual change is decreasing what difference will this make to your calculations?

ANTICIPATED ANSWERS

A1. The declination diagram is located on the right side of the map in the marginal information.

A2. There are 60 minutes.

A3. When the annual change is decreasing it is subtracted from the original declination.

Teaching Point 3 **Have the Cadet Calculate Magnetic Declination Using East and West Declination Examples**

Time: 30 min Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadets practice calculating magnetic declination.

RESOURCES

Declination problem worksheet located at Annex A.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Distribute a worksheet to each cadet.
2. Have the cadets individually complete as many problems on the worksheet as possible in 20 minutes.
3. Correct the declination worksheet with the cadets using the answer key located at Annex B.
4. Answer questions, and calculate declination on a visual aid to clarify questions.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the in-class activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' calculation of magnetic declination will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

Cadets are encouraged to complete or retry any problems that they have experienced trouble with.

METHOD OF EVALUATION

This EO will be assessed IAW A-CR-CCP-703/PG-001, Chapter 3, Annex B, Appendix 5 (322 PC).

CLOSING STATEMENT

Knowing how to calculate magnetic declination adds to basic map and compass skills and will allow cadets to plan route marches and navigate confidently during field training exercises. Calculating magnetic declination builds on the essential navigation skills required of a cadet in the expedition stream.

INSTRUCTOR NOTES/REMARKS

Cadets may use a calculator for calculating declination.

REFERENCES

A2-041 B-GL-382-005/PT-001 Canadian Forces. (2006). *Maps, Field Sketching, Compasses and the Global Positioning System*. Ottawa, ON: Department of National Defence.

ROYAL CANADIAN ARMY CADETS

SILVER STAR

INSTRUCTIONAL GUIDE

SECTION 3

EO M322.03 – IDENTIFY COMPONENTS OF THE GLOBAL POSITIONING SYSTEM (GPS)

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-703/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to orient the cadets to the components of the GPS and to present background material.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have identified the components of the GPS.

IMPORTANCE

It is important for cadets to be able to identify the components of the GPS so they have the background knowledge and information required to effectively operate a GPS receiver when navigating.

Teaching Point 1 | **Discuss the GPS**

Time: 10 min | Method: Interactive Lecture

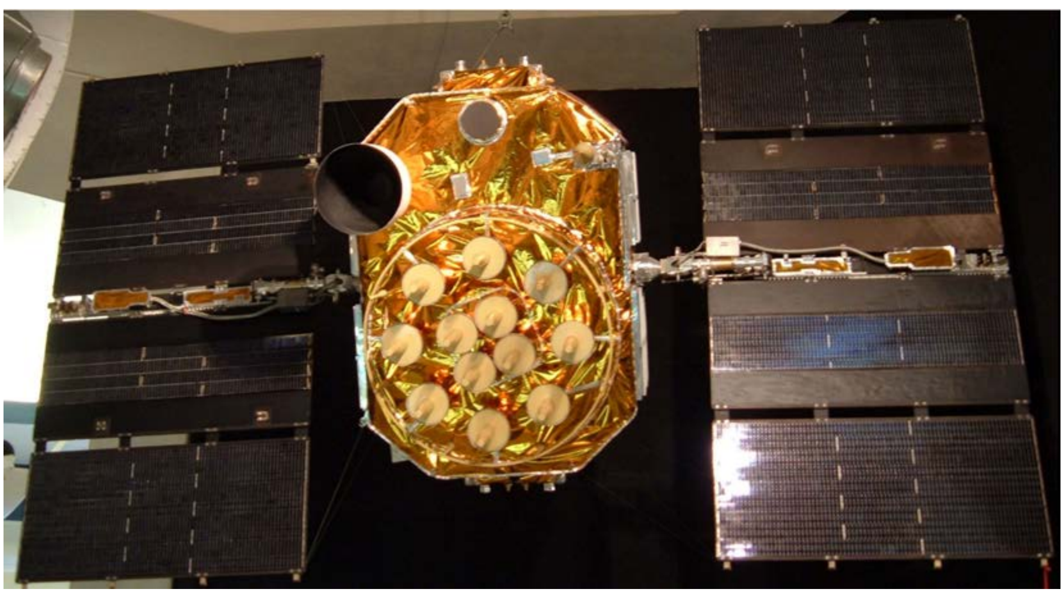
Determine the level of understanding cadets have of the GPS by carrying out a short discussion.

It is expected that most cadets will assume the GPS is the unit a person looks at to determine position. Prior to moving to TP 2 ensure cadets understand that the GPS is a constellation of satellites and is comprised of many components.

WHAT THE GPS IS

Global Navigation Satellite System (GNSS) is the generic term for satellite navigation systems that provide autonomous geo-spatial positioning with global coverage. The Global Positioning System (GPS) is a constellation of satellites, ground stations and receivers created, owned and operated by the United States. This system is used to navigate and enables anyone with a GPS receiver to know where they are 24 hours a day in any kind of weather.

The GPS is a group of 21 satellites (and three spares) that orbits the Earth and sends radio signals from their positions above the Earth back to Earth's surface. A GPS receiver is an electronic device that detects the radio signals from the satellites and calculates the receiver's position on the Earth. It is capable of giving location, speed, time and altitude.



"Wikipedia", Global Positioning System Satellite. Retrieved March 27, 2008, from http://en.wikipedia.org/wiki/Image:Global_Positioning_System_satellite.jpg

Figure 13-3-1 GPS Satellite

The United States GPS is not the only satellite navigation system currently deployed in space. Other nations that have begun or have established a similar satellite navigation system are:

- European Union – GALILEO Satellite System,
- Russian – GLONASS System, and

- Chinese – Beidou System.

HOW THE GPS WORKS

The system is divided into three parts or segments: space, ground control and users. The space segment consists of 24 satellites that orbit 20 200 km above the Earth and send radio signals toward Earth. The radio signals broadcast the position of each satellite in the sky with an electronic code.

Each satellite performs a relatively simple primary task: it transmits a timing signal using its built-in atomic clock. When a device on the ground receives that signal, it can determine its distance from the satellite.

That single measurement alone does not accomplish much, but when a GPS receiver collects timing signals from three different satellites the receiver can determine two precise coordinates: latitude and longitude. With four satellite signals, the GPS receiver is able to determine altitude as well.

A GPS receiver is also capable of determining more than latitude, longitude, and altitude. It can also determine other variables such as speed and heading.

COMPONENTS OF THE GPS

Satellites

The GPS and its satellites have the following characteristics:

- The minimum number of satellites that are required to cover the entire Earth is 18, however the number of satellites in orbit fluctuates between 24 and 29 satellites due to spares and upgrading.
- Satellites orbit in a semi-synchronous orbit (orbits are coordinated, but not identical).
- Each satellite completes an orbit every 12 hours.
- Satellites orbit the Earth at 20 200 km (12 552 miles) (airplanes routinely fly at 11–13 km [37 000–43 000 feet], the shuttle orbits at 370 km [230 miles]).
- Each satellite has three key pieces of hardware:
  - **Computer.** Controls its flight and order functions.
  - **Atomic Clock.** Keeps accurate time within three nanoseconds (approximately three-billionths of a second).
  - **Radio Transmitter.** Sends signals to Earth.

Ground Stations

The ground control segment of the GPS is comprised of five ground stations that track the satellites, monitor their condition and make any necessary adjustments to keep the system accurate. The entire system functions and is monitored by the US Department of Defence. Information from the stations are sent to a master control station – the Consolidated Space Operations Centre (CSOC) at Schriever Air Force Base in Colorado where the data is processed and adjustments are made. The five ground stations are in Hawaii, Colorado, Diego Garcia, Ascension Island and Kwajalein.

Receivers

GPS receivers make up the user segment. It is the GPS receiver, whether it is in an airplane, a truck, a boat or in a hiker's hand, that detects the radio signals from the satellites and calculates the receiver's position.

When a receiver is turned on, it interprets the radio signals and extracts the satellite location information. The GPS signal broadcasts information that tells the receiver the location of each satellite in the system. The receiver then interprets the radio signal to determine the exact time. This is required to calculate position.

The orbits of the GPS satellites ensure that there will be a minimum of four satellites covering any spot on the globe at all times. The receiver uses the signal from one satellite to continuously monitor and be synchronized with the time maintained by the other satellites. The receiver collects the signals from the other satellites and calculates the difference between them. This calculation positions the receiver from each satellite and triangulates its location. Based on a four satellite fix, the receiver will identify location giving the user latitude, longitude and altitude (altitude is only possible with a four satellite fix).

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What does GPS stand for?

Q2. What are ground stations responsible for?

Q3. How does a receiver calculate your position?

ANTICIPATED ANSWERS

A1. GPS stands for Global Positioning System.

A2. Ground stations are responsible for tracking the satellites, monitoring their condition and making any necessary adjustments to keep the system accurate.

A3. The receiver uses the signal from one satellite to continuously monitor and be synchronized with the time maintained by the satellites. The receiver collects the signals from the other satellites and calculates the difference between them. This calculation positions the receiver from each satellite and triangulates its location. This location gives the user latitude, longitude and altitude.

Teaching Point 2	**Explain GPS Terminology**
Time: 5 min	Method: Interactive Lecture

As cadets are introduced to and continue to use GPS receivers they may encounter the following terms. Explain the terms to the cadets and give examples where possible.

GPS. Global Positioning System, a constellation of 21 satellites (and three spares) used to determine location, speed, time and altitude.

Three-Dimensional (3D) Coordinate. Requires a four satellite signal lock, giving a position as determined by latitude, longitude, and altitude.

Assisted GPS (A-GPS). GPS with assistance from cellular technology. Found mostly in new GPS-equipped phones. A-GPS relies on cellular networks to help do some of the tracking because GPS signals will not penetrate indoors.

Differential GPS (DGPS). A stationary receiver working in conjunction with the satellites to correct errors in the timing signals, resulting in a more precise measurement of location.

Latitude. Imaginary parallel horizontal lines encircling the Earth, measuring 90 degrees north and 90 degrees south from the equator. The line at the equator represents zero degrees of latitude.

Longitude. Imaginary vertical lines running from the North Pole to the South Pole. The prime meridian (zero degrees longitude) runs through Greenwich, England, and serves as the reference line from which longitude is measured. Latitude and longitude create a grid covering the planet from which one can extrapolate coordinates.

Triangulation. What GPS receivers do to determine position based on data received from three or more GPS satellites.

Wide Area Augmentation Service (WAAS). Improves GPS accuracy and availability. WAAS was designed with aviation in mind as it improves a GPS receiver's accuracy to within three metres.

Waypoint. An intermediate position between the starting and destination points along a navigational route. If one makes three stops along the route to the final destination, the GPS receiver will consider each one of these stops a waypoint.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What is a 3D coordinate?

Q2. What is triangulation?

Q3. What is a waypoint?

ANTICIPATED ANSWERS

A1. A 3D coordinate is one's position as determined by latitude, longitude, and altitude.

A2. Triangulation is what a GPS receiver does to determine position based on data received from three or more GPS satellites.

A3. A waypoint is an intermediate position between the starting and destination points along a navigational route.

Teaching Point 3	**Discuss GPS Receivers and the Information They Provide**
Time: 10 min	Method: Interactive Lecture

The GPS receiver is a piece of equipment that processes the signals sent from satellites. The information the receiver calculates from the signals can be used in many ways.

ACCURACY

The accuracy of a GPS receiver depends on the number of satellites from which signals are being recieved, and the use of augmentation systems. A GPS receiver without WAAS measures to an accuracy of 5 m (16.4 feet) 95 percent of the time, and with WAAS to an accuracy of 3 m (9.8 feet).

> WAAS is most often found on GPS receivers for aircraft. Landing safely in fog is difficult without an accurate location of the runway.

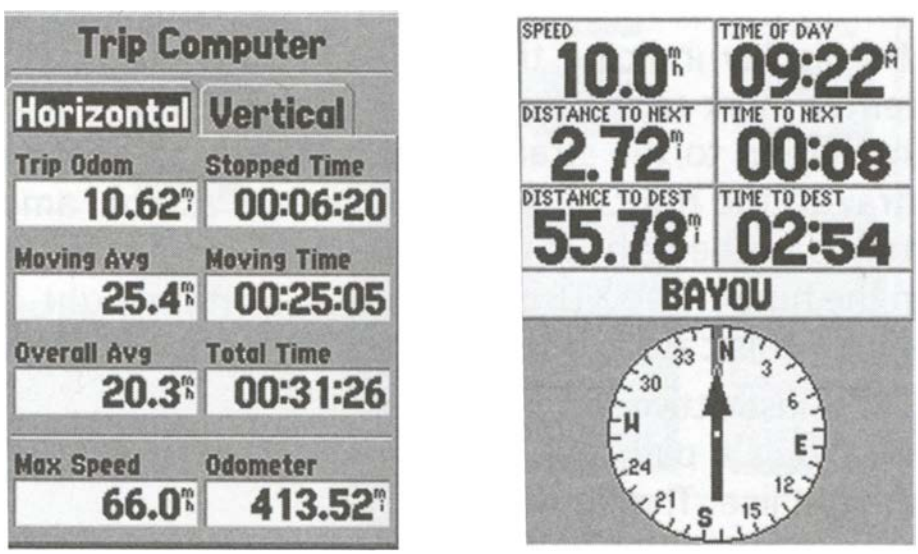
TIME

A GPS receiver receives time information from atomic clocks, so it is more accurate than a wristwatch. Receivers report a variety of times as navigation statistics, to include:

- **Estimated Time of Arrival (ETA).** The ETA is the time of day one will arrive at the destination (eg, 1230 hrs).
- **Estimated Time Enroute (ETE).** ETE tells how much longer one must travel before arriving at the destination and is measured in minutes or hours.

ETA and ETE are only useful when travelling in a straight line like in a boat or on a plane. However if a route is planned with waypoints to guide the route, the ETA and ETE timings will be accurate to follow.

- **Trip Time.** Also known as elapsed time, the trip timer measures time from the last time it was reset. This can be used to calculate average speed because it continues counting time regardless if a person is moving or not.
- **Time Moving.** The amount of time that speed is not zero. When you come to a stop, the timer stops counting. The time moving is used to calculate the average moving speed.
- **Time Not Moving.** The time not moving timer counts only when you are standing still. It represents the time you sit motionless. If the times on the time moving and the time not moving timers are added together, they should equal the trip timer.
- **Time of the Day.** All receivers provide the time of the day. The GPS satellites keep what is known as GPS time.



L. Letham, GPS Made Easy (4th ed.), The Mountaineers (p. 54–55)

Figure 13-3-2 Time Screens

LOCATION

GPS provides location in three dimensions:

- latitude (X-coordinate),
- longitude (Y-coordinate), and

- altitude.

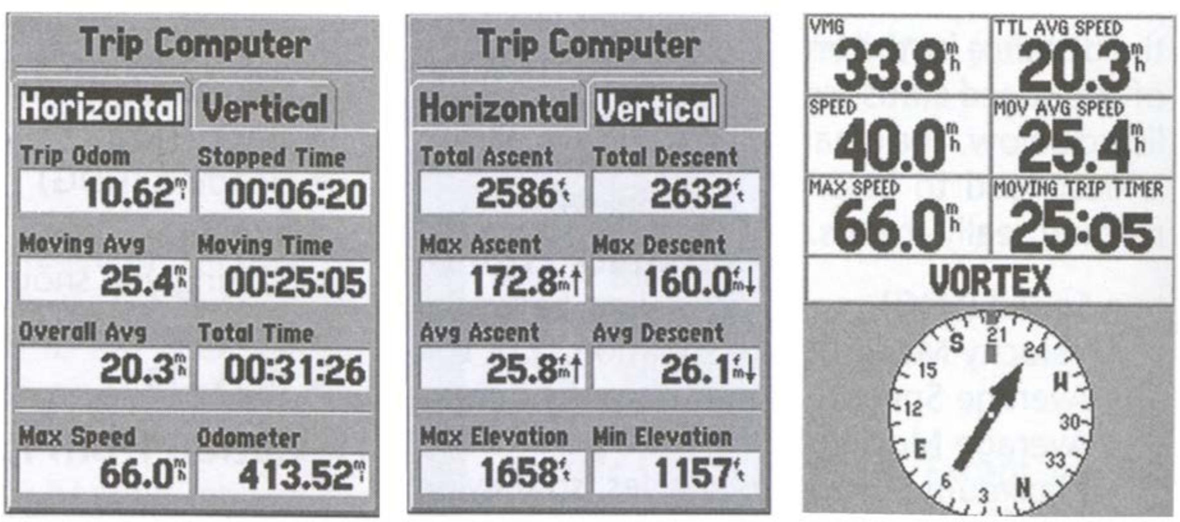
The location can be displayed in a number of coordinate systems (eg, latitude/longitude, Universal Transverse Mercator [UTM]).

The altitude calculation of a consumer GPS receiver is not very accurate (+/- 15 m [49.2 feet]).

SPEED

A receiver measures the time and distance between the point where a person is and the point where the person was a short time ago, then divides the distance by the time it takes to travel there (speed = distance/time). Some of the speed statistics are:

- **Speed Over Ground (SOG).** The SOG (also known as ground speed) is just like the speed displayed by the speedometer in a car. It measures how fast you are going at that moment. Speed does not take into consideration if you are on course. It is a measurement of speed regardless of direction.
- **Velocity Made Good (VMG).** The speed at which the destination is approached. VMG takes into account the present course and destination.
- **Average Speed.** Divides the distance by the amount of time it took to travel that distance.
- **Average Moving Speed.** The average speed excluding the time the receiver stands still.
- **Maximum Speed.** The fastest speed travelled during the trip.
- **Vertical Speed.** The instantaneous speed measured for up and down movements only.
- **Average Ascent and Descent.** Much like average speed, the average ascent and descent is the distance of vertical movement divided by the amount of time to make the movement. It is the average rate of change in altitude.
- **Maximum Ascent and Descent.** The maximum rate of a vertical change in position.



L. Letham, GPS Made Easy (4th ed.), The Mountaineers (p. 54–55)

Figure 13-3-3 Speed Screens

DIRECTION OF TRAVEL

A GPS receiver can display the direction of travel if the receiver is moving. If the unit is stationary, it can not use satellite signals to determine which direction a person is facing.

Some GPS units have a electronic compass that shows the direction the receiver is pointed, whether moving or standing still. All directions calculated by a receiver can be expressed as a bearing or in degrees.

STORED LOCATION

Locations can be stored in the GPS receiver. It can store where a person has been and where a person wants to go. These location positions are waypoints. A GPS receiver can provide a person with directions and information on how to get to a waypoint.

CUMULATIVE DATA

A GPS receiver can keep track of information such as the route travelled, total distance travelled, average speed, minimum speed, elapsed time, and time to arrival at a specific location.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. What is the accuracy of a GPS receiver without WAAS?

Q2. What three dimensions will a GPS receiver report location in?

Q3. How does a GPS receiver calculate speed?

ANTICIPATED ANSWERS

A1. A GPS receiver without WAAS measures to an accuracy of 5 m, 95 percent of the time.

A2. A GPS receiver provides location in the following three dimensions:

- latitude (X-coordinate),
- longitude (Y-coordinate), and
- altitude.

A3. A GPS receiver measures the time and distance between the point where a person is and the point where the person was a short time ago then divides the distance by the time it takes to travel there (speed = distance/time).

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What is the GPS?

Q2. What is triangulation?

Q3. What is a waypoint?

ANTICIPATED ANSWERS

A1. The GPS is a constellation of 24 satellites orbiting the Earth, receivers and ground stations. They are used to determine location, speed and time.

A2. Triangulation is what GPS receivers do to determine their position based on data received from three or more GPS satellites.

A3. A waypoint is an intermediate position between the starting and destination points along a navigational route. If one makes three stops along the route to the final destination, the GPS receiver will consider each one of these stops a waypoint.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

GPS training will introduce cadets to a new tool to use while navigating. The GPS is a technological advancement that is continuously evolving to present new ways and methods of navigating. As these advances become available for the Cadet Program, cadets will be challenged to learn and apply them while navigating.

INSTRUCTOR NOTES/REMARKS

It is recommended that this EO be instructed outside.

REFERENCES

C2-142 (ISBN 0-7645-6933-3) McNamara, J. (2004). *GPS for Dummies*. Hoboken, NJ: Wiley Publishing, Inc.

C2-143 (ISBN 1-58923-145-7) Featherstone, S. (2004). *Outdoor Guide to Using Your GPS*. Chanhassen, MN: Creative Publishing International, Inc.

C2-144 (ISBN 0-07-223171-8) Broida, R. (2004). *How to Do Everything With Your GPS*. Emerville, CA: McGraw-Hill.

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ROYAL CANADIAN ARMY CADETS

SILVER STAR

INSTRUCTIONAL GUIDE

SECTION 4

EO M322.04 – IDENTIFY FEATURES OF A GLOBAL POSITIONING SYSTEM (GPS) RECEIVER

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-703/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Ensure GPS receivers are available and ready to use (eg, batteries charged).

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP 1 to orient the cadets to components of a GPS receiver and to present background material.

Demonstration and performance was chosen for TP 2 as it allows the instructor to explain and demonstrate how to scroll through the different screen pages of a GPS receiver while providing an opportunity for the cadets to practice under supervision.

INTRODUCTION

REVIEW

Choose three to five of the questions provided to review the material covered in EO M322.03 (Identify Components of the Global Positioning System [GPS], Section 3). If additional review is required to confirm understanding, continue with questions. Be mindful of the time remaining to complete this lesson.

QUESTIONS

Q1. What does the acronym GPS stand for?

Q2. What are ground stations responsible for?

Q3. How does a receiver calculate your position?

Q4. What is a 3D coordinate?

Q5. What is triangulation?

Q6. What is a waypoint?

Q7. What is the accuracy of a GPS receiver without WAAS?

Q8. What three dimensions will a GPS receiver provide location in?

Q9. How does a GPS receiver calculate speed?

ANTICIPATED ANSWERS

A1. GPS stands for Global Positioning System.

A2. Ground stations are responsible for tracking the satellites, monitoring their condition and making any necessary adjustments to keep the system accurate.

A3. The receiver uses the signal from one satellite to continuously monitor, and be synchronized with, the time maintained by the satellites. The receiver collects signals from the other satellites and calculates the difference between them. This calculation positions the receiver from each satellite and triangulates its location. This location gives the user latitude, longitude and altitude.

A4. A 3D coordinate is one's position as determined by latitude, longitude, and altitude.

A5. Triangulation is what a GPS receiver does to determine position based on data received from three or more GPS satellites.

A6. A waypoint is an intermediate position(s) between the starting and destination points along a navigational route.

A7. A GPS receiver without WAAS measures to an accuracy of 5 m, 95 percent of the time.

A8. A GPS receiver provides location in the following three dimensions:

- latitude (X coordinate),
- longitude (Y coordinate), and
- altitude.

A9. To calculate speed a GPS receiver measures the time and distance between the point where a person was and the point where the person is and then divides the distance by the time to get to that speed (speed = distance/time).

OBJECTIVES

By the end of this lesson the cadet shall have identified features of a GPS receiver.

IMPORTANCE

It is important for cadets to know the features of a GPS receiver because GPS receivers will be used during expeditions for navigation and planning. The GPS is a navigational aid that will be used regularly.

Teaching Point 1	**Identify and Briefly Describe Components of a GPS Receiver**
Time: 10 min	Method: Interactive Lecture

Distribute GPS receivers. If there is not a receiver for each cadet, divide the cadets into groups so they may share.

Allow cadets to practice locating the information and pages being discussed.

The two terms “Point of Interest” and “Waypoints” mean the same thing – an intermediate position on a navigation map. In this lesson, the term “Point of Interest” will be used.

COMPONENTS OF A GPS RECEIVER

Antenna. Allows the GPS receiver to receive satellite signals.

Screen. Displays information.

Some GPS receivers use an arrow joystick that acts as a mouse, providing a simple to use interface with the GPS receiver.

Battery Compartment. Stores the receiver power supply.

The buttons in the following list are found on the Magellan eXplorist 200 GPS receiver. Other makes and models of GPS receivers may have different function buttons. Consult user manual for GPS receiver button functions.

BUTTONS

On/Off. Turns the receiver on and off.

Backlight. Turns the display backlight on and off and changes intensity.

Enter. Used to access highlighted menu items or highlighted page menu options.

Escape. Cancels, data inputs. Closes the accessed function and goes back to the previous screen and moves backward through the navigation screens.

Zoom In. Used on the map screen to zoom in on the map displayed. The map display can be zoomed in to 35 m (100 feet). Also used to move through the list of waypoints when using an alphabetical search.

Zoom Out. Used on the map screen to zoom out on the map displayed. The map display can be zoomed out to 2736 km (1700 miles). Also used to move through the list of waypoints when using an alphabetical search.

Menu. Displays a menu with available options. Options may be selected by using the arrow joystick to highlight the option and pressing “enter” to access it.

NAV. Moves through the navigation screens (Map screen, Compass screen, Position screen, Satellite screen).

Mark. Used to save present position as a waypoint. Waypoints are saved and stored in “My Points of Interest”.

GOTO. Creates a one-leg route from the present position to a destination selected from the POI database or by using the cursor on the background map and pressing GOTO on a point.

Arrow Joystick. Moves the cursor on the map screen. It also moves the highlighted bar to select menu options and data-entry fields.

Thales Navigation, Inc. Magellan eXplorist 200 Reference Manual, Thales Nav, Inc. (p. 1)

Figure 13-4-1 eXplorist 200 GPS Receiver

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Name three components of a GPS receiver.

Q2. What is the purpose of the NAV button on the GPS receiver?

Q3. What is the GOTO button used for on the GPS receiver?

ANTICIPATED ANSWERS

A1. Three components of a GPS receiver may be any of the following:

- antenna,
- screen,
- battery compartment, and
- buttons, to include:
  - on/off,
  - backlight,
  - enter,
  - escape,
  - zoom in,
  - zoom out,
  - menu,
  - NAV,
  - mark,
  - GOTO, and
  - arrow joystick.

A2. The NAV button moves through the navigation screens (Map screen, Compass screen, Position screen, Satellite screen).

A3. The GOTO button creates a one-leg route from the present position to a destination selected from the POI database or by using the cursor on the background map.

Teaching Point 2	**Explain and Have the Cadets Scroll Through the Screen Pages on a GPS Receiver**
Time: 15 min	Method: Demonstration and Performance

GPS receivers may differ in the way they present information, from unit to unit. Identify the screens that are similar to those contained in this TP, and have the cadets practice finding the different pages and the information they display.

Allow the cadets time to become familiar with the GPS receiver and its functions.

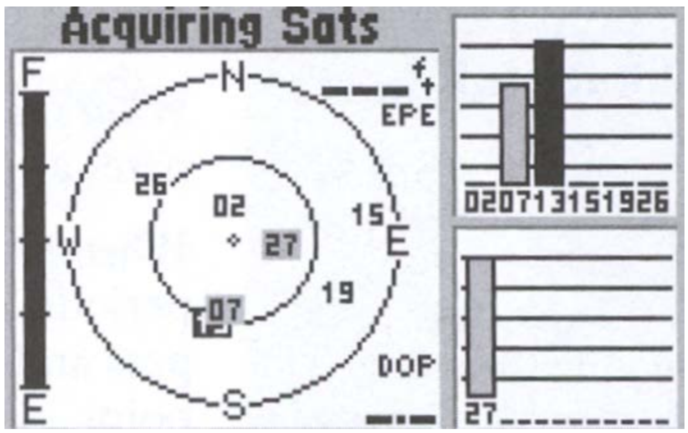
Note: The term “Page” refers to the different screens an operator can scroll through to locate different information in a GPS receiver.

SATELLITE STATUS

The satellite status screen displays the acquisition of satellites (satellite signal strength and satellite geometry) and the progress of the collection of satellite data. The receiver is constantly monitoring satellites. The display on the satellite status page graphically depicts the activity.

As new satellites come into view, a new bar appears in the graph. Bars that were solid minutes ago disappear as satellites pass over the horizon. If a satellite is being monitored but not used, the bar will appear hollow. On Wide Area Augmentation System (WAAS) enabled GPS receivers, the WAAS satellite signal strength is indicated on its own bar on the graph. On this page it is common for GPS receivers to display the following information:

- satellite signal strengths,
- battery strength, and
- estimated position error (EPE).



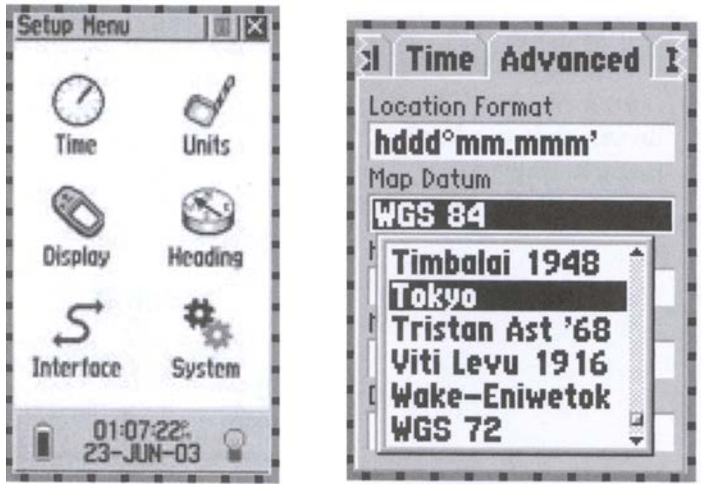
S. Featherstone, Outdoor Guide to Using Your GPS, Creative Publishing International, Inc. (p. 45)

Figure 13-4-2 Satellite Status Page

MENU

This page is used for customizing the GPS receiver. All data fields can be changed to give a person the information they require including waypoints, routes, time and speed, etc. On this page it is common for GPS receivers to display the following information:

- customization options for the GPS receiver,
- waypoints and routes, and
- map datum.



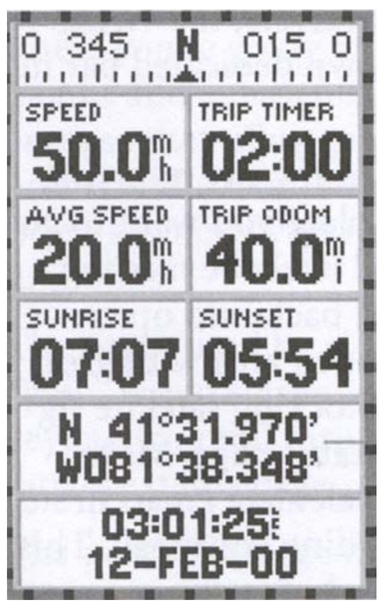
S. Featherstone, Outdoor Guide to Using Your GPS, Creative Publishing International, Inc. (p. 54)

Figure 13-4-3 Menu Page

POSITION

The position page is used for confirming coordinates, datum, time, date, and the EPE. This page is used infrequently, for brief periods, mostly in planning and after marking a waypoint. No easy-to-understand graphics, like a compass rose, are displayed. This page is not ideally laid out for user-friendly navigation.

After acquiring enough satellites to begin navigating, many GPS receivers automatically go to the position page or the map page. In addition to the information mentioned above, an operator may find current speed, heading and a trip odometer. On some GPS receivers the information displayed can be changed.



S. Featherstone, Outdoor Guide to Using Your GPS, Creative Publishing International, Inc. (p. 46)

Figure 13-4-4 Position Page

COMPASS NAVIGATION

This page shows the direction of travel (track) as it relates to the direction of the destination (bearing). It will show the distance from the destination and time to the destination. This page is used frequently when navigating from point to point and for navigating around obstacles.

The digital compass graphic should not be confused with a real compass. Although they look the same, it can give a very different reading because without movement GPS receivers cannot display direction. Read the owners manual and determine if the compass is an electronic compass capable of identifying a compass heading while the operator is standing still.

S. Featherstone, Outdoor Guide to Using Your GPS, Creative Publishing international, Inc. (p. 47)

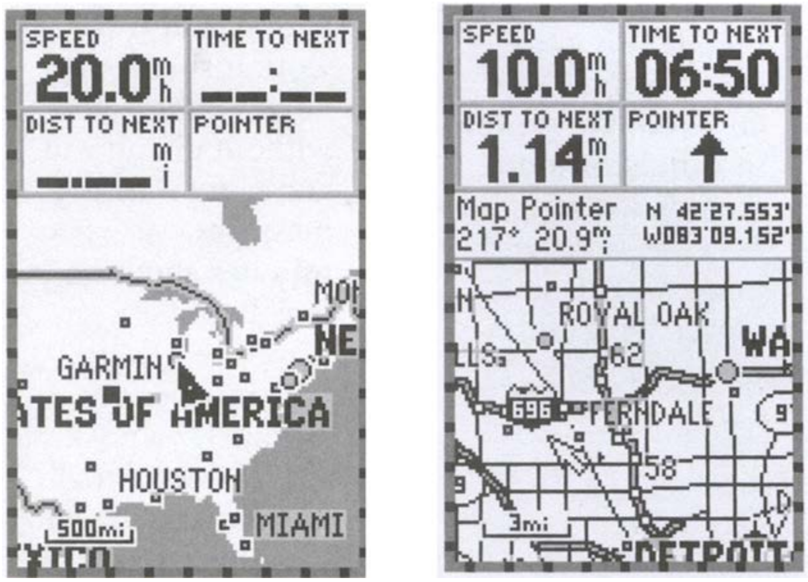
Figure 13-4-5 Compass Navigation Page

MAP

This page identifies position. A GPS without a built-in map will identify where a person is in relation to another waypoint. A GPS receiver with a built-in map will identify where a person is in relation to landmarks, such as roads, cities and bodies of water. A GPS receiver with downloadable maps will identify where a person is in relation to city streets and topographical features.

The advantage of this screen is its ability to identify the current position by looking at the features on a map rather than just the coordinates. Depending on the zoom level – which is shown at the bottom of the page – these features could be roads or cities or entire continents.

The map page allows an operator to pinpoint where one is and create a waypoint on the map the cursor over a feature and pressing “enter” or “mark”, making route building easier. The map page can also serve as an address book. By moving the cursor over a certain waypoint and pressing “enter”, information is displayed, such as phone numbers, addresses, and navigation information.



S. Featherstone, Outdoor Guide to Using Your GPS, Creative Publishing International, Inc. (p. 50)

Figure 13-4-6 Map Page

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. Where is the battery strength information located?

Q2. What is the possible problem of using a GPS digital compass for navigating?

Q3. Which screen identifies the coordinates and datum of the GPS?

ANTICIPATED ANSWERS

A1. The satellite status page identifies the battery strength information.

A2. The possible problem of using a GPS digital compass for navigating is if the navigator is standing still some GPS receivers cannot display direction. It only knows how to identify direction when moving.

A3. The position page identifies the coordinates and datum.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What does the menu button display on the GPS receiver?

Q2. On a GPS receiver's compass navigation page what information can you expect to find?

Q3. On a GPS receiver's satellite status page what information can you expect to find?

ANTICIPATED ANSWERS

A1. The menu button displays a menu with available options. Options can be selected by using the arrow joystick to highlight the option and pressing "enter" to access it.

A2. On the compass navigation page, a person can expect to find the following information:

- direction of travel,
- bearing,
- distance from destination,
- CDI, and
- time to destination.

A3. On the satellite status page a person can expect to find the following information:

- satellite signal strengths,
- battery strength, and
- EPE.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A

METHOD OF EVALUATION

This EO is assessed IAW A-CR-CCP-703/PG-001, Chapter 3, Annex B, Appendix 5 (322 PC).

CLOSING STATEMENT

GPS receivers have become a very common tool for navigating. Receivers vary from make to model, each offering its own method of use. By identifying the common features offered on a GPS receiver, cadets will be familiar with the information a GPS receiver can provide. Cadets who have an understanding of this information should be able to retrieve the required information from any make or model of GPS receiver.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C2-142 (ISBN 0-7645-6933-3) McNamara, J. (2004). *GPS for Dummies*. Hoboken, NJ: Wiley Publishing, Inc.

C2-143 (ISBN 1-58923-145-7) Featherstone, S. (2004). *Outdoor Guide to Using Your GPS*. Chanhassen, MN: Creative Publishing International, Inc.

ROYAL CANADIAN ARMY CADETS

SILVER STAR

INSTRUCTIONAL GUIDE

SECTION 5

EO M322.05 – SET A MAP DATUM ON A GLOBAL POSITIONING SYSTEM (GPS) RECEIVER

Total Time:	60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-703/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Photocopy and create OHP slides of Annexes C and D.

Photocopy Annex E and distribute to each cadet.

Ensure there is a GPS receiver and topographical map of the area for each group in TP 2.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TPs 1–3 to orient the cadets to map datums.

Demonstration and performance was chosen for TP 2 as it allows the instructor to explain and demonstrate how to set a map datum while providing an opportunity for the cadets to practice under supervision.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have identified map datum on a topographical map and set it on a GPS receiver.

IMPORTANCE

It is important for cadets to know how to set a map datum because if an incorrect datum is set on the GPS receiver and the user identifies the coordinates from a GPS receiver on a map, an incorrect location will be given.

Teaching Point 1 | **Explain Map Datum**

Time: 10 min | Method: Interactive Lecture

MODEL PROJECTION OF THE EARTH

The Earth is represented in many different forms including models, globes, maps, atlases, etc. When these items are designed they are drawn using a reference point called datum.

Map Datum. The reference point used to draw a map.

All maps are drawn using a reference point. A grid is a series of lines on a map that helps describe a location in reference to the datum point. A map can have several grids, but only one datum. If one were to consider a map to be a two-dimensional picture of the ground covered by a grid, the datum tells where to line up the grid on the map – the grid represents the lines of latitude and longitude used to define a location on a map.

Most datums only cover a portion of the earth. The North American Datum of 1927 (NAD-27), covers only the continent of North America. There are many different kinds of datum in the world and each country may use a different datum to draw maps. Countries often issue maps that have been created using a different datum to describe their own land area.

Depending on the datum used, the coordinates you read can differ by almost 200 m.

Datums are important to the user because if the datum in the GPS receiver does not match the map's datum, the coordinates will look the same but be describing two different places on the map.

When using a GPS receiver, any time a coordinate is plotted using a map or manually inputted from some other source, change the GPS receiver datum to match the map's datum. The map's datum can be found in the legend area.

Ellipsoid. Is a solid of which all the plane sections normal to one axis are circles and all the other plane sections are ellipses.

NAD-27

NAD-27 is a datum based on the Clarke ellipsoid of 1866. The reference is located at Meads Ranch in Kansas. There are over 50 000 survey monuments used as starting points for more local surveying and mapping. Use of this datum is gradually being replaced by the North American Datum 1983 (NAD-83).

NAD-83

NAD-83 is an earth-centred datum based on the Geodetic Reference System of 1980. It was created to meet requirements for better accuracy and precision. The size and shape of the earth was determined through measurements made by satellites and other sophisticated electronic equipment. The measurements accurately represent the earth within 2 m.

WORLD GEODETIC SYSTEM 1984 (WGS-84)

WGS-84 is the standard physical model of the Earth used for GPS applications. The unified system became essential in the 1950s for several reasons:

- the beginning of international space science and of astronautics;
- the lack of intercontinental geodetic information;
- the inability of the large geodetic systems to provide a worldwide geo-data basis; and
- a need for a global map for navigation, aviation and geography.

Geodetic is a branch of earth sciences. It is the scientific discipline that deals with the measurement and representation of the earth including its gravitational field in a three-dimensional time varying space.

Previous World Geodetic Systems have been in place; WGS-60, WGS-66 and WGS-72 and the current WGS-84. A new model is now being created to replace WGS-84 tentatively called Earth Gravity Model 06.

Use Annex C (Simulated Map Datum) and Annex D (Grid Overlay), to illustrate a datum.

- Place the two slides on an OHP, laying the grid over the map.
- Identify a fictitious fixed point (mountain, lake, boulder) as the map datum (reference point, eg, NAD-27).
- Discuss how the reference point determines the grid's base point.
- Make another fictitious map datum (reference point, eg, WGS-84).
- Show how the uses of different datums relate to different positions dependant on the datum used as a reference point. This will reinforce the importance of setting the appropriate datum before identifying position on a GPS receiver.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is a map datum?

Q2. What is the NAD-27?

Q3. What is the WGS-84?

ANTICIPATED ANSWERS

A1. A map datum is the reference point used to draw maps.

A2. The NAD-27 is the North American Datum 1927 based on the Clarke ellipsoid of 1866. The reference is located at Meads Ranch in Kansas.

A3. The WGS-84 is the standard physical model of the Earth used for GPS applications. The unified system became essential in the 1950s.

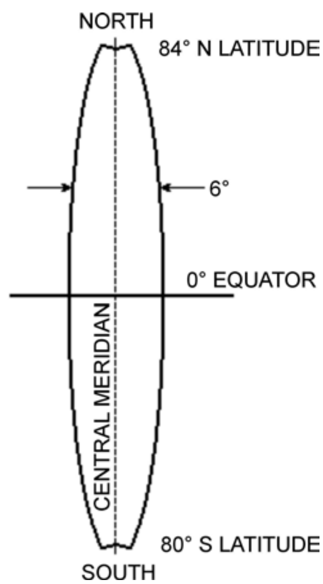
Teaching Point 2	Discuss the Universal Transverse Mercator (UTM) Grid System
Time: 10 min	Method: Interactive Lecture

Because the world is round, any type of representation of its surface on a flat piece of paper will have distortions. These are relatively insignificant on maps that show only small parts of the earth, like city maps or 1 : 50 000 scale maps, but quite considerable for maps of countries or continents.

UTM GRID

Map Projection

Map projection is a geometrical method of reducing the amount of distortion on a flat map. In very large countries such as Canada, mapmakers divide the country into strips from north to south, called zones, and project each zone. One system of strip projection is the UTM projection. All National Topographical System (NTS) maps use this system.



Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 13-5-1 Shape of a UTM Zone – Six Minutes of Longitude Wide

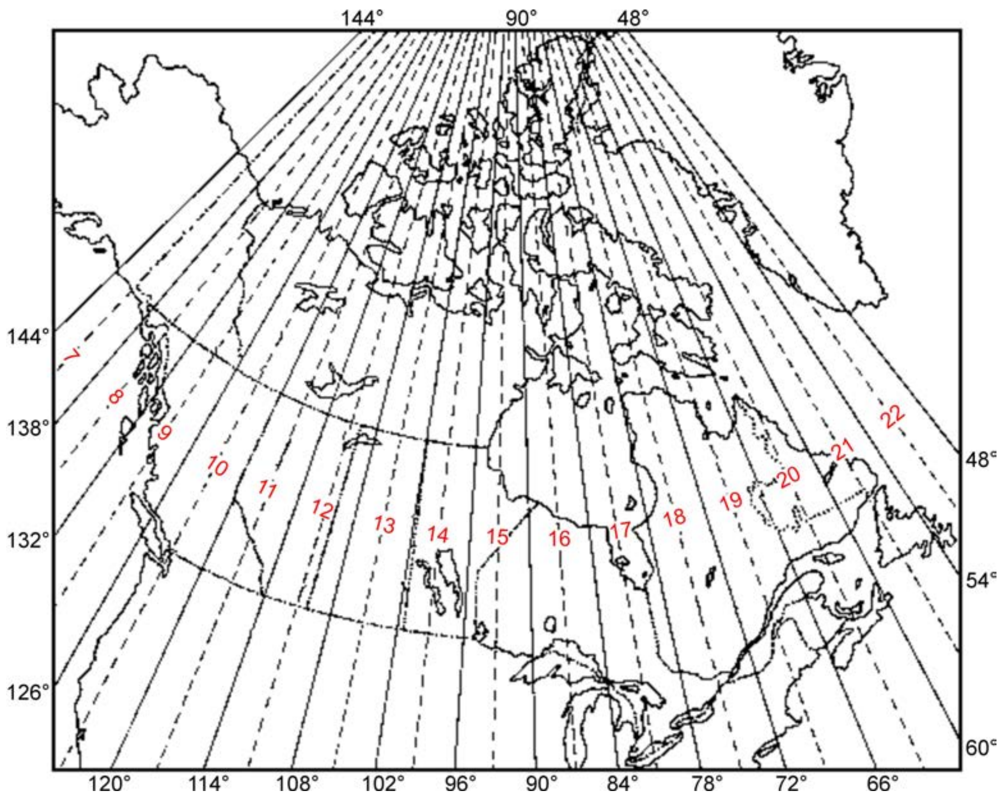
UTM ZONE

To picture a UTM zone, imagine the earth as an orange. All the geographical features are drawn on the peel. Take a knife and after slicing small circles at each pole, cut the peel into many narrow strips from pole to pole. Then take the strip of peel and press it flat against a smooth surface. Even though the details in the middle of the peel might become a little distorted, the strip is narrow enough for the details to remain accurate enough for regular map users.

UTM PROJECTION

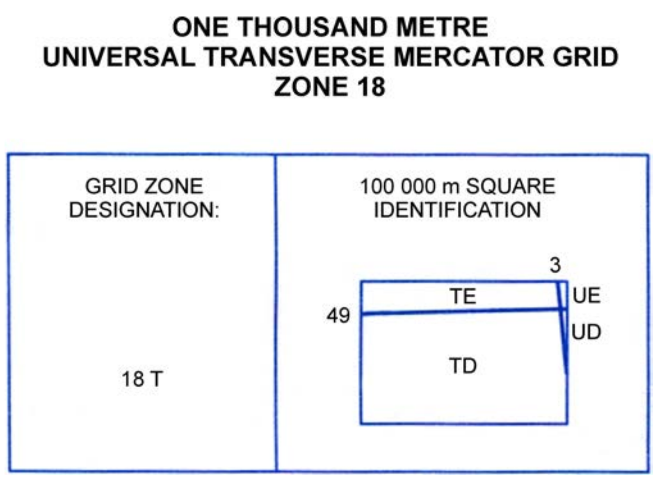
For the UTM Projection, the Earth's surface has been divided into 60 zones. Sixteen of these zones, numbered 7 through 22, cover Canada from west to east. Shown below are the numbered zones with their centre meridian marked with a dotted line. Each zone is divided into sections, and these sections are published as 1 : 250 000 scale maps by the NTS. Each 1 : 250 000 scale map can then be divided into smaller areas, like 1 : 50 000 scale maps. The location of the topographical map zone number can be found in the marginal information, in the grid zone designator box as seen in Figure 13-5-3.

Have cadets identify their location in Canada from the handout in Annex E and identify what zone they would be located in.



"Natural Resources Canada", The Universal Transverse Mercator Grid, Copyright 1969 by Department of Energy, Mines and Resource Canada, Surveys and Mapping Branch. Retrieved April 4, 2008, from http://maps.nrcan.gc.ca/topo101/utm2_e.php

Figure 13-5-2 Canadian UTM Zones



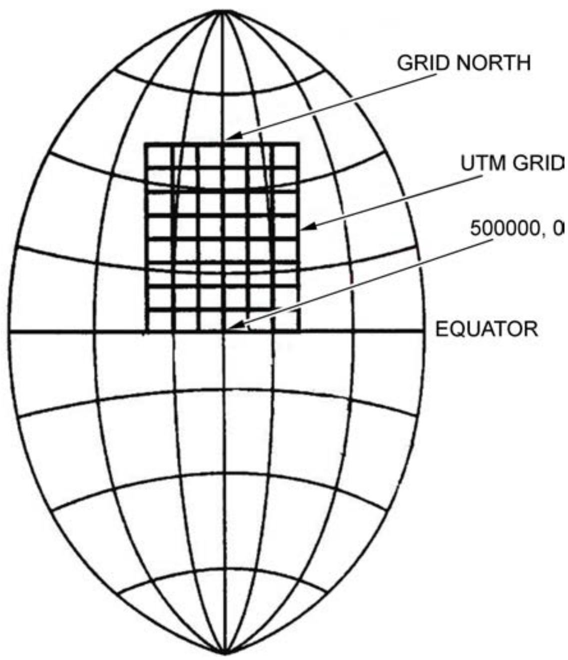
Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 13-5-3 Grid Zone Identifier

GRID REFERENCE SYSTEMS

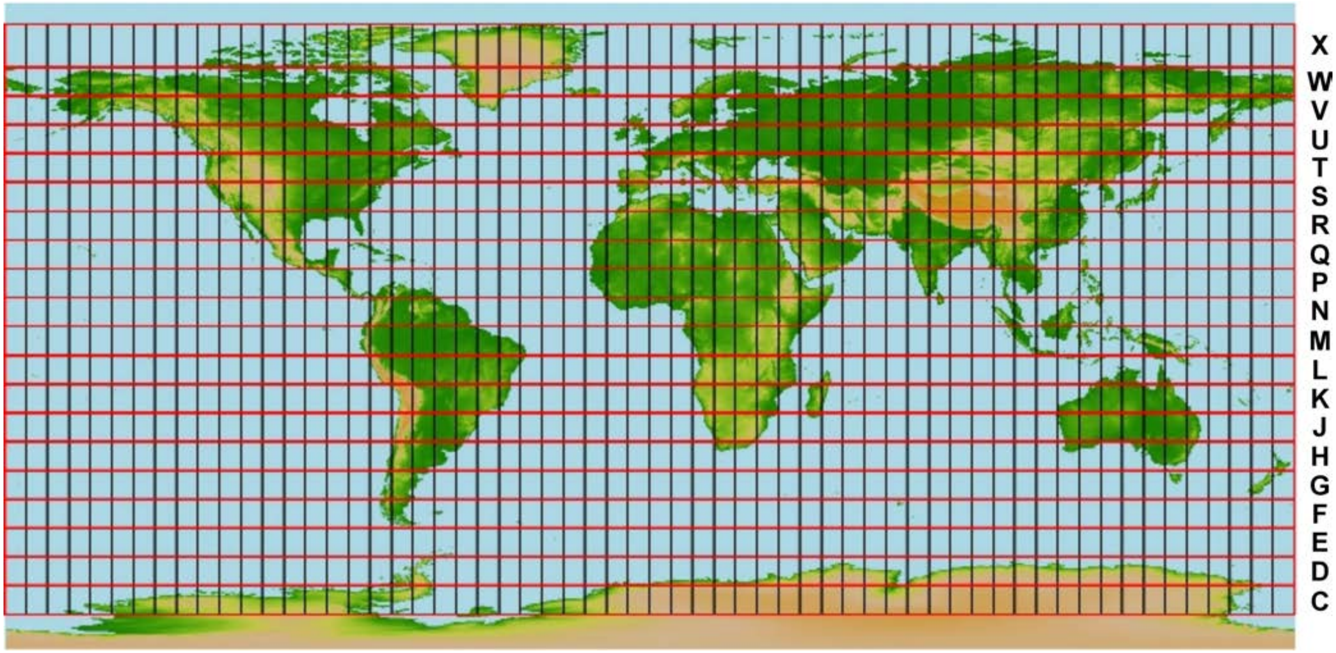
When a map-maker has projected a zone, and divided it into sections, a rectangular grid is laid over top of the projection as seen in Figure 13-5-4. These grid lines are shown in blue on a topographical map. The grid lines are exactly parallel to each other. The vertical grid lines are printed parallel to the meridian of the zone, and the horizontal grid lines are parallel to the equator. These horizontal parallel lines to the equator make up the sub UTM grid zones as seen in Figure 13-5-4.

The largest of the grids are squares 100 km by 100 km. Each of these 100-km squares is identified by a letter which is stated after the UTM zone number. In Figure 13-5-3, the Grid Zone Designation is 18 T. Each large square is further divided into smaller squares of 10 km, and then again into 1 km. It is these 1 km by 1 km (1 000 m by 1 000 m) squares that is depicted on a 1 : 50 000 scale topographical map.



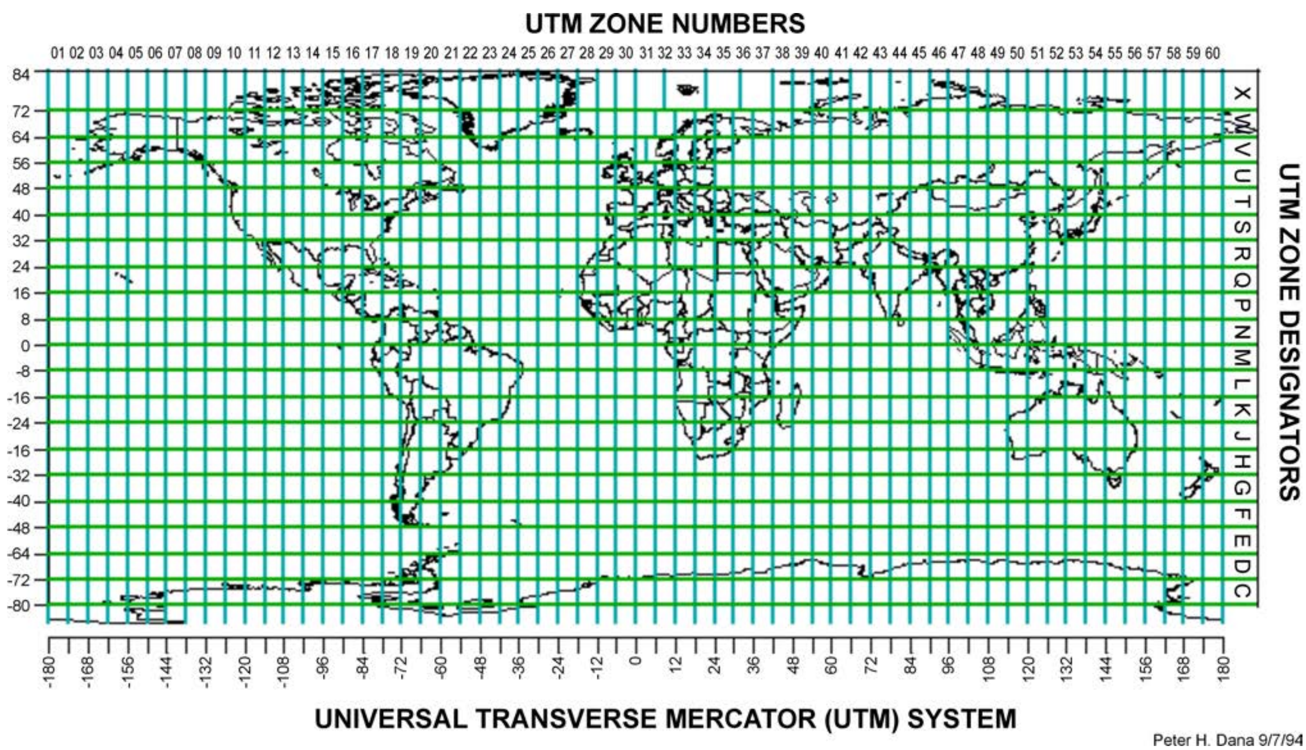
"Geology 350y – Field Studies", Geological Mapping. Retrieved May 1, 2008, from http://instruct.uwo.ca/earth-sci/350y-001/acadimages/utm2.jpg

Figure 13-5-4 Grid Overlay



"Warner College of Natural Resources", UTM Sub Zones, Copyright 2007 Colorado State University. Retrieved May 2, 2008, from http://welcome.warnercnr.colostate.edu/class_info/nr502/lg3/datums_coordinates/utm.html

Figure 13-5-5 UTM Sub Zones



"Department of Geography, The University of Colorado at Boulder", The Geographer's Craft Project, Copyright 1999 by Peter H. Dana. Retrieved May 1, 2008, from http://w3.impa.br/~pcezar/cursos/GIS/mapproj.htm

Figure 13-5-6 UTM Zone Numbers

Each grid line in the 1 000 m grid is numbered.

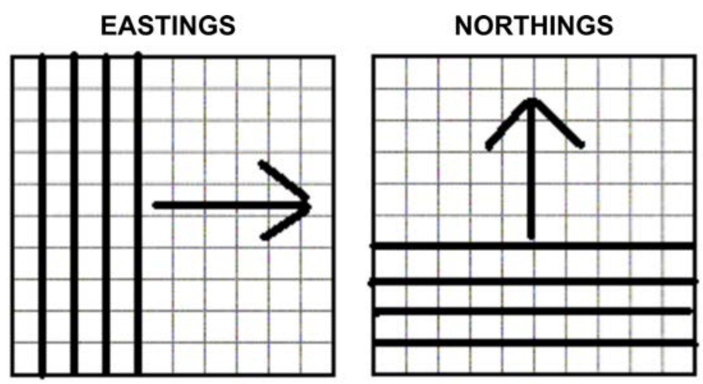
Have a topographical map available for viewing purposes when presenting information about eastings and northings.

Eastings

The vertical lines are numbered from an imaginary line 500 000 m west of the zone's centre meridian. Each zone then starts at zero in the west and each 1 000-m line is numbered going toward the east. Each vertical grid line's number, usually a two-digit number at the top and bottom ends of the line, is located in the bottom and top margins. The full number, represented with an E printed behind it, is located in the bottom left corner. This number explains how many metres east the grid line is from the start point. These lines are called eastings because they are numbered from west towards the east.

Northings

The horizontal line is numbered starting with zero at the equator. In the left and right margins there are two-digit numbers at the ends of each horizontal line. The full number of metres from the equator with the letter N printed behind it can be found in the bottom left. These lines are called northings because they are numbered from the equator towards the north.

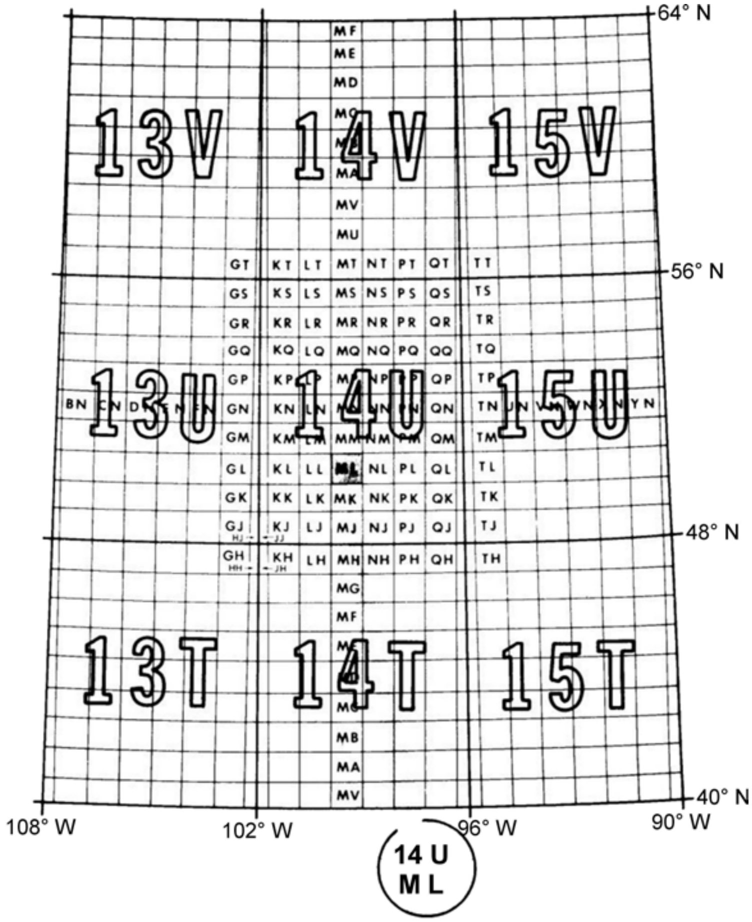


Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 13-5-7 Eastings and Northings

Military Grid Reference System (MGRS). The military traditionally identifies grid lines by stating the two-digit short form of the grid line numbers. These two-digit numbers repeat over a large area (every 100 km) so the military has established a letter code for each 100 km by 100 km square. The military grid codes come from the UTM projection that is broken down into smaller 100 000 m square identification (as per Figure 13-5-8). The military grid code is found in the right margin underneath the UTM zone number.

Have cadets identify the MGRS code on the topographical map.



Department of National Defence, Military Training Volume 8, Map Field Sketching and Compasses, Department of National Defence, 1976, Department of National Defence (p. 75)

Figure 13-5-8 Layout of MGRS

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. UTM projection divides Canada into strips from north to south. What do these strips represent?

Q2. How many UTM zones is the Earth's surface divided into?

Q3. Where is the 100 000 m square identifier found on a topographical map?

ANTICIPATED ANSWERS

A1. The UTM projection that divides Canada into strips from north to south, represent UTM zones.

A2. The Earth's surface is divided into 60 zones.

A3. The 100 000 m square identifier is found in the marginal information.

Teaching Point 3 — **Discuss Using a GPS Receiver in Conjunction With a Topographical Map**

Time: 15 min — Method: Interactive Lecture

This TP will provide cadets with the knowledge on how to use a GPS receiver in conjunction with a topographical map.

The provided examples correspond to the Trenton, Ont., 1:50 000 map, # 31 C/4. The map datum for this map is NAD-27.

These examples should be reproduced using a GPS receiver and a local topographical map of the area. This will provide cadets with realistic examples and hands-on experience.

Ensure that the GPS receiver coordinate system is set to MGRS.

IDENTIFYING MGRS GRID SYSTEM ON A GPS RECEIVER

GPS receivers will identify the UTM coordinates when reading location, to include:

- grid zone designator,
- 100 000 m square identifier, and
- grid reference (GR).

GPS receivers, depending on the make and model, are capable of selecting a MGRS accuracy of four-, six-, eight-, and ten-figure GR. If the GPS receiver being used for this TP is enabled with this capability, it is suggested that it be set to a 6-figure GR.

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Figure 13-5-9 GPS Receiver Coordinates

The coordinates displayed on the GPS receivers in Figure 13-5-9, are set to MRGS. Each GPS receiver is set with a different datum for the same location.

GPS Receiver Datum set to NAD-27	GPS Receiver Datum set to NAD-83
The coordinates are identified as: • Grid Zone Designator – 18 T, • 100 000 m square identifier – TD, and • 10-figure GR as –96785 86748	The coordinates are identified as: • Grid Zone Designator – 18 T, • 100 000 m square identifier – TP, and • 10-figure GR as – 96830 86973

Note the difference between the coordinates of the same location using a different datum.

PROCESS FOR CONFIRMING CORRECT MGRS COORDINATES

MGRS coordinates allow a GPS receiver to work in conjunction with a topographical map. To confirm the MGRS coordinates correspond with the topographical map the user will have to:

1. Identify the MGRS grid system on the topographical map.
2. Locate the grid zone designator.
3. Confirm the 100 000 m square identifier.

Identifying MGRS Grid System on a Topographical Map

Locating the MGRS grid system on topographical maps provides the navigator with another method to confirm the GPS receiver is reporting coordinates that correspond with the map being used. If the coordinates are different, the navigator will know that the GPS receiver is set to another datum and will have to be adjusted to provide the correct coordinates.

Locating the Grid Zone Designator

The location of the grid zone designator is found in the marginal information. The zone for the example in Figure 13-5-10, is 18 T.

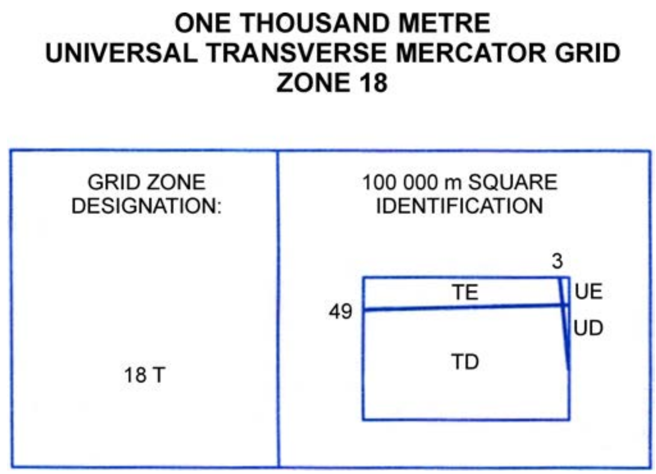

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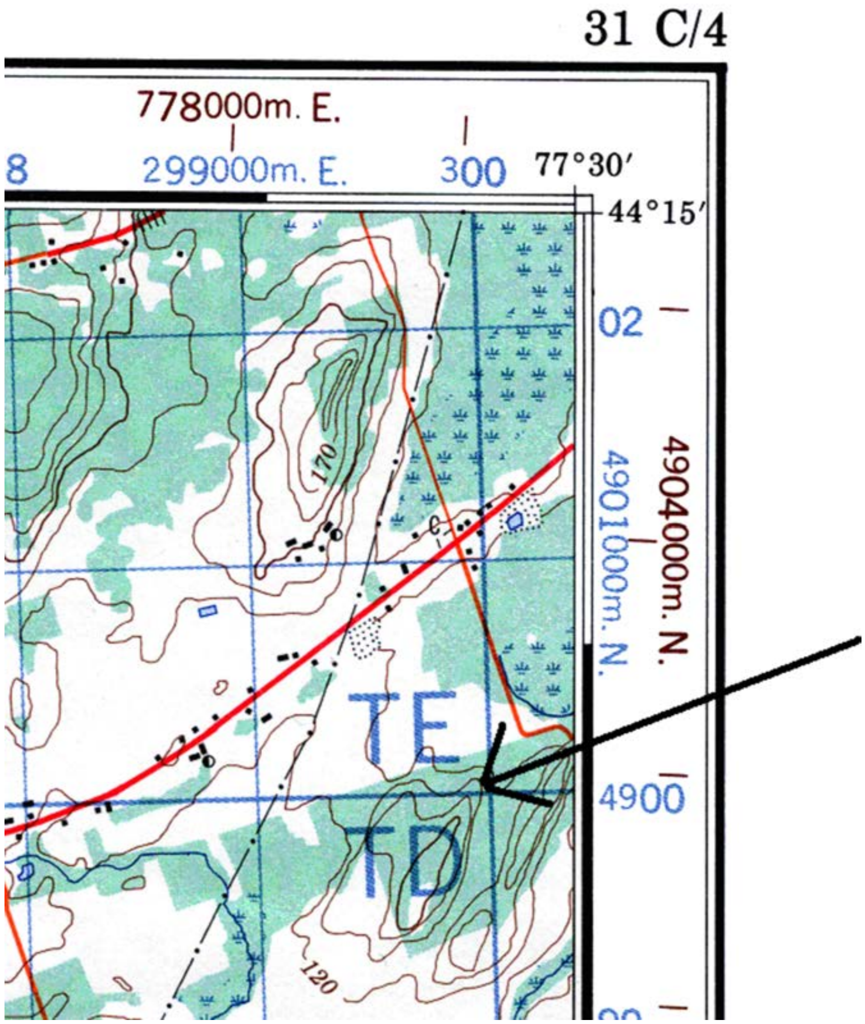
Figure 13-5-10 Grid Zone Designator

Confirming the 100 000 m Square Identifier

The 100 000 m square identifier is located in the same marginal information area as the grid zone designator. The example in Figure 13-5-10 states that the map is adjacent to the 100 000 m square identifications UE and UD. Additionally when the 100 000 m square identifier on a topographical map joins an adjacent grid zone, the identifier will be noted on the map in the 00 00 grid square. This is illustrated in Figure 13-5-11.



Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 13-5-11 Topographical Map 100 000 m Square Identifier

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. What MGRS coordinates are identified by a GPS receiver?

Q2. What is the process for confirming correct MGRS coordinates?

Q3. Where is the 100 000 m square identifier located on a topographical map?

ANTICIPATED ANSWERS

A1. The GPS receiver will identify:

- grid zone designator,
- 100 000 m square identifier, and
- GR.

A2. The process for confirming correct MGRS coordinates is to:

- Identify the MGRS grid system on the topographical map.
- Locate the grid zone designator.
- Confirm the 100 000 m square identifier.

A3. The 100 000 m square identifier is located in the marginal information on the topographical map.

Teaching Point 4 — **Explain, Demonstrate and Have the Cadets Practice Setting the Map Datum on the GPS Receiver**

Time: 15 min — Method: Demonstration and Performance

For this TP, it is recommended that instruction take the following format:

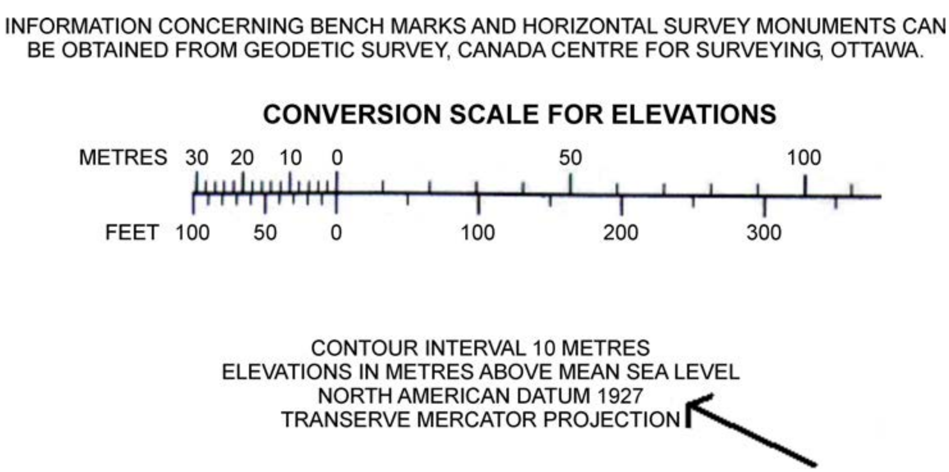
1. Explain and demonstrate the complete skill while cadets observe.
2. Explain and demonstrate each step required to complete the skill. Monitor cadets as they imitate each step.
3. Monitor the cadets' performance as they practice the complete skill.

Note: Assistant instructors may be employed to monitor the cadets' performance.

Divide cadets into groups based on the number of GPS receivers and topographical maps available. Distribute a GPS receiver and a topographical map to each group.

IDENTIFING THE MAP DATUM FROM A TOPOGRAPHICAL MAP

The map datum of a topographical map is located in the lower right side of the marginal information, under the conversion scale for elevations.



Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 13-5-12 Map Datum

Have the cadets locate the map datum on the topographical map.

SETTING A DATUM ON A GPS

To set a datum on a GPS:

1. Identify the map datum of the topographical map being used as the reference.
2. With the GPS, go to the set-up menu then, "navigation", then "system" or "units".
3. Highlight the map datum's box.
4. Scroll through the list of datums and find the map datum being used.
5. Set the correct datum.

To set the datum of the eXplorist 200 GPS receiver:

1. Power up the receiver.
2. Press the ENTER button.
3. Press MENU button.
4. Highlight the preferences and press ENTER.
5. Highlight the map units and press ENTER.
6. Highlight the map datum and press ENTER.
7. Highlight the correct datum and press ENTER.

ACTIVITY

Time: 10 min

OBJECTIVE

The objective of this activity is have the cadets practice setting the map datum on a GPS receiver.

RESOURCES

- Topographical map (one per group), and
- GPS receiver (one per group).

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide cadets into groups, based on the amount of GPS receivers and topographical maps available.

2. Provide one GPS receiver and topographical map to each group.
3. Have cadets identify the map datum on the topographical map.
4. Have each cadet in the group power up the GPS receiver and set the map datum.
5. Choose a random map datum in the list provided within the GPS receiver and have each cadet in the group set a different datum.
6. If outside and the map is of the area, have the cadets set the correct datum of the map and identify their position on the map using the coordinates provided by the GPS receiver.
7. Once the location is identified, have the cadets set a different datum and note the difference in their position.
8. Discuss the importance of having the correct datum set on the GPS receiver when using maps.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 4

The cadets' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' setting the datum on a GPS receiver will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

This EO is assessed IAW A-CR-CCP-703/PG-001 Chapter 3, Annex B, Appendix 5 (322 PC).

CLOSING STATEMENT

Setting the correct datum on a GPS receiver ensures the position identified on the GPS will correspond with the map being used. The simple mistake of using a different datum when identifying position on a GPS will result in errors when trying to identify position on a map.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

A2-036 A-CR-CCP-121/PT-001 Director Cadets 3. (2003). *Royal Canadian Army Cadet Reference Book*. Ottawa, ON: Department of National Defence.

C2-143 (ISBN 1-58923-145-7) Featherstone, S. (2004). *Outdoor Guide to Using Your GPS*. Chanhassen, MN: Creative Publishing International, Inc.

ROYAL CANADIAN ARMY CADETS

SILVER STAR

INSTRUCTIONAL GUIDE

SECTION 6

EO M322.06 – IDENTIFY LOCATION USING A GLOBAL POSITIONING SYSTEM (GPS) RECEIVER

Total Time:	120 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-703/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Ensure GPS receivers have fully-charged batteries.

Prepare a navigational route of six legs.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

A practical activity was chosen for this lesson as it is an interactive way to allow the cadets to identify location using a GPS receiver.

INTRODUCTION

REVIEW

The review for this lesson is from EO M322.05 (Set a Map Datum on a Global Positioning System [GPS] Receiver, Section 5). Review how to use the GPS receiver to identify position by:

1. confirming the correct map datum is set on the GPS receiver;
2. locating the geographical position page on the GPS receiver;
3. reading the current 10-figure grid reference (GR), extract the six-figure GR from the 10-figure GR shown; and
4. plotting the six-figure GR on the topographical map of the area.

OBJECTIVES

By the end of this lesson the cadet shall have identified their location using a GPS receiver.

IMPORTANCE

It is important for cadets to be able to identify location using a GPS receiver because it provides a more accurate position. Being able to identify the position on a GPS receiver and translate and plot that position onto a topographical map will support one's location and provide a backup in the case of a GPS receiver failure.

Teaching Point 1 — **Have the Cadets Navigate Along a Predetermined Route Using a Topographical Map**

Time: 110 min — Method: Practical Activity

BACKGROUND INFORMATION

Cadets have covered the following material in EOs M322.03 (Identify Components Of The Global Positioning System [GPS], Section 3), M322.04 (Identify Features Of A Global Positioning System [GPS] Receiver, Section 4) and M322.05 (Set A Map Datum On A Global Positioning System [GPS] Receiver, Section 5).

If required, complete a quick review on:

- the components of a GPS receiver,
- GPS screen pages,
- identifying the map datum from a topographical map, and
- setting a map datum on a GPS receiver.

COMPONENTS OF A GPS RECEIVER

Antenna. Allows the GPS receiver to receive satellite signals.

Screen. Location where all information is displayed.

Some GPS receivers use an arrow joystick that acts as a mouse, providing a simple to use interface with the GPS receiver.

Battery Compartment. Stores the receiver power supply.

The buttons in the following list are found on the Magellan eXplorist 200 GPS receiver. Other makes and models of GPS receivers may have different function buttons. Consult the owner's manual for GPS receiver button functions.

On/Off. Turns the receiver on and off.

Backlight. Turns the display backlight on and off and changes intensity.

Enter. Used to access highlighted menu items or highlighted page menu options.

Escape. Cancels data inputs. Closes the accessed function and goes back to the previous screen and moves backward through the navigation screens.

Zoom In. Used on the map screen to zoom in on the map displayed. The map display can be zoomed in to 35 m (100 feet). Also used to move through the list of waypoints when using an alphabetical search.

Zoom Out. Used on the map screen to zoom out on the map displayed. The map display can be zoomed out to 2736 km (1700 miles). It is also used to move through the list of waypoints when using an alphabetical search.

Menu. Displays a menu with available options. Options may be selected by using the arrow joystick to highlight the option and pressing “enter” to access it.

NAV. Moves through the navigation screens (Map screen, Compass screen, Position screen, Satellite screen).

Mark. Used to save present position as a waypoint. Waypoints are saved and stored in “My Points of Interest” (POI).

GOTO. Creates a one-leg route from the present position to a destination selected from the POI database or by using the cursor on the background map and pressing GOTO on a point.

Arrow Joystick. Moves the cursor on the map screen. It also moves the highlighted bar to select menu options and data-entry fields.

Thales Navigation, Inc., Magellan eXplorist 200 Reference Manual, Thales Nav, Inc. (p. 1)

Figure 13-6-1 eXplorist 200 GPS Receiver

GPS SCREEN PAGES

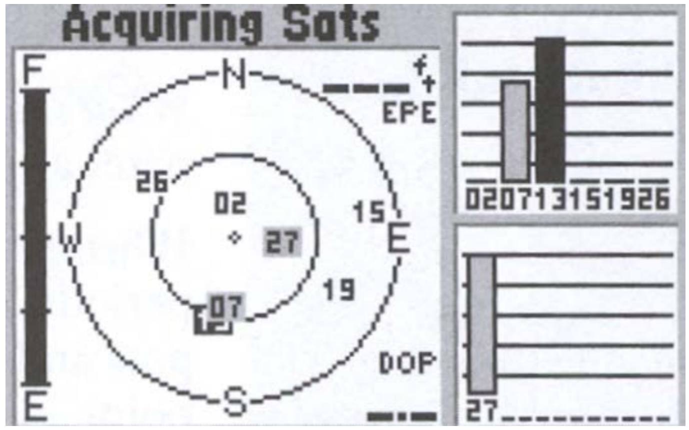
GPS receivers may differ in the way they present information, from unit to unit. Identify the screens that are similar to those contained in this TP.

Note: The term “Page” refers to the different screens an operator can scroll through to locate different information in a GPS receiver.

Satellite Status. The satellite status screen displays the acquisition of satellites (satellite signal strength and satellite geometry) and the progress of the collection of satellite data. The receiver is constantly monitoring satellites. The display on the satellite status page graphically depicts the activity.

As new satellites come into view, a new bar appears in the graph. Bars that were solid minutes ago disappear as satellites pass over the horizon. If a satellite is being monitored but not used, the bar will appear hollow. On Wide Area Augmentation System (WAAS) enabled GPS receivers, the WAAS satellite signal strength is indicated on its own bar on the graph. On this page it is common for GPS receivers to display the following information:

- satellite signal strengths,
- battery strength, and
- estimated position error (EPE).

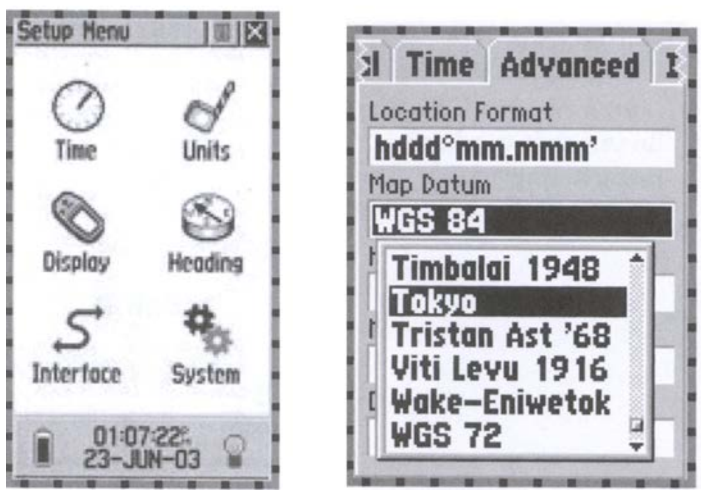


S. Featherstone, Outdoor Guide to Using Your GPS, Creative Publishing International, Inc. (p. 45)

Figure 13-6-2 Satellite Status Page

Menu. This page is used for customizing the GPS receiver. All data fields can be changed to give a person the information they require including waypoints, routes, time and speed, etc. On this page it is common for GPS receivers to display the following information:

- customization options for the GPS receiver,
- waypoints and routes, and
- map datum.

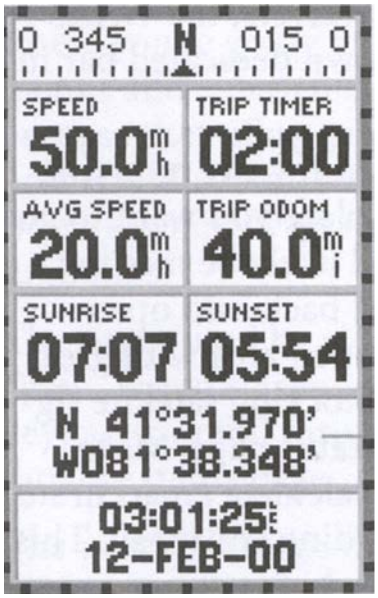


S. Featherstone, Outdoor Guide to Using Your GPS, Creative Publishing International, Inc. (p. 54)

Figure 13-6-3 Menu Page

Position. The position page is used for confirming coordinates, datum, time, date, and the EPE. This page is used infrequently, for brief periods, mostly in planning and after marking a waypoint. No easy-to-understand graphics, like a compass rose, are displayed.

After acquiring enough satellites to begin navigating, many GPS receivers automatically go to the position page or the map page. In addition to the information mentioned above, an operator may find current speed, heading and a trip odometer. On some GPS receivers the information displayed can be changed.



S. Featherstone, Outdoor Guide to Using Your GPS, Creative Publishing International, Inc. (p. 46)

Figure 13-6-4 Position Page

Compass Navigation. This page shows the direction of travel (track) as it relates to the direction of the destination (bearing). It will show the distance from the destination and time to the destination. This page is used frequently when navigating from point-to-point and for navigating around obstacles.

The digital compass graphic should not be confused with a real compass. Although they look the same it can give a very different reading because without movement GPS receivers cannot display direction. Read the owner's manual and determine if the compass is an electronic compass capable of identifying compass heading while standing still.

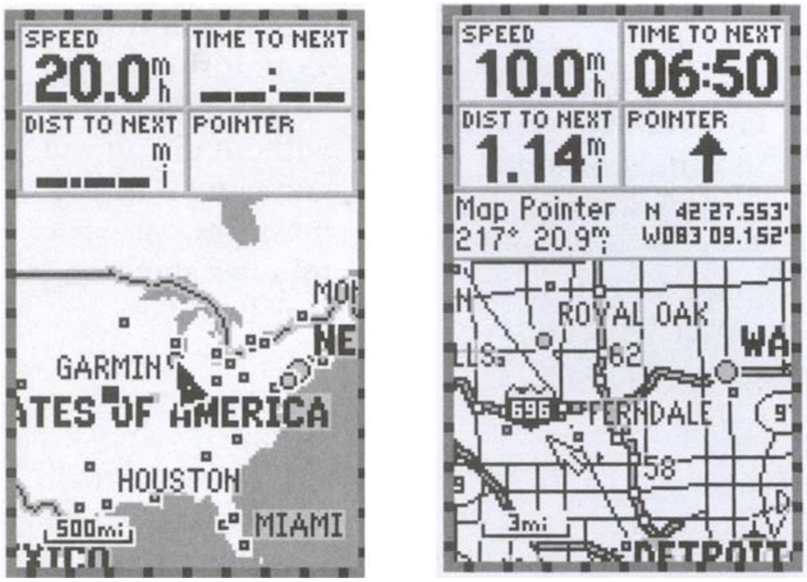
S. Featherstone, Outdoor Guide to Using Your GPS, Creative Publishing International, Inc. (p. 47)

Figure 13-6-5 Compass Navigation Page

Map. This page identifies position. A GPS without a built-in map will identify where a person is in relation to another waypoint. A GPS receiver with a built-in map will identify where a person is in relation to landmarks, such as roads, cities and bodies of water. A GPS receiver with downloadable maps will identify where a person is in relation to city streets and topographical features.

The advantage of this screen is its ability to identify the current position by looking at the features on a map rather than just the coordinates. Depending on the zoom level – which is shown at the bottom of the page – these features might be roads or cities or entire continents.

The map page allows an operator to pinpoint where one is and create a waypoint over a feature by pressing “enter” or “mark”, making route building easier. The map page can also serve as an address book. By moving the cursor over a certain waypoint and pressing “enter”, information is displayed such as phone numbers, addresses, and navigation information.



S. Featherstone, Outdoor Guide to Using Your GPS, Creative Publishing International, Inc. (p. 50)

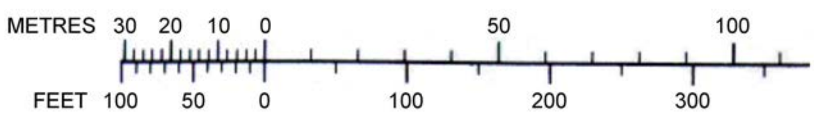
Figure 13-6-6 Map Page

IDENTIFY THE MAP DATUM FROM A TOPOGRAPHICAL MAP

The map datum of a topographical map is located in the lower right side of the marginal information, under the conversion scale for elevations.

INFORMATION CONCERNING BENCH MARKS AND HORIZONTAL SURVEY MONUMENTS CAN BE OBTAINED FROM GEODETIC SURVEY, CANADA CENTRE FOR SURVEYING, OTTAWA.

CONVERSION SCALE FOR ELEVATIONS



CONTOUR INTERVAL 10 METRES
ELEVATIONS IN METRES ABOVE MEAN SEA LEVEL
NORTH AMERICAN DATUM 1927
TRANSERVE MERCATOR PROJECTION

Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 13-6-7 Map Datum

Have the cadets locate the map datum on the topographical map.

SETTING A DATUM ON A GPS

To set a datum on a GPS:

1. Identify the map datum of the topographical map being used as the reference.
2. With the GPS, go to the set-up menu then “navigation” then “system” or “units”.
3. Highlight the map datum’s box.
4. Scroll through the list of datums and find the map datum being used.
5. Set the correct datum.

To set the datum of the eXplorist 200 GPS receiver:

1. Power up the receiver.
2. Press the ENTER button.
3. Press MENU button.
4. Highlight preferences and press ENTER.
5. Highlight map units and press ENTER.
6. Highlight map datum and press ENTER.
7. Highlight correct datum and press ENTER.

EXTRACTING A 6-FIGURE GR FROM A 10-FIGURE GR

A 10-figure grid reference given from a GPS receiver has 10 digits and is accurate to 1 m. To extract the 6-figure GR from the 10-figure GR one must understand how the figures work.

GRID REFERENCE WRITTEN FIGURES		
Definition	**Easting**	**Northing**
A 10-figure GR accurate to 1 m is written as	96779	86744
A 8-figure GR accurate to 10 m is written as	9677	8674
A 6-figure GR accurate to 100 m of the same coordinates is written as	967	867
A 4-figure GR accurate to 1 000 m of the same coordinates is written as	96	86

As illustrated in the above chart the 10-figure GR has two sets of numbers. The first five digits are eastings and the last five digits are the northing coordinates. When taking a GR from a GPS receiver is important to identify the 10 digits and extract the first three numbers from the easting portion and the first three numbers from the northing portion (eg, **967**79 **867**44). The 6-figure grid reference can then be plotted on a map as GR 967 867.

IDENTIFYING MGRS GRID SYSTEM ON A GPS RECEIVER

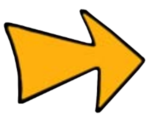
The provided examples correspond to the Trenton, Ont., 1 : 50 000 map, # 31 C/4. The map datum for this map is NAD-27.

These examples should be reproduced using a GPS receiver and a local topographical map of the area. This will provide cadets with realistic examples and hands on experience.

Ensure that the GPS receiver coordinate system is set to Military Grid Reference System (MGRS).

GPS receivers will identify the MGRS coordinates when reading location, to include:

- grid zone designator,
- 100 000 m square identifier, and
- GR.



GPS receivers, depending on the make and model, are capable of selecting a MGRS accuracy of four-, six-, eight-, and ten-figure GRs. If the GPS receiver being used for this TP is enabled with this capability, it is suggested that it be set to a six-figure GR.

Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 13-6-8 GPS Receiver Coordinates

The coordinates displayed on the GPS receivers in Figure 13-6-8, are set to MRGS. Each GPS receiver is set with a different datum for the same location.

GPS Receiver Datum Set to NAD-27	GPS Receiver Datum Set to NAD-83
The coordinates are identified as: • grid zone designator – 18 T, • 100 000 m square identifier – TD, and • 10-figure GR as – 96785 86748	The coordinates are identified as: • grid zone designator – 18 T, • 100 000 m square identifier – TP, and • 10-figure GR as – 96830 86973

Note the difference between the coordinates of the same location using a different datum.

PROCESS FOR CONFIRMING CORRECT MGRS COORDINATES

MGRS coordinates allow a GPS receiver to work in conjunction with a topographical map. To confirm the MGRS coordinates correspond with the topographical map the user will have to:

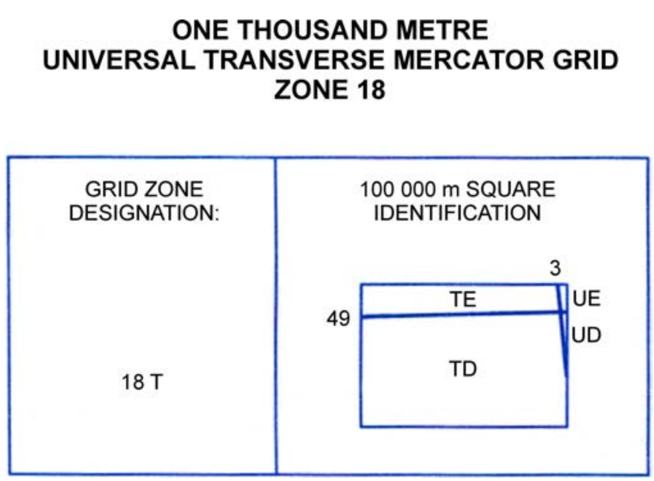
1. Identify the MGRS grid system on the topographical map.
2. Locate the grid zone designator.
3. Confirm the 100 000 m square identifier.

Identifying MGRS Grid System on a Topographical Map

Locating the MGRS grid system on topographical maps provides the navigator with another method to confirm the GPS receiver is reporting coordinates that correspond with the map being used. If the coordinates are different, the navigator will know that the GPS receiver is set to another datum and will have to be adjusted to provide the correct coordinates.

Locating the Grid Zone Designator

The location of the grid zone designator is found in the marginal information. The zone for the example in Figure 13-6-10, is 18 T.

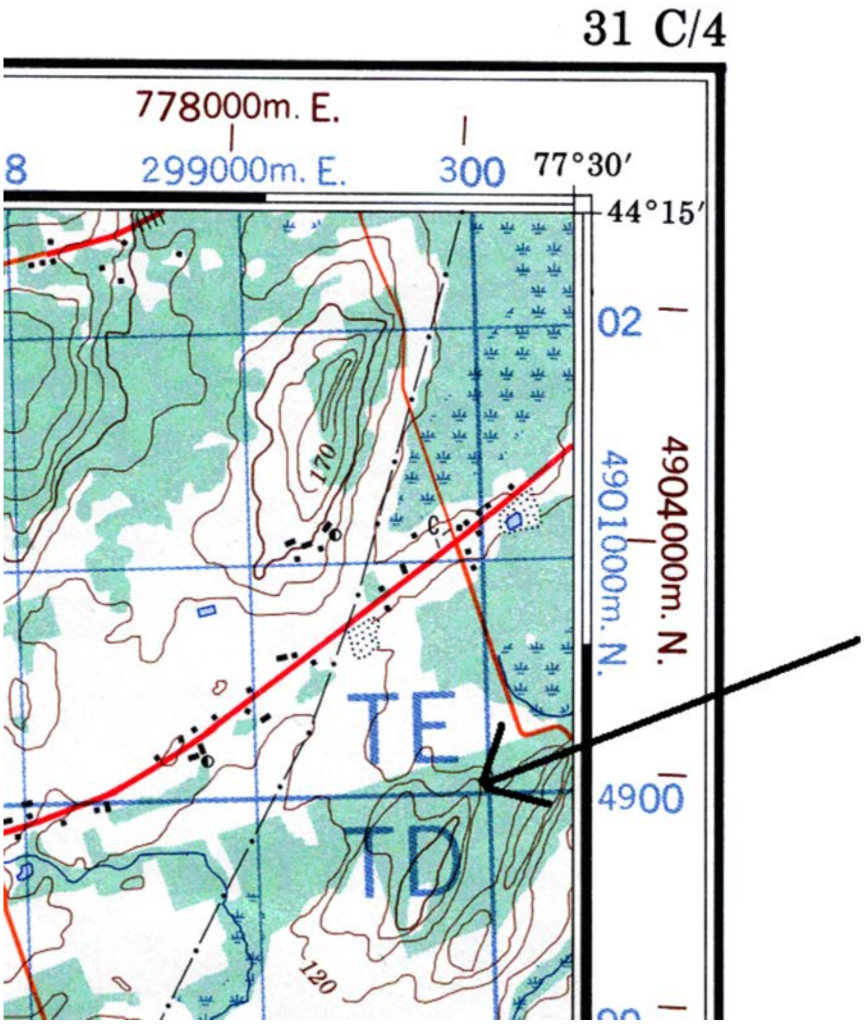


Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 13-6-9 Grid Zone Designator

Confirming the 100 000 m Square Identifier

The 100 000 m square identifier is located in the same marginal information area as the grid zone designator. The example in Figure 13-6-9 states that the map is adjacent to the 100 000 m square identifications UE and UD. Additionally, the 100 000 m square identifier on a topographical map joins an adjacent grid zone, the identifier will be noted on the map in the 00 00 grid square. This is illustrated in Figure 13-6-10.



Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 13-6-10 Topographical Map 100 000 m Square Identifier

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadets identify location using a GPS receiver and plot that position on a topographical map.

RESOURCES

- GPS receiver,
- Topographical map of the area,
- Compass,
- Pen/pencil,
- First aid kit, and
- Communication equipment.

ACTIVITY LAYOUT

1. Prepare a route along Class 1 or 2 terrain that does not exceed 6 km (3.7 miles).
2. Along the route mark off six specific checkpoints. Record the six-figure GR off of the topographical map and the 10-figure GR from the GPS for every point.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into groups of no more than six.
2. Assign each cadet in the group one of the six checkpoints.
3. Have each cadet lead the group to their designated checkpoint navigating with a topographical map.
4. Before moving to the next sequential checkpoint, have the designated cadet identify their current location using a topographical map through a six-figure GR.
5. At the checkpoint have the cadet identify position using a GPS receiver, to include:
   (a) confirming the correct map datum is set on the GPS receiver,
   (b) locating the geographical position page on the GPS receiver and confirm:
      (1) grid zone is the same as printed on the topographical map,
      (2) the 100 000 m square identifiers are the same; and
   (c) reading the current 10-figure GR and extracting the 6-figure GR; and
   (d) plotting the 6-figure GR on the topographical map of the area.
6. Confirm the plotted six-figure GR corresponds with the assigned checkpoint.

Remember that a 6-figure GR is accurate to 100 m. The plotted GR should be within 100 m of the actual group location.

SAFETY

Communications and emergency first aid equipment shall be carried with each group in case of emergency.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

This EO is assessed IAW A-CR-CCP-703/PG-001, Chapter 3, Annex B, Appendix 5 (322 PC).

CLOSING STATEMENT

Being able to use a GPS receiver to identify position and plot that position on a map provides the the cadet a secondary means to confirm position and backs up the location of the cadet in the case of a GPS receiver failure.

INSTRUCTOR NOTES/REMARKS

322 PC shall be scheduled on the weekend bivouac/survival FTX.

The route will consist of Class 1 or 2 terrain and will not exceed 4 km (2.5 miles).

REFERENCES

A2-036 A-CR-CCP-121/PT-001 Director Cadets 3. (2003). *Royal Canadian Army Cadet Reference Book*. Ottawa, ON: Department of National Defence.

C2-143 (ISBN 1-58923-145-7) Featherstone, S. (2004). *Outdoor Guide to Using your GPS*. Chanhassen, MN: Creative Publishing International, Inc.

ROYAL CANADIAN ARMY CADETS

SILVER STAR

INSTRUCTIONAL GUIDE

SECTION 7

EO C322.01 – PRACTICE NAVIGATION AS A MEMBER OF A SMALL GROUP

Total Time:	90 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-703/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Review the activities in TP 2 to confirm local resources required and prepare the route to be used to include grid references and bearings.

Prepare a route based on the area and activity.

If assistant instructors are not available, determine a safety bearing to a known location.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP 1 to give direction on procedures and to illustrate the application of rules for the navigation exercise.

A practical activity was chosen for TP 2 as it is an interactive way to allow cadets to experience navigation in a safe, controlled environment. This activity contributes to physical fitness and to the development of navigation skills and knowledge in a fun and challenging setting.

A group discussion was chosen for TP 3 as it allows the cadets to interact with their peers and share their knowledge, experiences, opinions, and feelings about navigation training.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have practiced navigation as a member of a small group.

IMPORTANCE

It is important for cadets to practice navigation skills taught in Silver Star using a map, compass and a GPS receiver. Participation in these activities contributes to the development of navigation skills and knowledge in a fun and challenging setting. Cadets will rely on this skill set throughout navigation and expedition training.

Teaching Point 1 — **Attend a Safety Briefing**

Time: 10 min — Method: Interactive Lecture

This briefing is being conducted to pass on vital information and to answer any questions regarding the safe conduct of a navigation activity, to include:

- actions that can be taken if they become lost, may include:
  - returning to the previous checkpoint;
  - using a radio, if available; or
  - following a safety bearing to a known location;
- a time limit for the activity of 55 minutes;
- boundaries set for the conduct of the activity;
- rules and safety procedures for the activity; and
- a narrative of the activity being conducted.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What actions shall be taken if a group becomes lost?

Q2. What is the time limit for this activity?

Q3. What are the boundaries for this activity?

ANTICIPATED ANSWERS

A1. If a group becomes lost, they should return to the previous checkpoint, use a radio, if available or follow a safety bearing to a known location.

A2. This activity will last no more than 55 minutes.

A3. The answers to this question will vary based on the local area used.

Teaching Point 2 | **Have the Cadets Participate in a Navigation Activity**

Time: 55 min | Method: Practical Activity

> Conduct one of the following activities in the time allocated. If time permits, conduct both activities. Prepare for each activity in advance using available resources.

NAVIGATION TRAIL

Cadets will be given a map, compass and GPS receiver. Upon arrival at each point, cadets will be given directions by a staff member travelling with the group or at a checkpoint. (magnetic or grid bearing and distance in metres or paces) to follow from one checkpoint to the next. The course will consist of a minimum of six legs, approximately 100–200 m in length. When each group arrives at the checkpoint, they will compare the grid reference (GR) on the map with that on the GPS receiver, determine the distance between each checkpoint and be given directions to the next checkpoint. The group with the most accurate GRs and distance between each checkpoint and the fastest time is the winning group.

NAVIGATION BRAIN TEASER

Using a map, compass and GPS receiver, cadets will navigate to predetermined points on the map. The course will consist of a minimum of six legs, approximately 100–200 m in length. Following the clues provided, when each group arrives at the checkpoint, they will record the GR on the GPS receiver (to ensure they were at each checkpoint) and be given clues (magnetic bearing, GR, or distance) directing them to another checkpoint. The clues should make the cadets think about and use their navigations skills to find the next checkpoint. The group that locates the most checkpoints and has the fastest time is the winning group.

PHOTO FINISH

Create a sheet of 12 - 20 prominent but relatively small landmarks within the immediate area of the cadet training area. Each landmark should be given a point value based on the difficulty to locate the object. Instructions must include the Datum (NAD 83) and the reference system (MGRS) to set on the GPS. Groups of cadets will then seek out the landmark and upon finding one record the 10 figure MGRS grid reference of the object. The group that gives the correct GR of landmarks to achieve the highest point score in the time allocated wins.

> Depending on terrain selected and complexity of the navigation instructions, a navigation trail can be as easy or as challenging as you wish to make it.

ACTIVITY 1 – NAVIGATION TRAIL

OBJECTIVE

The objective of the Navigation Trail activity is to have the cadets, as a member of a small group, use navigation training taught during Silver Star.

RESOURCES

- GPS receiver (one per group),

- Topographical map of the area (one per group),
- Compass (one per group), and
- A predetermined navigation route.

ACTIVITY LAYOUT

Clearly mark the start and finish lines.

ACTIVITY INSTRUCTIONS

To keep things interesting, interchange the type of bearing and distance directions for each checkpoint (eg, magnetic or grid, paces or metres).

1. Divide the cadets into groups by the number of GPS receivers available.
2. Issue each group a map, compass and GPS receiver.
3. Have the cadet leading the group plot the bearing and distance onto the map.
4. Start groups at two-minute intervals and record start times.
5. Have cadets record GRs and distance for each leg.
6. Have cadets alternate turns leading the group at least once.
7. Record the finish time for each group.
8. Compare the results of each group.
9. The group with the most accurate GRs and distances between each checkpoint and the fastest time is the winning group.

If available, use an assistant instructor at each checkpoint to answer questions and to prevent groups from following each other or sharing answers.

SAFETY

N/A.

ACTIVITY 2 – NAVIGATION BRAIN TEASER

OBJECTIVE

The objective of the Navigation Brain Teaser activity is to have the cadets, as members of a small group, use their navigations skills to find as many checkpoints as possible.

RESOURCES

- GPS receiver (one per group),
- Topographical map (one per group),

- Compass (one per group), and
- A predetermined navigation route.

ACTIVITY LAYOUT

- Clearly mark the start and finish lines.
- Position a clue at each point to direct the groups to the next point.

ACTIVITY INSTRUCTIONS

To keep things interesting, the clues should not be too easy or too hard for the cadets to find each checkpoint. Stagger the clues to prevent groups from following each other or sharing answers.

1. Divide the cadets into groups by the number of GPS receivers available.
2. Issue each group a map, compass and GPS receiver.
3. Give the clue for the first checkpoint to the cadet leading the group.
4. Start groups at two-minute intervals and record start times.
5. On a piece of paper, have cadets record clues in the order they complete the checkpoints.
6. Have cadets alternate turns leading the group at least once.
7. Collect sheets and record the finish time for each group.
8. The group that locates the most checkpoints and has the fastest time is the winning group.

If available, use an assistant instructor at each checkpoint to give cadets the next clue and answer questions.

SAFETY

N/A.

ACTIVITY 3 – PHOTO FINISH

OBJECTIVE

The objective of the Photo Finish activity is to have the cadets, as members of a small group, use a GPS to locate a series of ten figure GRs.

RESOURCES

- GPS receiver (one per group),
- Photo Hunt activity sheet including 12 to 20 landmark photos and GPS setup information (one per group),

ACTIVITY LAYOUT

- Create a photo hunt activity sheet to include 12 to 20 photos of prominent landmarks in the area of the training location. Landmarks should be small enough that an accurate grid reference can be obtained for the location (+/- 15 m), eg, an intersection street sign, legion cenotaph, advertising sign, etc. Landmarks must not be on private property without the express permission of the landowner. The sheet must also include the applicable GPS setup information, eg, Datum (NAD 83) and grid system (MGRS).
- Create an answer sheet using a GPS with the same setup information as prescribed on the photo hunt activity sheet.
- Establish a finish time for the activity, which may include a point score penalty system for late arrivals.
- Ensure GPS units are not set to the same setup information as listed on the photo hunt activity sheet.
- Establish a finish location.

ACTIVITY INSTRUCTIONS

To keep things interesting, the difficulty of finding the landmarks should vary and point values should be based on difficulty, eg, distance and/or obscurity of the landmark.

1. Divide the cadets into groups by the number of GPS receivers available.
2. Issue each group a photo hunt activity sheet and GPS receiver.
3. Have the cadets assign a peer leader for the group.
4. Groups may start at the same time or at intervals depending on the number of groups.
5. On a piece of paper, have cadets record the GR of each landmark as they find it.
6. Have cadets alternate using the GPS to identify the GR.
7. Collect sheets and record the point score less any time penalty for each group.
8. The group that has the highest point score is the winning group.

SAFETY

Cadets shall be briefed on boundaries which must take into account any dangerous obstacles or crossings. If radios are available each group should be given a radio.

CONFIRMATION OF TEACHING POINT 2

The cadets' participation in the navigation activities will serve as the confirmation of this TP.

Teaching Point 3 | **Conduct a Debriefing**

Time: 15 min | Method: Group Discussion

BACKGROUND KNOWLEDGE

GROUP DISCUSSION

TIPS FOR ANSWERING/FACILITATING DISCUSSION

- Establish ground rules for discussion, eg, everyone should listen respectfully; don't interrupt; only one person speaks at a time; no one's ideas should be made fun of; you can disagree with ideas but not with the person; try to understand others as much as you hope they understand you; etc.
- Sit the group in a circle, making sure all cadets can be seen by everyone else.
- Ask questions that will provoke thought; in other words avoid questions with yes or no answers.
- Manage time by ensuring the cadets stay on topic.
- Listen and respond in a way that indicates you have heard and understood the cadet. This can be done by paraphrasing their ideas.
- Give the cadets time to respond to your questions.
- Ensure every cadet has an opportunity to participate. One option is to go around the group and have each cadet answer the question with a short answer. Cadets must also have the option to pass if they wish.
- Additional questions should be prepared ahead of time.

SUGGESTED QUESTIONS

Q1. What navigation skills were required to complete the activity?

Q2. What was the hardest part of the activity to complete?

Q3. What was the most exciting part of the activity?

Q4. How will the activity help you with navigation in the future?

Other questions and answers will develop throughout the group discussion. The group discussion should not be limited to only those suggested.

Reinforce those answers given and comments made during the group discussion, ensuring the teaching point has been covered.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the group discussion will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in the navigation activities and the group discussion will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Navigating using a GPS receiver or a map and compass are skills that can also be used in situations outside the Cadet Program. True proficiency in the skills used during these activities can only be achieved by practicing. These activities allow the cadets the opportunity to develop their navigation skills and knowledge in a fun and challenging setting.

INSTRUCTOR NOTES/REMARKS

The intent of this activity is to give the cadet experience navigating with a map and compass, determine distance and follow a bearing from point-to-point.

This activity may be conducted using any available map appropriate for this activity.

This complementary activity can be conducted up to three times during supported complementary days or sessions. Participation is limited to a maximum of nine periods.

REFERENCES

A2-041 B-GL-382-005/PT-001 Canadian Forces. (2006). *Maps, Field Sketching, Compasses and the Global Positioning System*. Ottawa, ON: Department of National Defence.

ROYAL CANADIAN ARMY CADETS

SILVER STAR

INSTRUCTIONAL GUIDE

SECTION 8

EO C322.02 – IDENTIFY FACTORS THAT IMPACT NAVIGATION IN THE WINTER

Total Time:	120 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-703/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An in-class activity was chosen for TP 1 as an interactive way to provoke thought and stimulate an interest on how terrain features are affected in the winter.

An interactive lecture was chosen for TPs 2 and 3 to present background information to the cadet on the factors that affect visibility and weather conditions which can impact navigation in the winter.

A group discussion was chosen for TP 4 as it allows the cadet to interact with their peers and share their knowledge, experiences, opinions and feelings about navigating in the winter.

A practical activity was chosen for TP 5 as it is an interactive way to allow the cadet to experience navigating in the winter. This activity contributes to the development of winter navigational skills in a fun and challenging setting under supervision.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall be expected to identify factors that impact navigation in the winter.

IMPORTANCE

It is important for cadets to understand the impact of weather on winter navigation skills. Navigating in the winter can become very confusing when the surroundings and weather conditions change unexpectedly. Applying some simple routine navigation techniques will ensure the cadets stay on course while enroute to their desired destination.

Teaching Point 1 **Conduct a Brainstorming Activity Where the Cadet Will Discuss How Terrain Features Are Affected in the Winter**

Time: 15 min Method: In-Class Activity

BACKGROUND KNOWLEDGE

Winter weather conditions have a direct impact on how people travel during the winter months. When participating in a winter hiking activity, there are some key factors which must be considered.

TRAILS/FOOTPATHS

Popular trails are easier to follow in winter than little-used trails, because staying on an unbroken trail can be extremely challenging. Just a few inches of snow can obscure the footpath and can be as bewildering as scanning a forest or open meadow; despite thinking or knowing that the trail is there somewhere, it all looks the same.

TRAIL MARKERS

A trail has specific details about it that tell the hiker they are on the trail. The trail will show signs of previous travel, a corridor through the trees, blazes, cairns and other markers. When following a trail in the winter, whether on a track that previous hikers have broken in the snow or on a trail you are breaking, remain vigilant to watch for signs of the trail.

Cairns. Cairns are piles of rocks. They vary in size from a small grouping of three or four rocks to large piles that can be seen in thick fog. During the winter with snow covering the ground, trails marked with cairns may require more concentration to locate than a marking at eye level. They are easy to miss.

K. Berger, Backpacking and Hiking, DK Publishing Inc. (p. 158)

Figure 13-8-1 Sample Cairn

Paint Blazes. Paint blazes are markings on trees, pieces of wood, rocks, etc. The markings will differ from trail to trail. A trail may have its own specific logo, which could be something as simple as a rectangle, a circle or a triangle. Paint blazes are the most common type of trail marking and during winter, windblown snow may stick to the trees covering the markers.

Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 13-8-2 Sample Trail Blaze

PROMINENT LANDMARKS

Winter conditions change the way features may have looked in summer. Snow masks and covers the normal route features by covering worn down paths, masking slight elevation changes and covering streams, marshes and valleys. Navigators will have to resort to using more prominent and sometimes distant features to orient the map, locate their position and follow a desired route. The prominent features can be ridges, peaks and communication towers.

Ridges. A long narrow hilltop, mountain range, or watershed can easily be identified on a map and also be easily visible during wither conditions.

Peaks. Mountaintops that form a point. Peaks of mountains are defined and easily seen during trekking and can be good prominent landmarks for orienting the map during winter travel.

Communication Towers. Cellular and radio communications towers are found on most current topographical maps and are good aids when orienting a map during winter navigation.

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadets in a group discuss how terrain features are affected in the winter.

RESOURCES

- Flip chart paper, and
- Markers.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into groups of no more than four.

2. Provide each group with a sheet of flip chart paper and a marker.

3. Read the scenario in the note box to the cadets.

Scenario

Your cadet unit decided to conduct a three-day expedition in late fall. Prior to departure the weather and temperature was forecasted to be cool and partly sunny for most of the time but above the freezing point.

Starting out on the trek, the group travels for the first day. Camp is set up for the night and before lights out, some precipitation begins to fall. It is a cool night and all members decide to call it an early night and go to ground.

Waking up in the morning, the group is surprised to find 20 cm of snow on the ground. Luckily all members are prepared for the cool weather, and clothing and equipment will not be a problem. It is decided to continue the trek.

Before departing on the second day from base camp, it is noticeable that the snow is hanging in the trees and makes a solid layer of cover on the ground. While navigating, some members are finding it difficult, to identify features to orient the map.

4. Ask the cadets the following question and have them record their answers in point form on the flip chart paper, large enough to read from a distance.
   (a) When navigating, a person uses specific features to orient and guide their route of travel. If you were on the trek in the scenario, what navigation catching features would you expect to be difficult, if not impossible, to use because of the layer of snowfall?
   (b) Have the cadets brainstorm for 10 minutes then have each group post their flip chart paper on the wall and present the work to the group. Have one cadet from each group explain how they think snow will affect each of their answers.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the activity will serve as the confirmation of this TP.

Teaching Point 2	**Discuss the Three Most Common Factors That Can Reduce Visibility**
Time: 10 min	Method: Interactive Lecture

VISIBILITY

Visibility is the range or possibility of vision as determined by the conditions of light and atmosphere. In winter, people will experience a loss of visibility in blizzard conditions and at night.

Darkness. Typically most people will not be navigating after dark, but may choose to in the event they need to make up time. On nights when the moon is not visible, surroundings become shadowless, the horizon and distant features blend into the darkness and the snow absorbs light. Navigating on an overcast night is very difficult – if not impossible.

Blowing Snow. During this condition the wind picks up snow and whirls it about. The strength of the wind combined with snow creates a thick barrier that limits visibility.

Falling Snow. Falling snow can be so heavy at times that the milky colour of the air blends seamlessly into the equally milky and featureless snow-covered ground. If this occurs on terrain lacking trees or other vegetation, conditions of zero visibility occur. This condition is amplified with wind, creating a whiteout condition. During a whiteout in mountainous regions, a person may not be able to see sudden drop-offs.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What are three common factors which reduce visibility ?

Q2. How does blowing snow affect visibility?

Q3. What can create a whiteout condition?

ANTICIPATED ANSWERS

A1. Three common factors that reduce visibility are darkness, blowing snow, and falling snow.

A2. Blowing snow affects visibility when the wind picks up snow and whirls it about. The strength of the wind combined with snow, creates a thick barrier that limits visibility.

A3. A whiteout condition can be caused by falling snow that is so heavy at times that the milky colour of the air blends seamlessly into the equally milky and featureless snow-covered ground.

Teaching Point 3 **Identify Weather Conditions and Discuss Their Impacts on Navigation in the Winter**

Time: 10 min Method: Interactive Lecture

Wind. Wind combined with cold temperatures is a marriage of harsh elements that can make a navigation exercise uncomfortable. Wind transports moisture into a storm at the surface and aloft which allows the storm to intensify and continue unabated. As a result, wind impacts navigation by contributing to the development of ground blizzards, falling snow blizzards and whiteouts.

Fog. Fog occurs when the air is unable to hold any more moisture and is caused when the temperature reaches the dew point. During this weather condition, a milky white mist forms above the surface of the ground. Fog is common during early mornings as the sun rises and will not dissipate until the sun heats the surface of the earth, causing an increase in air temperature. Fog will affect navigation by restricting visibility and obscuring navigational features.

Snow. Snow is a type of precipitation in the form of crystalline water that falls from clouds. As snow falls, it accumulates on the ground. This accumulation over time will affect navigation by:

- covering well-defined paths and routes; and
- reducing visibility during snowfall.

Ground Blizzards. Ground blizzards occur when the wind is strong enough to pick up snow from open surfaces and whirl it through the air causing blinding conditions. Typically, such ground blizzards occupy the air to a height of 9–12 m (30–40 feet). It is actually possible to look straight up and see perfectly clear, blue sky overhead.

Ground blizzards can negatively affect navigation by:

- reducing visibility to the point that you may be able to see only from 100 metres ahead.
- reducing the visibility of prominent landmarks or features visible to effectively determine position and direction through map orientation; and
- forcing the navigator to be more cautious and vigilant when map reading. The concentration required because of these conditions reduces speed and increases travel time.

Falling Snow Blizzards. Falling snow blizzards occur when a considerable amount of snow is falling. It can be so heavy at times that the milky colour of the air blends seamlessly into the equally milky and featureless snow-covered ground. This condition is amplified with wind and creates whiteout conditions.

Falling snow blizzards can negatively affect navigation by:

- creating dangerous situations of very poor visibility, to the point that one may be able to see only metres ahead of oneself;
- making it impossible to see surrounding prominent landmarks or features for navigation. A GPS or compass is all that can be relied upon; and
- forcing the navigator to be more cautious and vigilant when map reading. The concentration required because of these conditions reduces speed and increases travel time exponentially.

Whiteouts. Whiteouts are weather conditions of heavy, wind-driven snowstorms that obliterate all natural landmarks and are not uncommon in the mountains. Visibility and vegetation contrasts are severely reduced by snow and diffused lighting caused from an overcast cloud layer.

Whiteouts can negatively affect navigation by:

- creating dangerous situations of very poor visibility, to the point that one may be able to see only metres ahead of oneself;
- making it impossible to see surrounding prominent landmarks or features for navigation. A GPS or compass is all that can be relied upon; and
- forcing the navigator to be more cautious and vigilant when map reading. The concentration required because of these conditions reduces speed and increases travel time exponentially.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. What is a ground blizzard and how will it impact navigation?

Q2. What causes a whiteout?

Q3. How will wind impact navigation?

ANTICIPATED ANSWERS

A1. A ground blizzard is wind that is strong enough to pick up snow from open surfaces and whirl it through the air causing blinding conditions. Typically, such ground blizzards occupy the air to a height of 9–12 m (30–40 feet). Ground blizzards can negatively affect navigation by:

- reducing visibility to the point that one may be able to see only 100 m ahead of oneself;
- reducing the visibility of prominent landmarks or features that are used to determine position and direction through map orientation; and
- forcing the navigator to be more cautious and vigilant when map reading. The concentration required because of these conditions reduces speed and increases travel time.

A2. A whiteout is caused by weather conditions of heavy, wind-driven snowstorms, obliterating all natural landmarks. Visibility and contrast are severely reduced by snow and diffused lighting from an overcast cloud layer.

A3. Wind impacts navigation by contributing to the development of blizzards, falling snow blizzards and whiteouts.

Teaching Point 4 **Discuss the Application of Individual Navigation Skills in the Winter**

Time: 20 min Method: Group Discussion

BACKGROUND KNOWLEDGE

USING A TOPOGRAPHICAL MAP

Winter conditions mask, distort and blend together many prominent features a navigator would use to orient a map. When navigating during winter conditions, a navigator will have to look beyond the simple easy to find features such as the trail ahead, a stream running nearby, or the cluster of boulders up ahead. All of these features are either covered by snow or have blended in with their surroundings making them indistinguishable. The features that can be used are:

- the mountains in the distance (contour lines),
- large bodies of water (open areas that are covered in ice),
- ridge lines,
- visible archways of known paths, and
- definable vegetation changes (open fields that change into forest).

When orienting the map, the navigator will now have to look beyond the immediate surroundings and view the distant landscape for identifiable features.

IDENTIFYING OBJECTS ON THE GROUND WITH OBJECTS ON THE MAP

Winter conditions distort navigation features. A well-defined island in a lake in the summer may blend into the background and look like the mainland in the winter. Seen from a distance, a bunch of small islands blend together and look like part of the mainland or like a big island that does not appear on the map.

In such situations where features become tricky to identify, good habits will help. For complicated areas full of bewildering features, keep checking position and progress by lining up, isolating, and checking ground features with the map. Predict what should come next; if the predictions are wrong stop and locate position.

TAKING BEARINGS

Before heading across a large body of frozen water, an open field, a valley or thick brush, take a bearing to the next checkpoint or destination from the current known position. Do this even in clear weather, whenever it is possible to support the direction of travel. If the winds build while crossing an open area or the weather changes, a group may become disoriented.

Taking a bearing before making the journey across a valley will ensure the person reaches their desired destination. If a person becomes disoriented because of a sudden change in weather conditions, attempting to take a bearing on something they almost see will not work if they cannot identify where they are.

Aiming Off. Aiming off is a method to ensure the navigator will not get disoriented or lost by planning a deliberate error in direction.

When taking a bearing, the navigator identifies the desired destination (eg, a path at the end of a wide open field) and selects a point to shoot the bearing a few degrees left or right of the path. If a navigator shoots a bearing directly to the desired destination (the path at the end of a wide open field) and follows the bearing under conditions of poor visibility and the navigator travels off course just slightly, the navigator upon arrival at the end of the field will be in a position that is unknown. Trying to identify what side of the path they are on will be impossible and a guess will have to be made.

If the navigator follows the bearing directly to a point left of the desired destination, the navigator knows where the location of the path is (to the right of the current location). Aiming off is used when the navigator will lose site of the final destination or sudden loss of visibility is expected because of weather. The navigator, even if some error is made during travel, can be assured to travel one direction to find the desired destination (path, trail, road way etc).

PACING

The pace counting method (pacing) is used for measuring a given distance by counting every other step. Two steps equal one pace. Pacing is a very important skill in navigation as each person has a different pace and needs to establish their pace before it can become a useful measurement tool. Pacing varies between individuals as it uses a natural stride – an average adult will pace about 60 to 70 paces in 100 m.

While navigating over snow-covered terrain, use pacing to help track distances covered. To determine an individual pace similar to summer treks, practice taking uniform, comfortable steps over a measured snow-covered distance (100 m) counting every second step of the dominant foot. Do this three to five times to get an average. This will be the individual's pace number and should be remembered.

PLANNING A ROUTE

To plan a route during the winter, the navigator must consider the changes winter brings. Speed of travel, prominent features, and desired shelter all change. Routes will change; even arriving at the starting point may change. Consider the following:

- Where is the destination?
- How much snow has fallen and accumulated on the route?
- What are the snow conditions?
- Is it a defined well-travelled path?
- Is the path groomed?
- Will the route have readily identifiable navigational features (lakes, mountains, valleys, etc)?
- What is the weather forecast?
- Is the distance to the destination a possible goal considering the conditions?
- What is the skill level of the group?
- What is the mode of travel (foot, skis or snowshoe)?
- What will be the anticipated travelling speed of the group?
- Are there shelter options along the route in case of a storm?

ENFORCING GROUP TRAVEL TECHNIQUES

Travelling on a clear day, maintaining direction and staying within sight of party members is simple. However, consider walking across a 5-km (3-mile) stretch of an open lake in a blizzard with only a few metres of vibisility, and trying to maintain direction without getting lost or losing sight of party members. This can be very difficult; however, the following practices can make such a trek a little easier:

- **Staying Within Sight of Each Other.** In a well-led, considerate group, members will adjust their pace to the slowest member. If caught in a storm, it is best to put the slowest person first in line. This way, normal stride and pacing will keep the group bunched up.
  Each person in line must be responsible to keep in sight, one person behind and one person ahead of them. No one should move until the last, or sweep, person is within sight of the second to last, and so on up the line. When each person is in sight of the next, the whole line can continue to move. Following this rule, the line functions even when visibility is so poor that each person can see only one person in each direction.
- **Assigning Numbers.** Groups travelling may find it more comforting to use numbers to identify each member in a group. Once the order is established, the person in the rear of the party is assigned the first number. This is sequentially followed to the lead person. At any time, any member of the group can call out for numbers and the group will number off starting with the rear person. Any numbers that are not accounted for indicates a missing person. The group can then stop and sort out the problem.
- **Taking Breaks as Required.** While trekking along a route, the leader can schedule routine rest stops. During these stops count the group members. This ensures all members are accounted for and provides time to address any issues.

GROUP DISCUSSION

TIPS FOR ANSWERING/FACILITATING DISCUSSION

- Establish ground rules for discussion, eg, everyone should listen respectfully; don't interrupt; only one person speaks at a time; no one's ideas should be made fun of; you can disagree with ideas but not with the person; try to understand others as much as you hope they understand you; etc.
- Sit the group in a circle, making sure all cadets can be seen by everyone else.
- Ask questions that will provoke thought; in other words avoid questions with yes or no answers.
- Manage time by ensuring the cadets stay on topic.
- Listen and respond in a way that indicates you have heard and understood the cadet. This can be done by paraphrasing their ideas.
- Give the cadets time to respond to your questions.
- Ensure every cadet has an opportunity to participate. One option is to go around the group and have each cadet answer the question with a short answer. Cadets must also have the option to pass if they wish.
- Additional questions should be prepared ahead of time.

SUGGESTED QUESTIONS

Q1. How would using a topographical map in the winter be different than in the summer?

Q2. What features are more noticeable during winter months?

Q3. You come upon a open field that stretches 5 km (3 miles) long. Your destination is a small inlet along the vegetation line directly across the field. There are definable mountains all around that make orienting the map easy. There is light snow falling; visibility at the moment is good. If you were handed the map and asked to lead the group across the field to the inlet, how would you proceed across the field safely, to arrive at your destination?

Q4. How would pace be affected in the winter? How would you test your pace prior to leaving on a trek in the winter?

Q5. What are some techniques a group could use when in a storm to ensure members do not get separated from the group? What are some other methods you may have used?

ANTICIPATED ANSWERS

A1. Using a topographical map in the winter would be different because when orienting the map the navigator will now have to look beyond the immediate surroundings and view the distant landscape for identifiable features.

A2. The features that are more noticeable during winter months are:

- the mountains in the distance (contour lines),
- large bodies of water (open areas that are covered in ice),
- ridge lines,
- visible archways of known paths, and
- definable vegetation changes (open fields that change into forest).

A3. The safest method to navigate across the field would be to shoot a bearing aiming off to one side of the destination. Once arriving at the vegetation line, follow the edge opposite the direction you aimed off (left or right) to the destination. At any time, the winds could pick up and without a bearing you would not know what direction to travel.

A4. Pacing would be affected in winter by the different conditions of the terrain being covered. Snow conditions, depth and the personal equipment you are using will all affect pace.
To determine an individual pace similar to summer treks, practice taking uniform, comfortable steps over a measured snow-covered distance (100 m) counting every second step of the dominant foot. Do this three to five times to get an average. This will be the individual's pace number and should be remembered.

A5. The techniques that can be used to ensure no members get separated from the group are making sure members stay in sight of each other, assigning numbers and taking scheduled breaks.

Other questions and answers will develop throughout the group discussion. The group discussion should not be limited to only those suggested.

Reinforce those answers given and comments made during the group discussion, ensuring the teaching points have been covered.

CONFIRMATION OF TEACHING POINT 4

The cadets' participation in the group discussion will serve as the confirmation of this TP.

Teaching Point 5 **Conduct an Activity Where the Cadet Will Practice Navigating in the Winter**

Time: 60 min Method: Practical Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadets practice navigating in the winter.

RESOURCES

- Topographical map (one per cadet),
- Magnetic compass (one per cadet), and
- Prepared navigation route.

ACTIVITY LAYOUT

The navigational activity must take place in an area with snow-covered surroundings away from most man-made features.

ACTIVITY INSTRUCTIONS

1. Provide each cadet with a topographical map and a compass.
2. Have cadets navigate a short predetermined route that crosses open terrain.
3. Have cadets practice aiming off of their destinations when trekking across the open area.
4. Have cadets practice group travel techniques.
5. Periodically stop cadets and have them orient their maps. Point out conflicting features and discrepancies between visual features compared to map based features. Identify the prominent features that will identify position.

SAFETY

First aid equipment and a device for communicating with base camp are to be carried in case of emergency.

END OF LESSON CONFIRMATION

The cadets' participation in the navigation activity will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Cadets who a participating in a trek in the winter may suddenly experience a rapid deterioration in weather conditions. Using winter navigational skills can ensure the group remains on course and arrives safely at their destination.

INSTRUCTOR NOTES/REMARKS

Corps may choose to schedule and instruct only TPs 1–4.

REFERENCES

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ROYAL CANADIAN ARMY CADETS

SILVER STAR

INSTRUCTIONAL GUIDE

SECTION 9

EO C322.03 – IDENTIFY THE PRINCIPLES OF MAP-MAKING

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-703/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Collect examples of different types of maps.

If available, photocopy an early explorer's map of the local area as a handout.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to present background information on maps and map-making.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have identified the principles of map-making.

IMPORTANCE

It is important for cadets to be able to identify the principles of map-making because using maps is an integral component of expedition activities. Cadets will be required to use a variety of maps throughout their cadet career. Knowing how maps are made will provide the cadets with additional background information that they can use to assist them in navigating. As well, maps are something used in everyday life, whether travelling from home to a relative's house or hiking in a provincial park. Maps show a user where they are going and how they are going to get there.

Teaching Point 1 | **Discuss Maps**

Time: 5 min | Method: Interactive Lecture

This TP is a review of material presented in previous star levels. Cadets should already have a clear understanding of what a map is. Guide the cadets, through leading questions, to ensure that they understand the main concepts.

Once a person understands the "language" of a map, they will be able to go anywhere.

WHAT IS A MAP

A map is a scale, or proportionately smaller, representation of the ground that uses universally accepted symbols to represent both natural and man-made features found on the ground.

TYPES, CHARACTERISTICS AND FEATURES OF MAPS

There are many types of maps, each determined by the purpose for which it is designed.

Topographical Map. A topographical map is the most common map used by the military. The purpose of a topographical map is to present a picture of the ground as it really exists. Topographical maps show as much detail as the scale allows, generally 1 : 25 000, 1 : 50 000, or 1 : 250 000. Features on a topographical map include physical features of the ground – rivers, woods, contours, roads, buildings, etc – as well as names of specific features – towns, villages, rivers, etc.

Orienteering Map. Through the International Orienteering Federation (IOF), specific rules and standards have been set for the production of an orienteering map, including colour, symbols, and scales. It is more detailed than a topographical map, both with reference to vegetation and landforms. They are usually produced in a scale smaller than 1 : 10 000.

Street and Road Map. A street and road map is designed to assist commuters and tourists to locate key sites such as roads and highways, police stations, fire halls, hospitals, schools and parks.

Relief Map. A relief map is a three-dimensional representation, usually of terrain. The terrain elevation is usually exaggerated by a factor between five and ten. This helps to recognize the terrain features.

Digital Map. A digital map, such as those found on computer programs and when using a GPS receiver, is useful as a reference tool as it is updated regularly. This allows a digital map to be a more accurate reference than other types of maps.

Political Map. A political map shows countries, provinces or other political borders–eg, globes and atlases.

Statistical Map. A statistical map shows statistical information such as the population, and production levels of crops or minerals across a country.

Outline Map. An outline map shows only borders, rivers, coastlines, etc.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is a map?

Q2. What type of map is most commonly used by the military?

Q3. What type of map provides a three dimensional representation of terrain?

ANTICIPATED ANSWERS

A1. A map is a scale, or proportionately smaller, representation of the ground that uses universally accepted symbols to represent both natural and man-made features.

A2. A topographical map is the most common map used by the military.

A3. A relief map is a three-dimensional representation, usually of terrain.

Teaching Point 2	**Discuss Cartography**
Time: 5 min	Method: Interactive Lecture

Cartography will be a new concept for most cadets. Have a flip chart detailing the main headings of the TP as a visual aid for cadets.

CARTOGRPAHY

Cartography, as defined by the International Cartographic Association, is a discipline which deals with the conception, production, dissemination and study of maps. In essence, cartography is the entire process of mapping. Cartography is also an academic discipline, which deals not only with the people who make maps, but also with the people who teach about, and complete research on maps. It is an ever-changing, complex field, which has the process of map-making at its centre and all functions related to map-making surrounding it.

TWO ESSENTIAL CHARACTERISTICS OF CARTOGRAPHY

Level of Importance to Society

The Canadian Cartographic Society states that maps perform a fundamental and indispensable role as one of the key elements of civilization. Few, if any, activities related to the earth's surface – property ownership, road construction, emergency response, and navigation – would be possible without maps.

Dynamic Nature

The discipline of cartography is continuously changing. Map-making has always been impacted by technological change; however, the speed with which technology is advancing has enormous implications. While there are still some who use pen and ink techniques for map-making, the majority of maps have been developed using the very latest computer hardware and graphic software. Today images are being generated faster and with less cost, and this will continue to improve with further advances in technology.

ROLE OF A CARTOGRAPHER

Most cartographers are employed in map-making occupations, although, that does not mean they do the same job. A cartographer's job depends on individual specialties and areas of interest.

The following are basic tasks that are generally performed, in some capacity, by all cartographers:

Liaising. Cartographers do not work in isolation. There is a requirement for them to work with outside agencies. It is their responsibility to discuss and set guidelines for the project with the client.

Editing. Editing encompasses a number of tasks, including the evaluation and processing of data; selecting scales and projections; making design decisions; drawing up flow charts and specifications; preparing compilations; and checking the final product.

Drafting. This is the process of constructing the map image. It is completed using a combination of hand – pen and ink work, scribing, etc – and computer methods.

Researching. A cartographer will have to complete research: search out suitable data for a specific map; analyze output from Global Information Systems (GIS); scientifically study maps and map-making and map-reading processes; and develop new techniques for map-making.

Teaching. Many cartographers work as teachers in colleges and universities.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What is the definition of cartography?

Q2. What activities would be impossible without maps?

Q3. The process of constructing the map image is what job of a cartographer?

ANTICIPATED ANSWERS

A1. Cartography, as defined by International Cartographic Association, is a discipline which deals with the conception, production, dissemination and study of maps.

A2. Any activities related to the earth's surface – property ownership, road construction, emergency response and navigation – would be impracticable without maps.

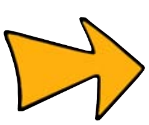
A3. Drafting is the process of constructing the map image.

Teaching Point 3 — **Identify the Principles of Map-Making**

Time: 15 min — Method: Practical Activity

Map-making has become a technologically based skill. Understanding the principles of making a map by hand is still very important. Cadets will be introduced to the four-step process used to develop a map during this TP.

Before people took pictures from airplanes, maps were drawn by someone travelling over the terrain and drawing by hand. With aerial photography, map-making has become much easier–but still requires a great deal of work from the map-maker (cartographer).



Much of Canada was mapped by hand by European explorers like Champlain, Tyrell, MacKenzie and Thompson.

If available, distribute a copy of an early explorer's map of the local area.

STEP 1 – DETERMINING LOCATION

The first step in preparing a map is for the individual to determine their current location. The location of any point or place on the earth's surface can only be understood with reference to its distance from another point or place.

The easiest way to do this is to use landmarks. Landmarks are features that are man-made – houses, buildings, railroads, churches – or natural – a river, lakes, forested areas.

Have the cadets list 'landmarks' which could be in a classroom. These may include desks, chairs, windows, chalkboard, door, tables, OHP, etc.

The exact location of an object must be determined, to ensure that the map-user can easily find the site depicted without depending on another person for guidance. To make this possible, the earth's surface has been divided into a grid system of imaginary lines – lines of longitude (eastings) and lines of latitude (northings) – which provide map-makers with the ability to place and locate landmarks with precision.

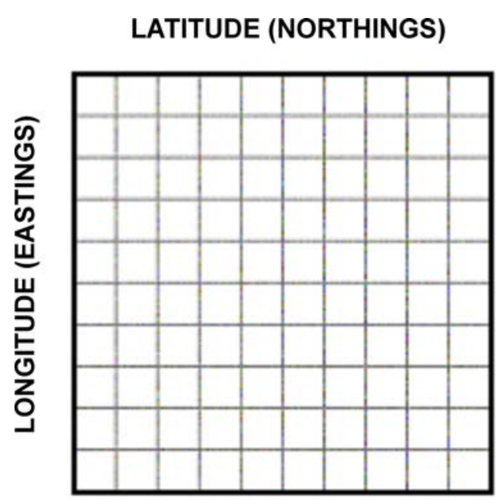


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Figure 13-9-1 Representation of Lines of Longitude and Latitude

STEP 2 – DETERMING PROJECTION AND SCALE

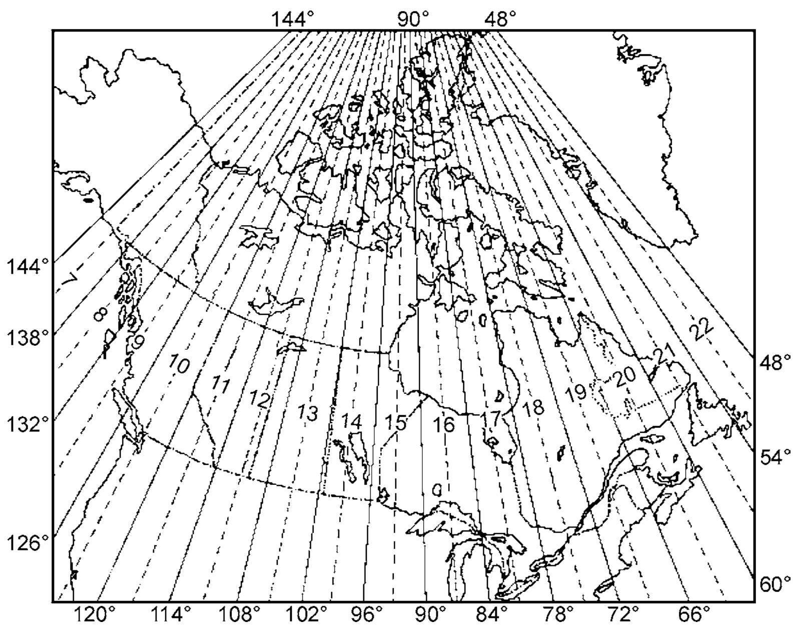
Any type of representation of the earth's surface on a flat piece of paper will have distortions because the world is round. These are relatively insignificant on maps that show only small parts of the earth, like street and road maps or 1 : 50 000 scale maps, but are quite considerable for maps of countries and continents.

Cadets will not be required to determine projection when developing a map. It is important that they are familiar with the concept, particularly Universal Transverse Mercator (UTM).

Map Projection

Map projection is a geometrical method of reducing the amount of distortion on a flat map. In very large countries such as Canada, map-makers divide the country into strips from north to south, called zones, and project each zone.

UTM. UTM is a system of strip projection which is used by all National Topographical System maps. For UTM Projection, the earth's surface has been divided into 60 zones. Sixteen of these zones, numbered 7–22, cover Canada from west to east.



"Natural Resources Canada", The Universal Transverse Mercator Grid, Copyright 1969 by Department of Energy, Mines and Resource Canada, Surveys and Mapping Branch, Ottawa, ON. Retrieved April 4, 2008, from http://maps.nrcan.gc.ca/topo101/utm2_e.php

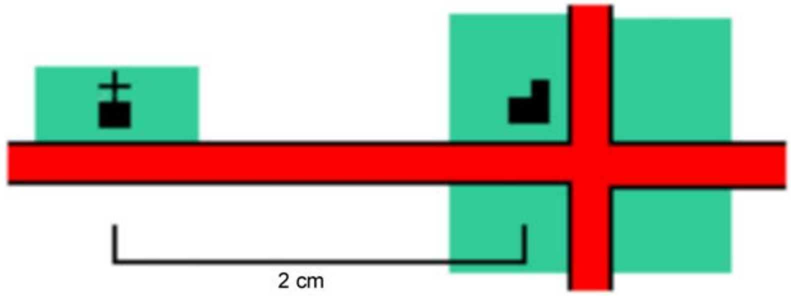
Figure 13-9-2 UTM Zones – Canada

Scale

Modern maps share one thing in common, they are all drawn to scale – meaning they are exact representations of the area they illustrate. The scale of a map is an expression of the ratio between one unit on the map and the distance it covers, in the same units, on the ground.

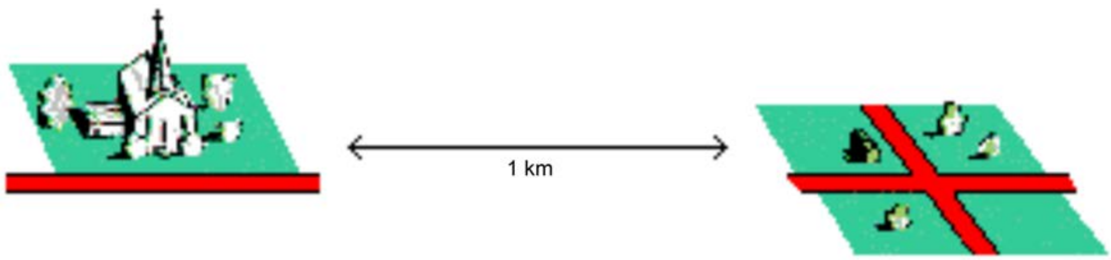
For example:

If 2 cm on a map, represents 1 km on the ground, the scale is 2 cm = 1 km.



"Natural Resources Canada", Map Scale, Copyright 1969 by Department of Energy, Mines and Resource Canada, Surveys and Mapping Branch, Ottawa, ON. Retrieved April 4, 2008, from http://maps.nrcan.gc.ca/topo101/scale_e.php

Figure 13-9-3 Scale – Map



"Natural Resources Canada", Map Scale, Copyright 1969 by Department of Energy, Mines and Resource Canada, Surveys and Mapping Branch, Ottawa, ON. Retrieved April 4, 2008, from http://maps.nrcan.gc.ca/topo101/scale_e.php

Figure 13-9-4 Scale – Real Distance

Another way to represent scale would be:

$$\frac{\text{DISTANCE ON THE MAP}}{\text{DISTANCE ON THE GROUND}} = \frac{2\text{ cm}}{1\text{ km}} = \frac{2\text{ cm}}{100\ 000\text{ cm}}$$

$$= \frac{1}{50\ 000}$$

$$= \textbf{1: 50 000 SCALE}$$

"Natural Resources Canada", Map Scale, Copyright 1969 by Department of Energy, Mines and Resource Canada, Surveys and Mapping Branch, Ottawa, ON. Retrieved April 4, 2008, from http://maps.nrcan.gc.ca/topo101/scale_e.php

Figure 13-9-5 Scale Representation

Ask cadets what scale should be used when drawing a map of the classroom. The scale should be in cm, given the size of a classroom. The scale ratio will be very small, as the map will show great detail. Figures 13-9-6 and 13-9-7 are examples of the scale.

For the map of the classroom the scale will be 1 : 50. This means that 1 cm on the map is equal to 0.5 m (50 cm) on the ground.

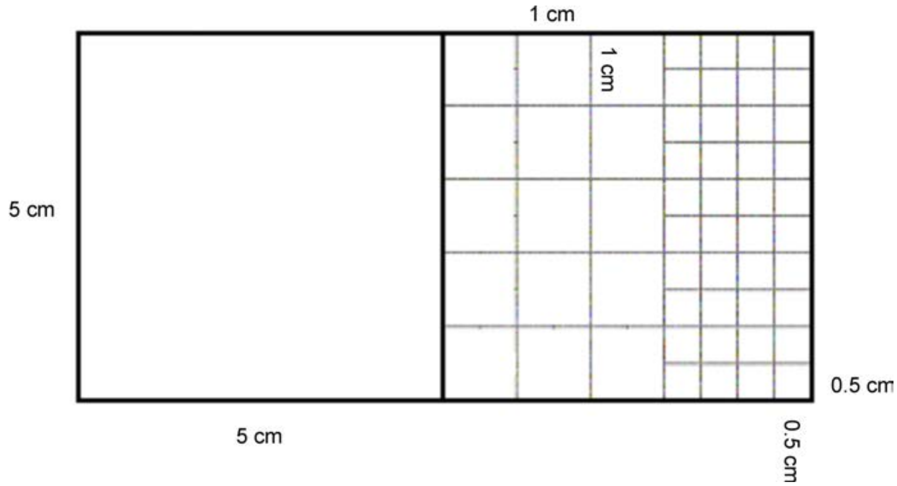


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Figure 13-9-6 Grid Square

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Figure 13-9-7 Map Scale

STEP 3 – IDENTIFYING FEATURES AND ADDING SYMBOLS

Once the map's projection and scale are determined, the next step is to add features of the physical landscapes that will most accurately and vividly represent the area being mapped. This is done by simplifying the features using symbols and colours.

Map Symbols. Map symbols are graphic images that represent something else. They may be depicted by pictorial images, abstract combinations of points and lines, or tonal shading and colour tints.

Have a selection of maps available so cadets can see the types of symbols used.

Map-makers use a key or legend to indicate what symbols represent. On topographical maps, this legend is included on the back of the map and sometimes in the map margin.

Have the cadets brainstorm symbols which correspond to the features they previously identified in the classroom. An example is an "x" to symbolize a chair.

Placing Symbols on the Map

Once the appropriate symbols have been identified, the map-maker must place them on the map. This is done by:

1. measuring the distance of the area/location which is to be mapped and marking this on the graph paper;
2. selecting a reference point. This could be the centre of the area being mapped, one of the four corners, etc;
3. selecting and plotting the first feature by placing the symbol on the map. This initial feature should be something that is known and easily transferred from the ground to the map;

> All maps are drawn from a reference point. The reference point is called the datum. Most map datum only cover a portion of the earth, like the North American Datum of 1927 (NAD–27), which only covers the continent of North America.

4. selecting the next feature, measuring the distance and direction between it and the initial feature, and then placing the symbol on the map; and

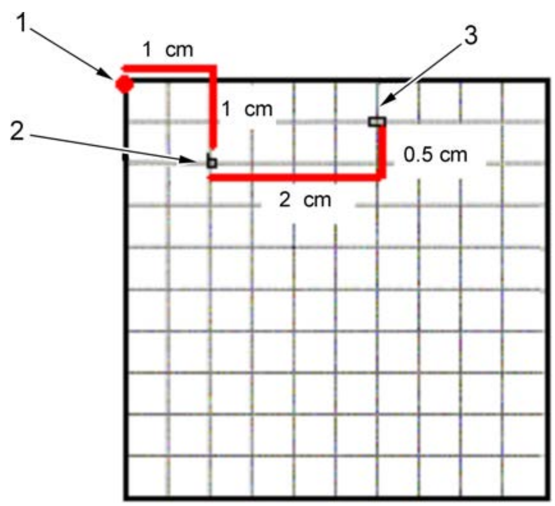

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Figure 13-9-8 Adding Symbols to the Map

> In the example in Figure 13-9-8, the map-maker:
>
> 1. selected the reference point – the northeast corner of the classroom;
> 2. measured the actual position (0.5 m across, 0.5 m down), then plotted the symbol in the correct location using the scale (1 cm across, 1 cm down); and
> 3. selected the next feature, the desk, and measured the actual distance across from the chair and then up to the desk (1 m [2 cm] by 0.25 m [0.5 cm]).

5. for each new feature added to the map, measuring its position in relation to those already added.

> The map-maker should add symbols one grid square at a time.

Step 4 – APPLYING GEOGRAPHICAL NAMES TO FEATURES

The final step in the making of a map is selecting and applying geographical names that identify relevant features, landmarks, and places. Geographical names are fundamental elements of maps.

> At this point most natural landmarks have already been named.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. Determining location is the first step in making a map. What is the easiest way to do this?

Q2. What is map projection?

Q3. The scale of a map is an expression of what type of ratio?

ANTICIPATED ANSWERS

A1. The easiest way to determine location is to use landmarks. Landmarks are features that are man-made – houses, buildings, railroads, churches – or natural – a river, lakes, forested areas.

A2. Map projection is a geometrical method of reducing the amount of distortion on a flat map. In very large countries such as Canada, map-makers divide the country into strips from north to south, called zones, and project each zone.

A3. The scale of a map is an expression of the ratio between one unit on the map and the distance it covers, in the same units, on the real ground.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. What is a map?

Q2. What are the five basic functions that are generally performed, in some capacity, by all cartographers?

Q3. What is the UTM?

ANTICIPATED ANSWERS

A1. A map is a scale, or proportionately smaller, representation of the ground that uses internationally accepted symbols to represent both natural and man-made features.

A2. The five basic functions that are generally performed, in some capacity by all cartographers are liaising, editing, drafting, researching and teaching.

A3. The UTM is a system of strip projection which is used by all National Topographical System maps. For UTM projection, the earth's surface has been divided into 60 zones. Sixteen of these zones, numbered 7–22, cover Canada from west to east.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Being able to identify the principles of map-making is an important concept to understand because using maps is an integral component to the army cadet training program. Knowing how a map is made and developed will assist cadets in reading a map.

INSTRUCTOR NOTES/REMARKS

Cadets will be given the opportunity to create their own maps in EO C322.04 (Draw a Map of an Area in the Local Training Facility, Section 10).

REFERENCES

C2-166 Geomatics Yukon Kids. (2002). *Cartography*. Retrieved February 21, 2008, from http://www.geomaticsyukpn.ca/kids/cartography1.html.

C2-168 EdGate. (2006). *Cartography Concepts: A Student's Guide to Mapmaking*. Retrieved February 21, 2008, from http://www.edgate.com/lewisandclark/cartography.html.

C2-170 Gorman, J., & Morris, M. (Eds.). (1998, April). *You Are Here*. The Backpacker, April, 74–81.

C2-190 The Canadian Cartographic Association. (2008). *Digital Pamphlet: Careers in Cartography*. Retrieved April 3, 2008, from http://www.cca-acc.org/careers.asp.

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ROYAL CANADIAN ARMY CADETS

SILVER STAR

INSTRUCTIONAL GUIDE

SECTION 10

EO C322.04 – DRAW A MAP OF AN AREA IN THE LOCAL TRAINING FACILITY

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-703/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Photocopy Annex F for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

A practical activity was chosen for this lesson as it is an interactive way to allow the cadet to experience map-making in a safe, controlled environment. This activity contributes to the development of map-making skills in a fun and challenging setting.

INTRODUCTION

REVIEW

The following review is from EO C322.03 (Identify the Principles of Map-Making, Section 9):

QUESTIONS

Q1. What are the four principles of map-making?

Q2. Determine location is the first step in making a map. What is the easiest way to do this?

Q3. The scale of a map is an expression of what type of ratio?

ANTICIPATED ANSWERS

A1. The four principles of map-making are:

- determine location;
- determine projection and scale;

- identify features and add symbols; and
- apply geographical names to features.

A2. The easiest way to determine location is to use landmarks. Landmarks can be in the form of manmade features – houses, buildings, railroads, churches—or natural features – rivers, lakes, forested areas.

A3. The scale of a map is an expression of the ratio between one unit on the map and the distance one unit covers on the ground.

OBJECTIVES

By the end of this lesson the cadet shall have drawn a map of an area in the local training facility using the principles of map-making.

IMPORTANCE

It is important for cadets to be able to draw a map of an area in the local training facility because understanding the concept of map-making will enhance the cadets' ability to read a map. Using maps is an integral component to the army cadet training program and it is critical that a cadet is able to use them effectively. Drawing a map, using the principles of map-making, will provide the cadet the opportunity to see a map as more than simply lines and symbols.

Teaching Point 1	**Have the Cadets Draw a Map of an Area in the Local Training Facility**
Time: 25 min	Method: Practical Activity

ACTIVITY

OBJECTIVE

The objective of this activity is for the cadet to draw a map of an area in the unit's local training facility.

RESOURCES

- Graph paper located at Annex F,
- Paper (letter size),
- Measuring tape (one per group),
- Ruler (one per group),
- Pen/pencil,
- Markers/pencil crayons, and
- Notebook.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into groups of no more than three.
2. Assign each group an area in the local training facility to map.

3. Have each group draw a map, which includes:
   (a) the name of the map,
   (b) the scale of the map, and
   (c) a legend of symbols.
4. Have each group present their map to the rest of the class.
5. Debrief the cadets discussing the practicality of making a map by hand, the difficulties they experienced, and what they learned from the activity.

SAFETY

If cadets are mapping outside, there must be an adult supervisor with the group at all times.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the practical activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' participation in the practical map-making activity will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Map reading is more than just looking at symbols and lines on a map. Participating in making a map will provide the cadet the opportunity to further understand how each symbol and line represents real features on the ground.

INSTRUCTOR NOTES/REMARKS

This EO is to be scheduled after EO C322.03 (Identify the Principles of Map-Making, Section 9).

REFERENCES

C2-168 EdGate. (2006). *Cartography Concepts: A Student's Guide to Mapmaking*. Retrieved February 21, 2008, from http://www.edgate.com/lewisandclark/cartography.html.

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DECLINATION PROBLEM WORKSHEET

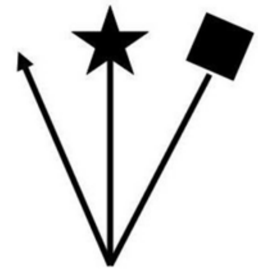
1. What is the declination for the following map where:

    a. the current year is 2010,

    b. the approximate mean declination is for 1998, and

    c. the annual change is increasing 10.0'?

12°22'



Answer: _______________ East/West (circle one).

2. What is the declination for the following map where:

    - the current year is 2011,
    - the approximate mean declination is for 2001, and
    - the annual change is decreasing 7.0'?

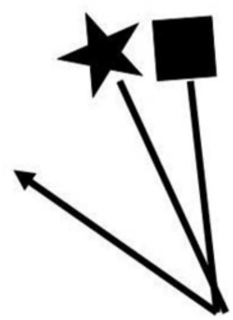
7°17'

Answer: _______________ East/West (circle one).

3. What is the declination for the following map:

    - the current year is 2015,
    - the approximate mean declination is for 2004, and
    - the annual change is increasing 8.32'?

5°53'

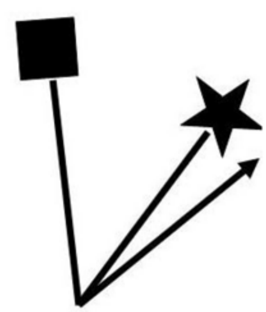


Answer: _______________ East/West (circle one).

4. What is the declination for the following map:

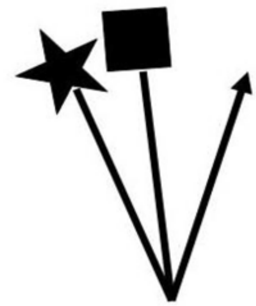
    - the current year is 2012,
    - the approximate mean declination is for 1998, and
    - the annual change is increasing 9.57'?

10°24'



Answer: _______________ East/West (circle one).

5. What is the declination for the following map:
   - the current year is 2014, 9°30'
   - the approximate mean declination is for 2001, and
   - the annual change is decreasing 18'.0?

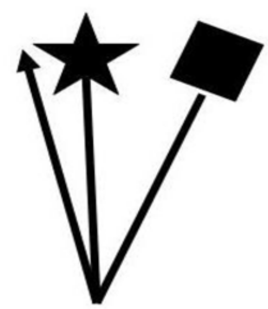


Answer: _______________ East/West (circle one).

6. What is the declination for the following map:
   - the current year is 2015, 17°45'
   - the approximate mean declination is for 2003, and
   - the annual change increasing 2.0'?

Answer: _______________ East/West (circle one).

7. What is the declination for the following map:
   - the current year is 2015, 14°12'
   - the approximate mean declination is for 2003, and
   - the annual change is decreasing 11.0'?



Answer: _______________ East/West (circle one).

8. What is the declination for the following map:
   - the current year is 2016, 7°39'
   - the approximate mean declination is for 2009, and
   - the annual change is decreasing 2.7'?

Answer: _______________ East/West (circle one).

ANSWER KEY TO DECLINATION PROBLEM WORKSHEET

DECLINATION WORKINGS				ANSWER
1.	2010 - 1998 = 12	12 x 10 = 120° 120 ÷ 60 = 2°	12°22' + 2° = 14° 22'	**14°22' W**
2.	2011 - 2001 = 10	7° x 10 = 70' 70 ÷ 60 = 1°10'	7°17' - 1°10' = 6°07'	**6°07' E**
3.	2015 - 2004 = 11	11 x 8.32 = 91.52	5° 53' + 91'52" = 5°144'52" 5°144'.52" = 7°24'52" = 7°25'	**7°25' W**
4.	2012 - 1998 = 14	14 x 9.57' = 133.98 133.98 ÷ 60=2°13'98"	10°24' + 2°13.98' = 12°37.98"	**12°38' E**
5.	2014 - 2001 = 13	13 x 18' = 234 234 ÷ 60 = 3° 54'	9°30' - 3°54' = 5°36'	**5°36' E**
6.	2015 - 2003 = 12	12 x 2' = 24'	17°45' + 24' = 18°09'	**18°09' E**
7.	2015 - 2003 = 12	12 x 11' = 132' 132' ÷ 60 = 2°12'	14°12' - 2°12' = 12°	**12° W**
8.	2016 - 2009 = 7	7 x 2.7' = 18.9'	7°39' - 18.9' = 7°20'	**7°20' W**

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SIMULATED MAP DATUM

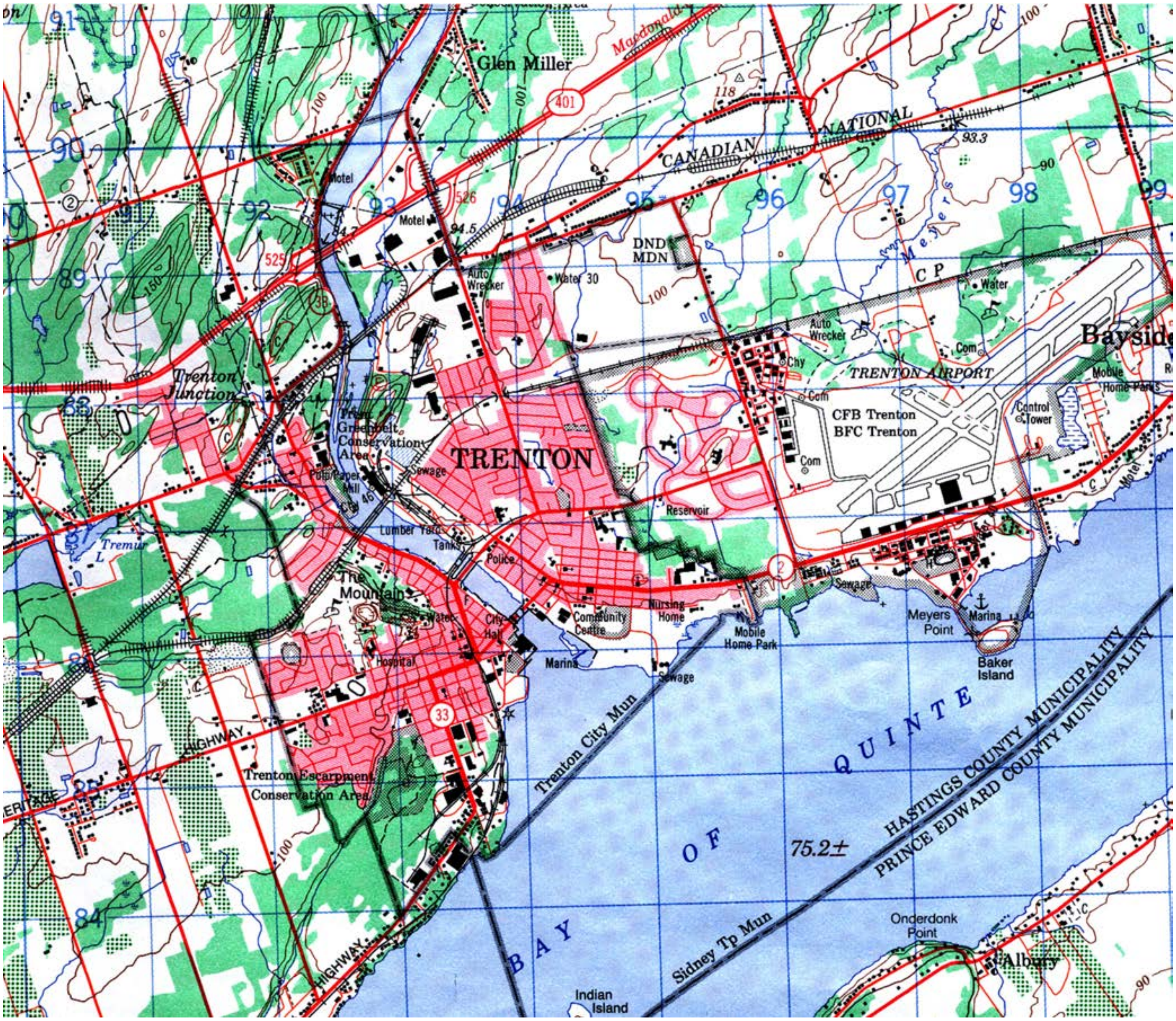

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Figure 13C-1 Simulated Map for Making a Datum

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GRID OVERLAY

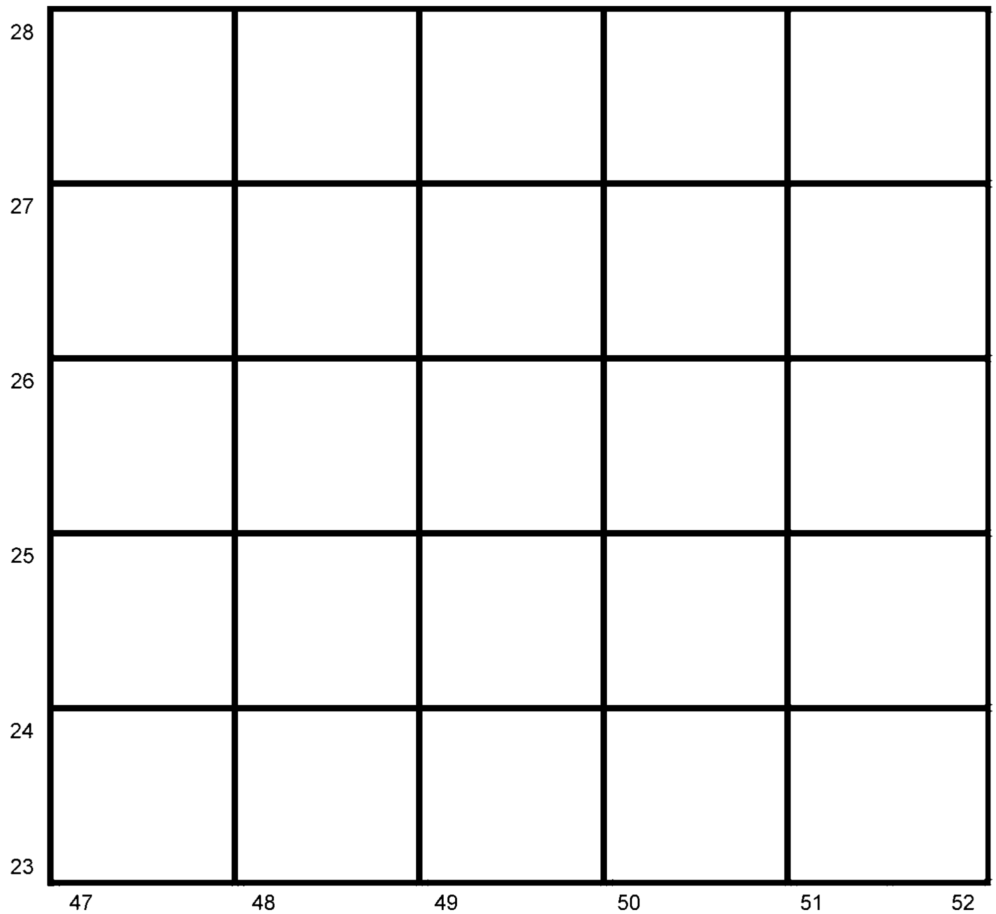

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Figure 13D-1 Grid Overlay

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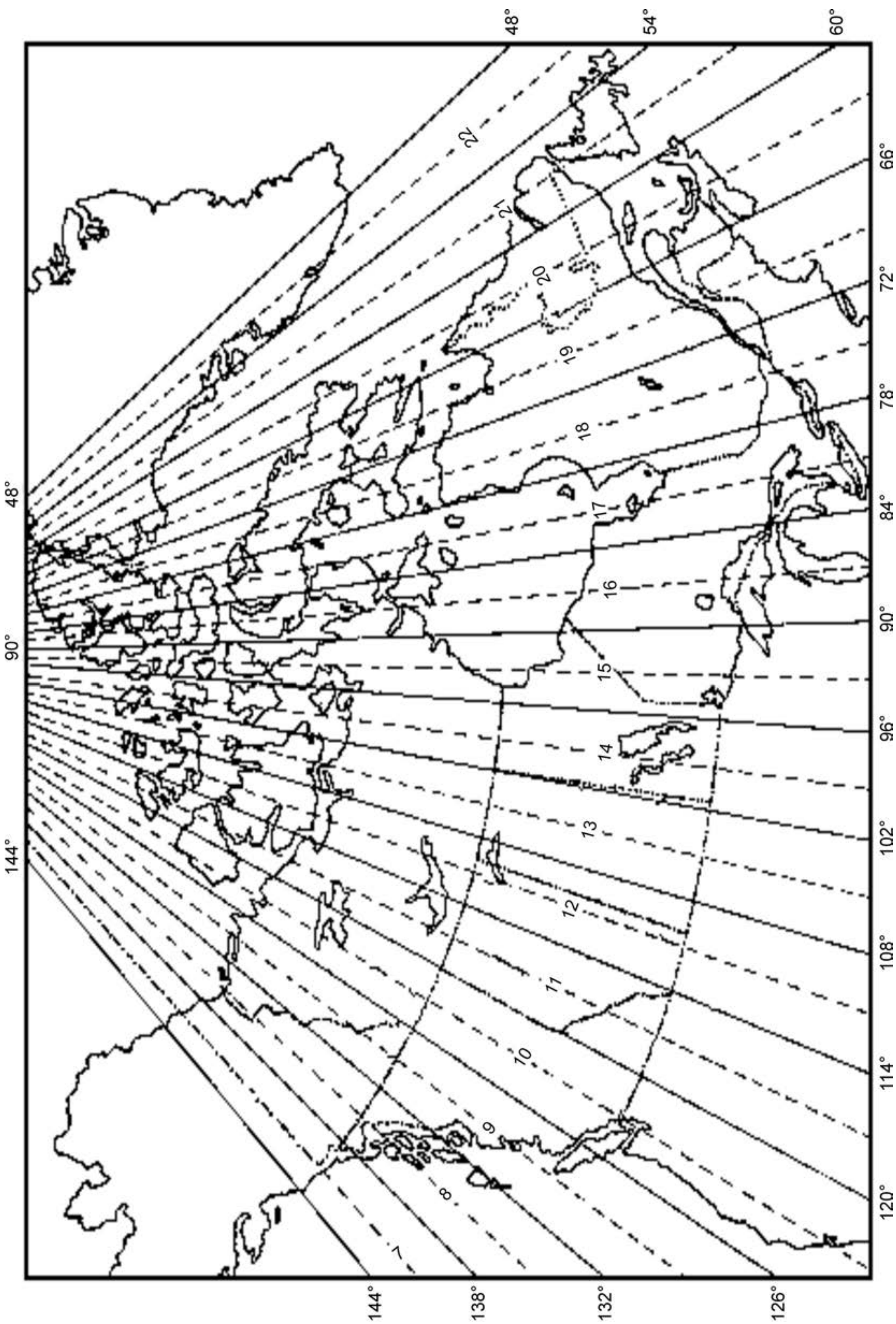
CANADIAN UTM ZONES



"Natural Resources Canada", The Universal Transverse Mercator Grid, Copyright 1969 by Department of Energy, Mines and Resource Canada, Surveys and Mapping Branch. Retrieved April 4, 2008, from http://maps.nrcan.gc.ca/topo101/utm2_e.php

Figure 13E-1 Canadian UTM Zones

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GRAPH PAPER

Map of ____

Scale ____

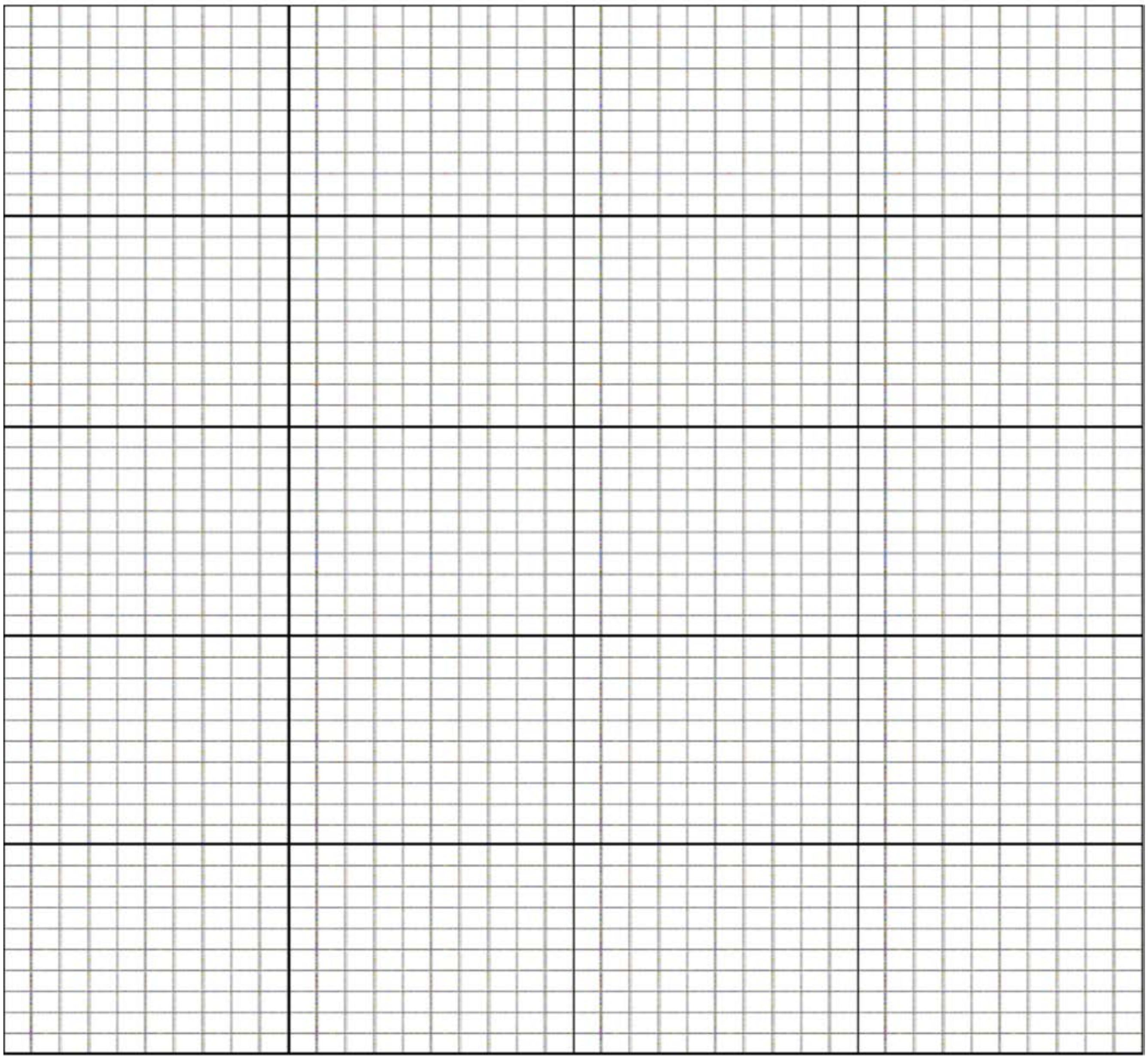

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Figure 13F-1 Graph Paper

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