**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.



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**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



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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.



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**Teaching point 2** **Discuss the Universal Transverse Mercator (UTM) Grid System**

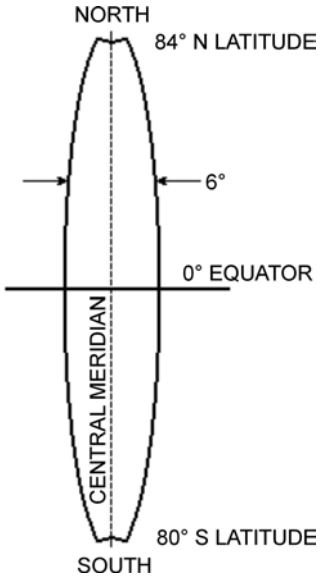
Time: 10 min Method: Interactive Lecture

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 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,



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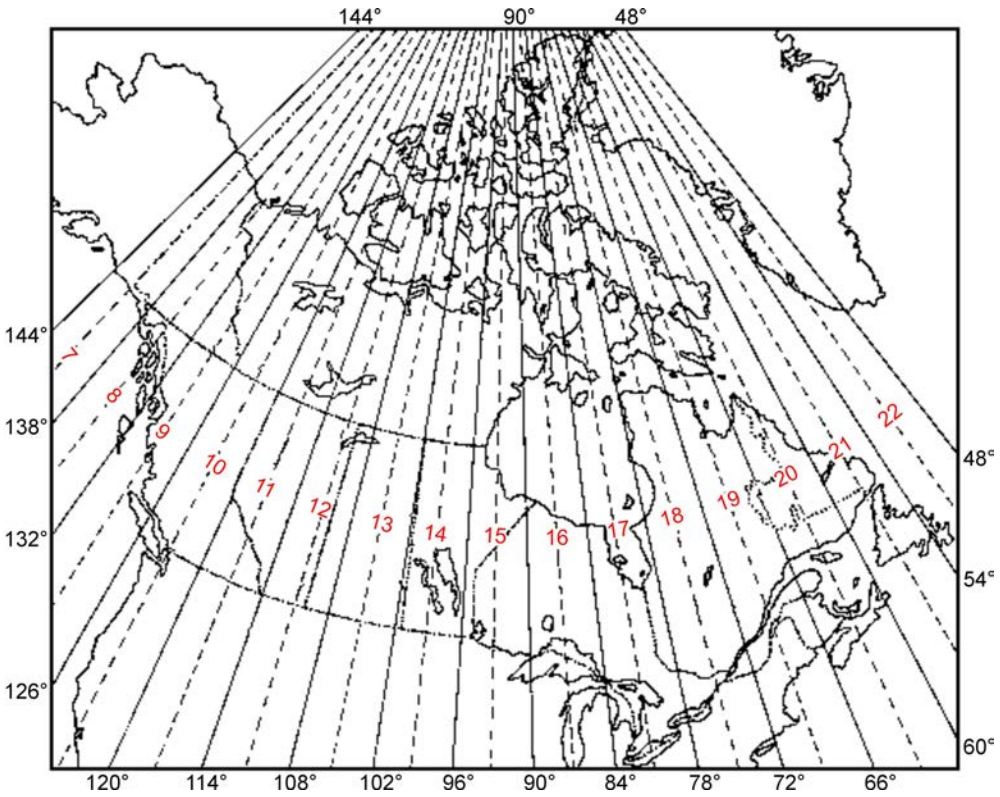
like 1 : 50 000 scale maps. The location of the topographical map zone number can be found in the marginal information, in the grid zone designator box as seen in Figure 3.

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 2 Canadian UTM Zones

**ONE THOUSAND METRE**
**UNIVERSAL TRANSVERSE MERCATOR GRID**
**ZONE 18**

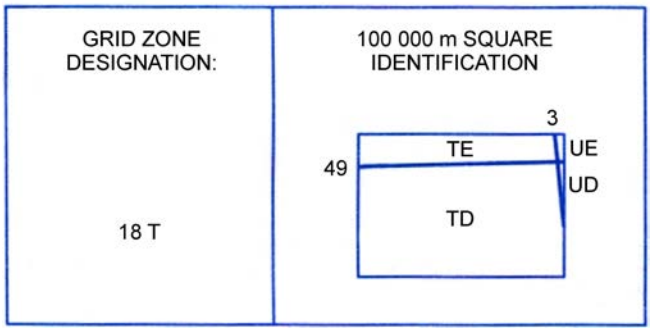



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Figure 3 Grid Zone Identifier



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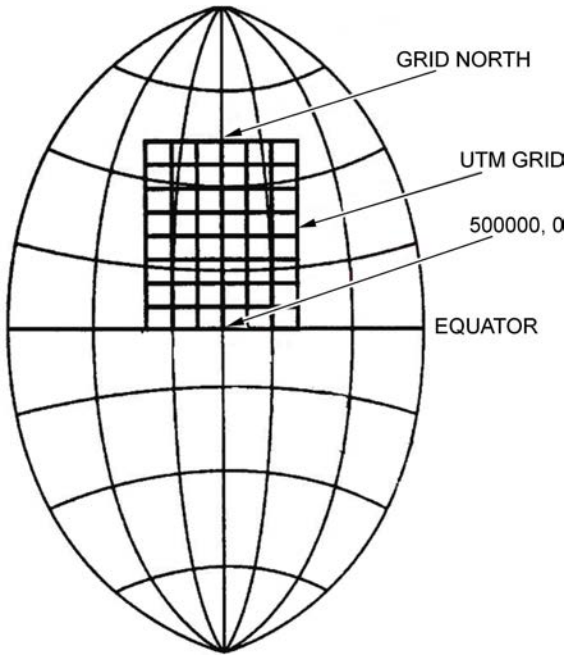
## GRID REFERENCE SYSTEMS

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 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 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 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 4 Grid Overlay



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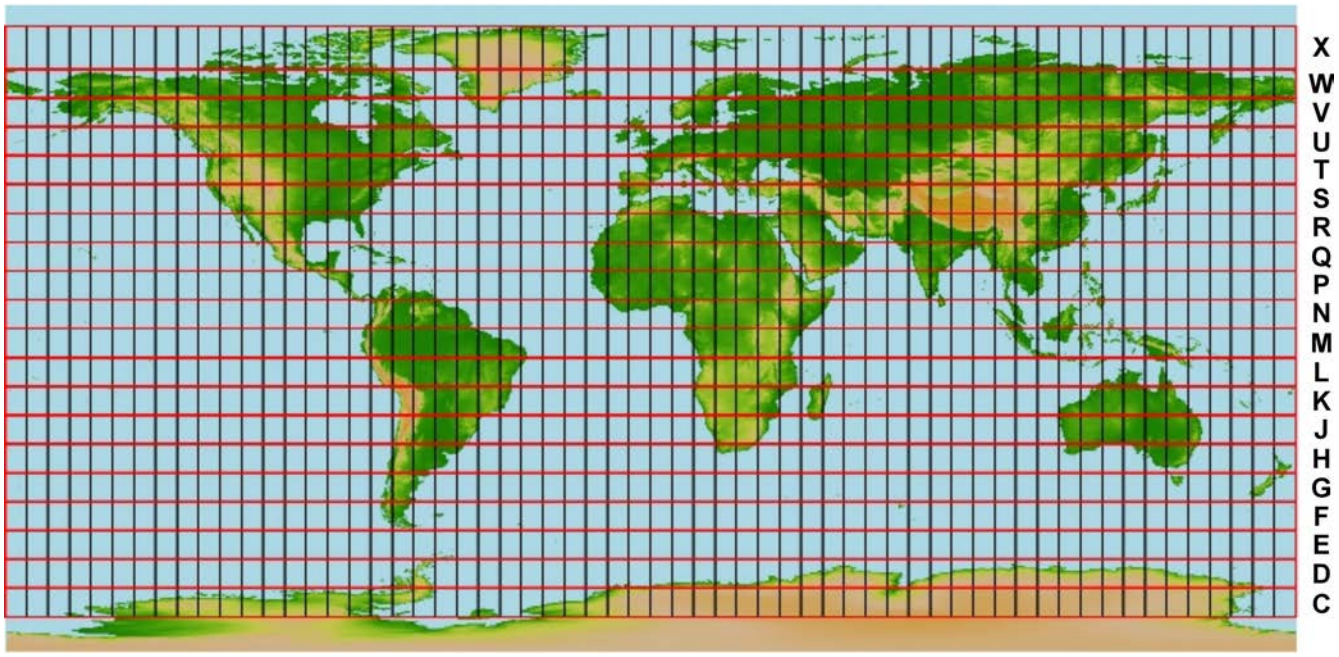
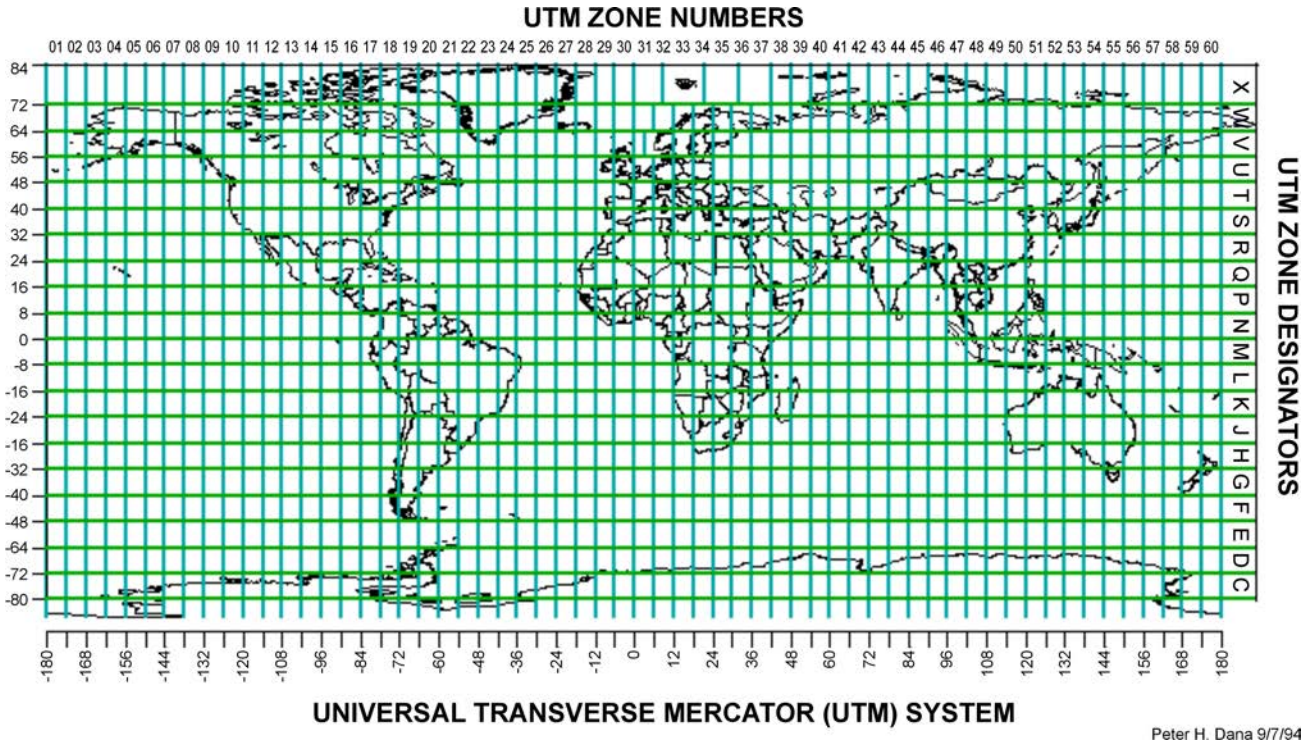



*"Warner College of Natural Resources", UTM Sub Zones, Copyright 2007 Colorado State University. Retrieved May 2, 2008, from http://welcome.warnercnr.colostate.edu/class_info/nr502/lg3/datums_coordinates/utm.html*

Figure 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 6 UTM Zone Numbers

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



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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.

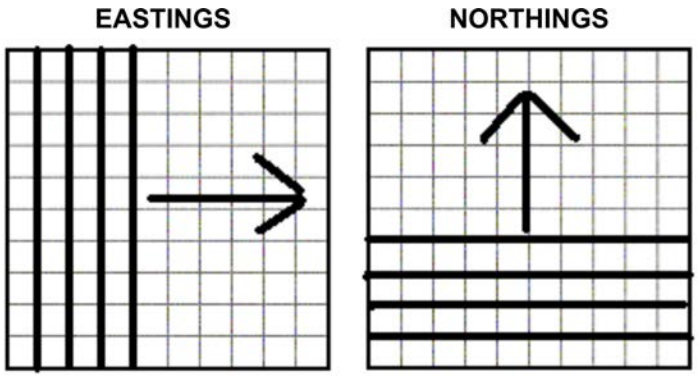


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Figure 7 Eastings and Northings

**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 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.



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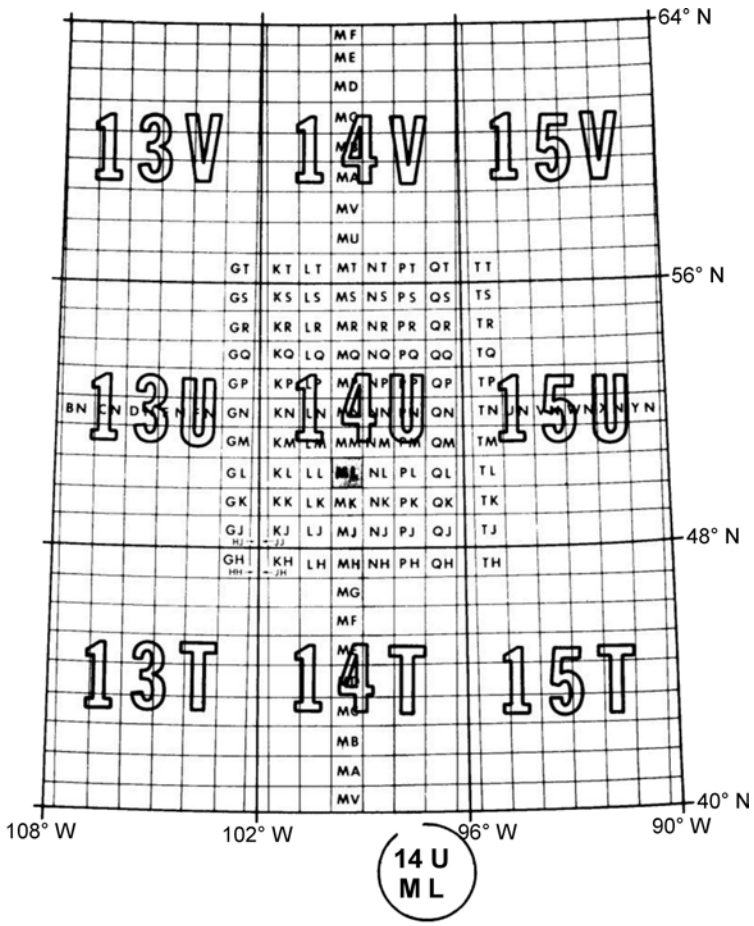


*Department of National Defence, Military Training Volume 8, Map Field Sketching and Compasses, Department of National Defence, 1976, Department of National Defence (p. 75)*

Figure 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.



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**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.

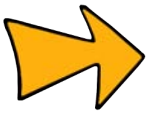


Ensure that the GPS receiver coordinate system is set to MGRS.

**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 9 GPS Receiver Coordinates

The coordinates displayed on the GPS receivers in Figure 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:<br>• Grid Zone Designator – 18 T,<br>• 100 000 m square identifier – TD, and<br>• 10-figure GR as –96785 86748 | The coordinates are identified as:<br>• Grid Zone Designator – 18 T,<br>• 100 000 m square identifier – TP, and<br>• 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.



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### 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 10, is 18 T.

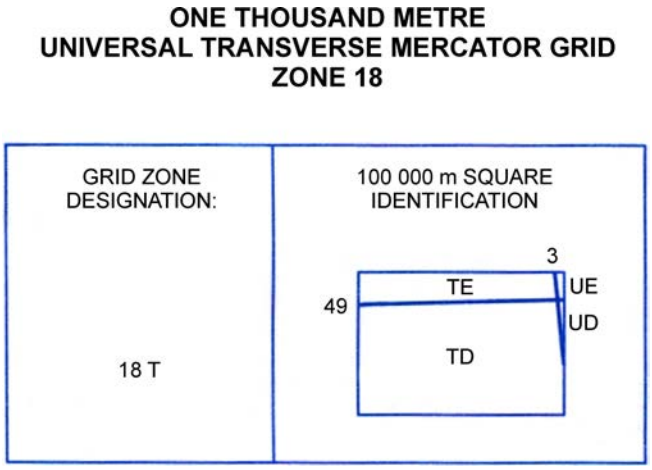


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Figure 10 Grid Zone Designator

### 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 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 11.



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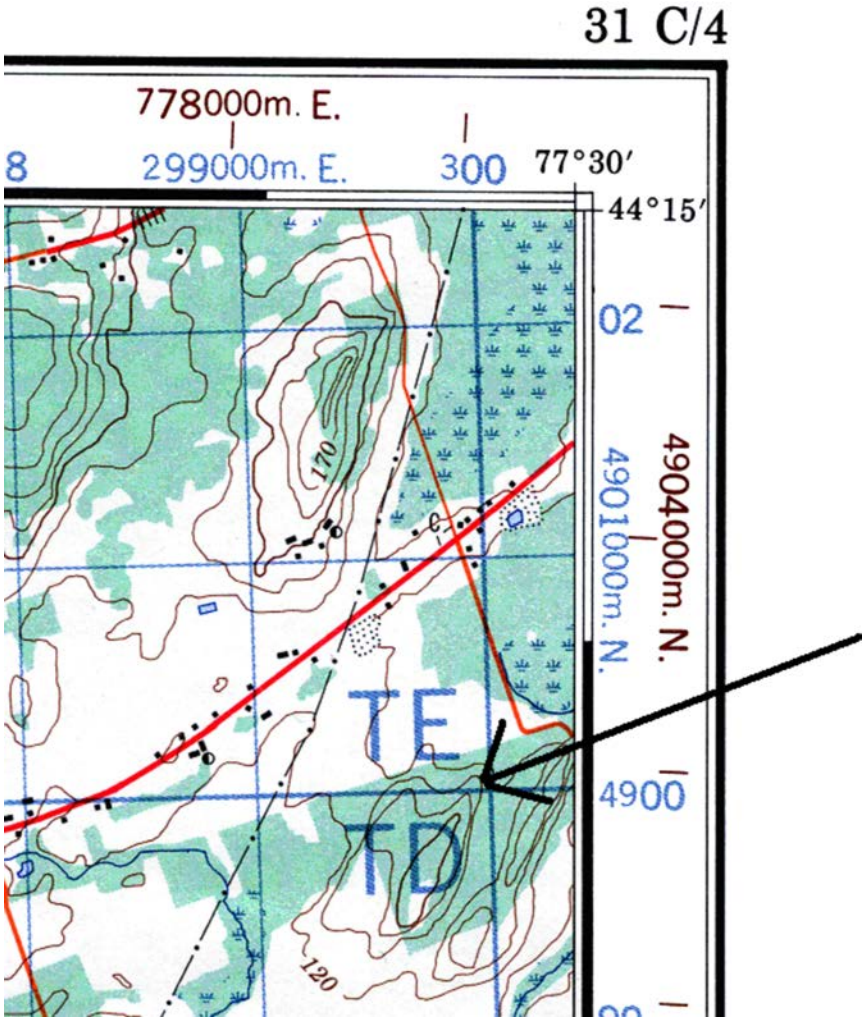


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Figure 11 Topographical Map 100 000 m Square Identifier

## 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:



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- 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.

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**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

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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.

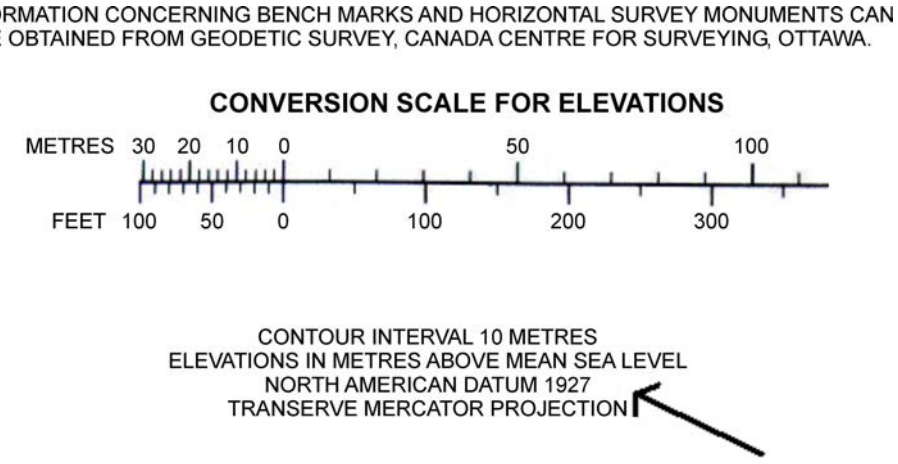


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Figure 12 Map Datum



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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.



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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.



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