EASTERN SHORE GROUND SEARCH AND RESCUE

Map & Compass Course

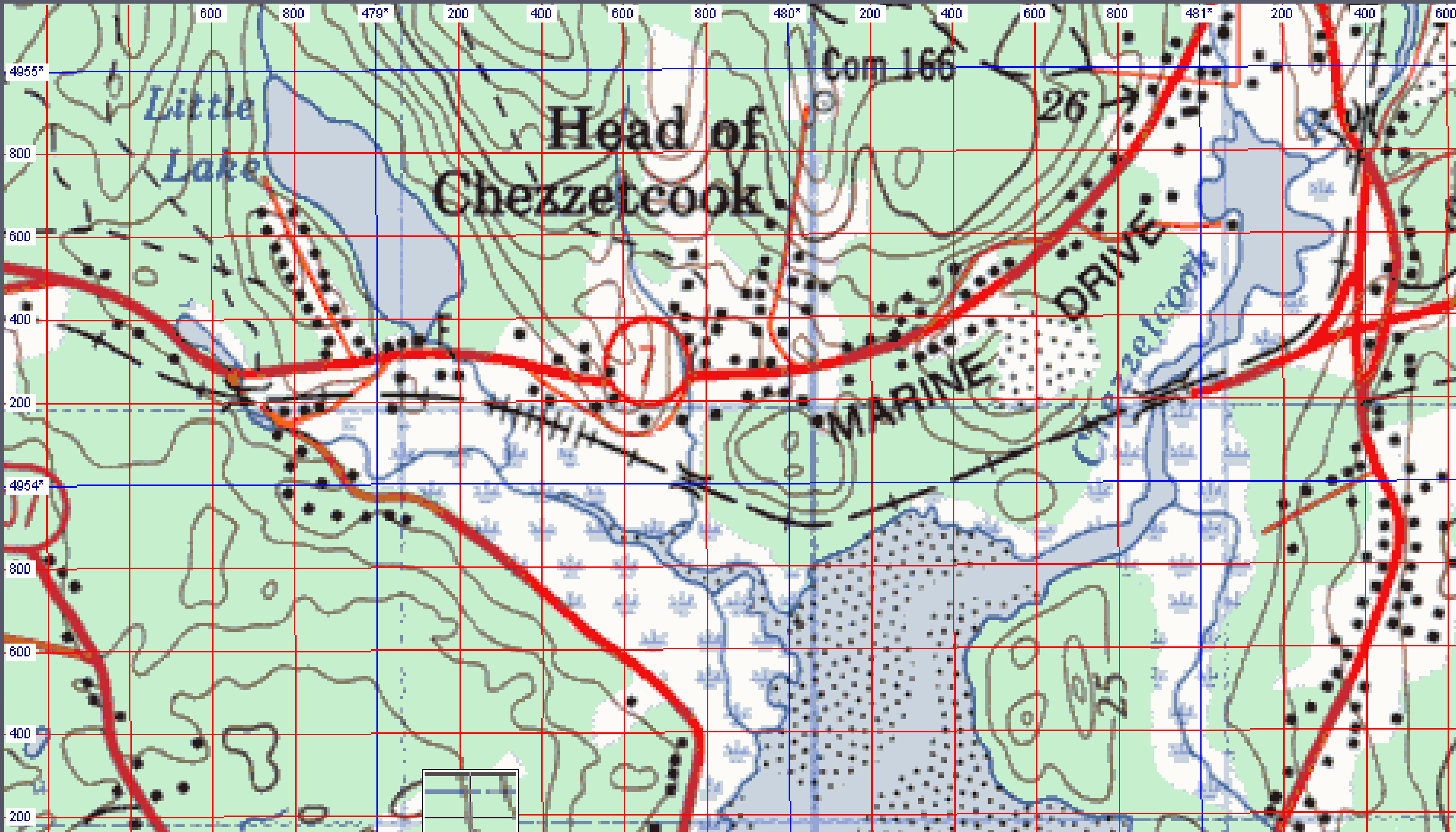
GSAR EXPECTATION

Map and compass skills are not optional for searchers.

All searchers <u>MUST</u> be able to use a map and compass easily and effectively.

TOPOGRAPHIC MAPS

- A MAP is a pictorial representation of a portion of the earth's surface.
- The most useful and commonly used map by the searcher is the ***TOPOGRAPHIC MAP***, which can be defined as:
    - *A two dimensional representation of the three dimensional configuration of a land surface.*



Example of a 1:10000 scale Searcher Map

Example of an Orthographic Map

TOPOGRAPHIC MAPS

- **Advantages Of A Topographic Map:**
  - Represent physical features of the earth's surface without distortion.
  - Made to scale (1:10000) which means there is a ratio of a distance on the map to the actual distance on the ground.
  - Have grids which allow the searcher to describe a point on a map with great accuracy.
  - Provide a wealth of information about a particular location.

MAP CONVENTIONS

- Topographic maps have a wide variety of applications, but all follow the same general conventions.
- Maps are made with North at the top.
- A black margin frames the ground area represented.
- The Title, Scale, Contour Interval, Reference Systems, Legend and other information are shown outside and are usually displayed along the bottom or right margin.
- Topographic map symbols are usually displayed on the back of the map.

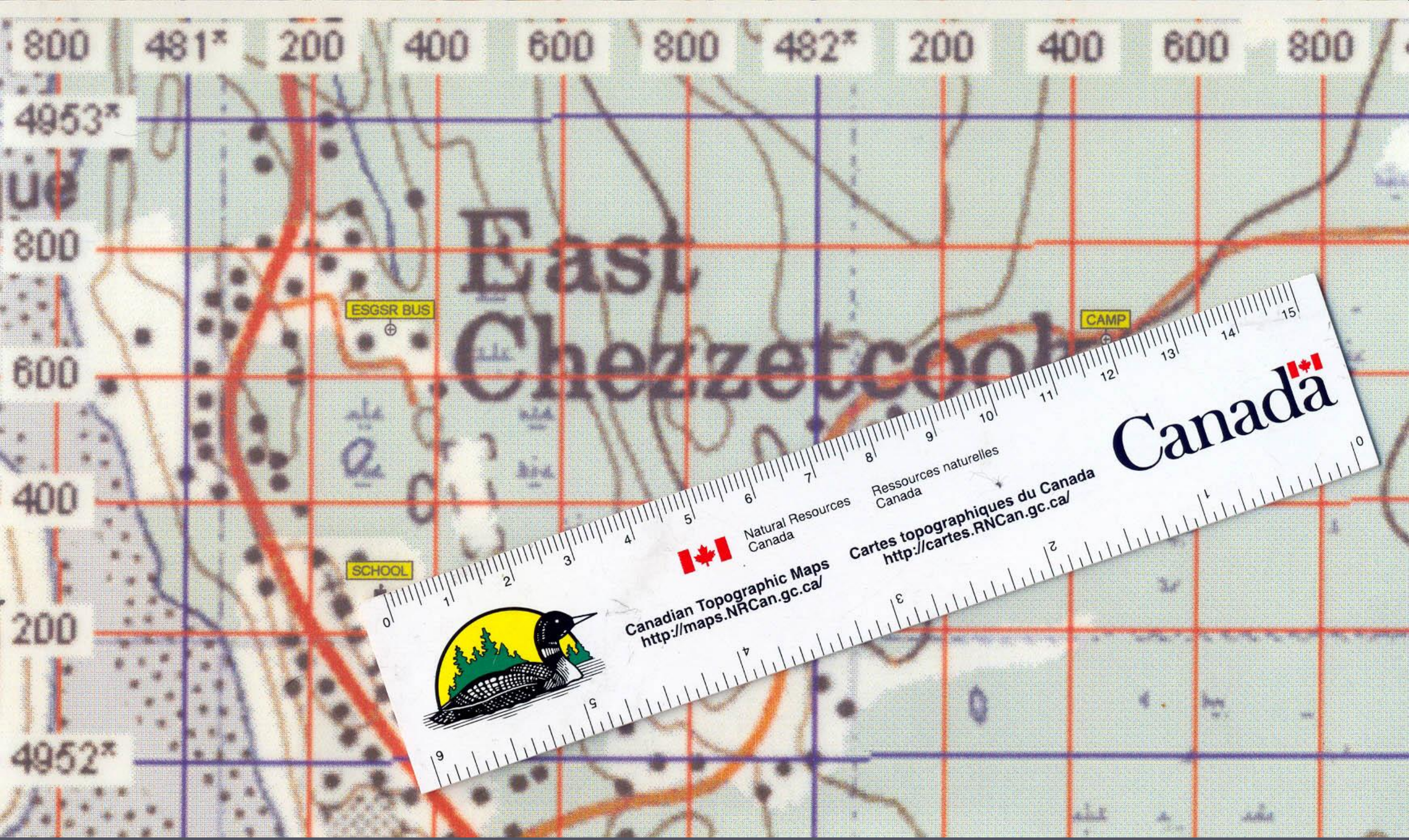
SCALE

- The scale of a map is a ratio between a unit of length on the map and the actual distance represented on the ground.

- The 1:10000 map scale is the most commonly used by ESGSAR. This scale simply states that 1cm on the map equals 10000 cm (100 m) on the ground.

MEASURING DISTANCE

- Two common methods searchers use to measure distance are:
  - Estimating distance by counting the number of map squares between two objects. On our 1:10000 searcher maps, the distance between each grid line is 200 m.
  - Measuring the distance between two objects with a metric ruler. On a 1:10000 map, each cm on the ruler equals 100 m. Each mm equals 10 m.



Measuring distance between SCHOOL and CAMP

MEASURING DISTANCE EXERCISE

Using the provided 1:10000 searcher map, determine the following distances in meters:

A) The distance between the ESGSAR BUS and the SCHOOL.

B) The distance between the SCHOOL and the CAMP.

C) The distance between the CAMP and the ESGSAR BUS.

D) The distance between Waypoint #4 and the SCHOOL.

MEASURING DISTANCE EXERCISE

ANSWERS

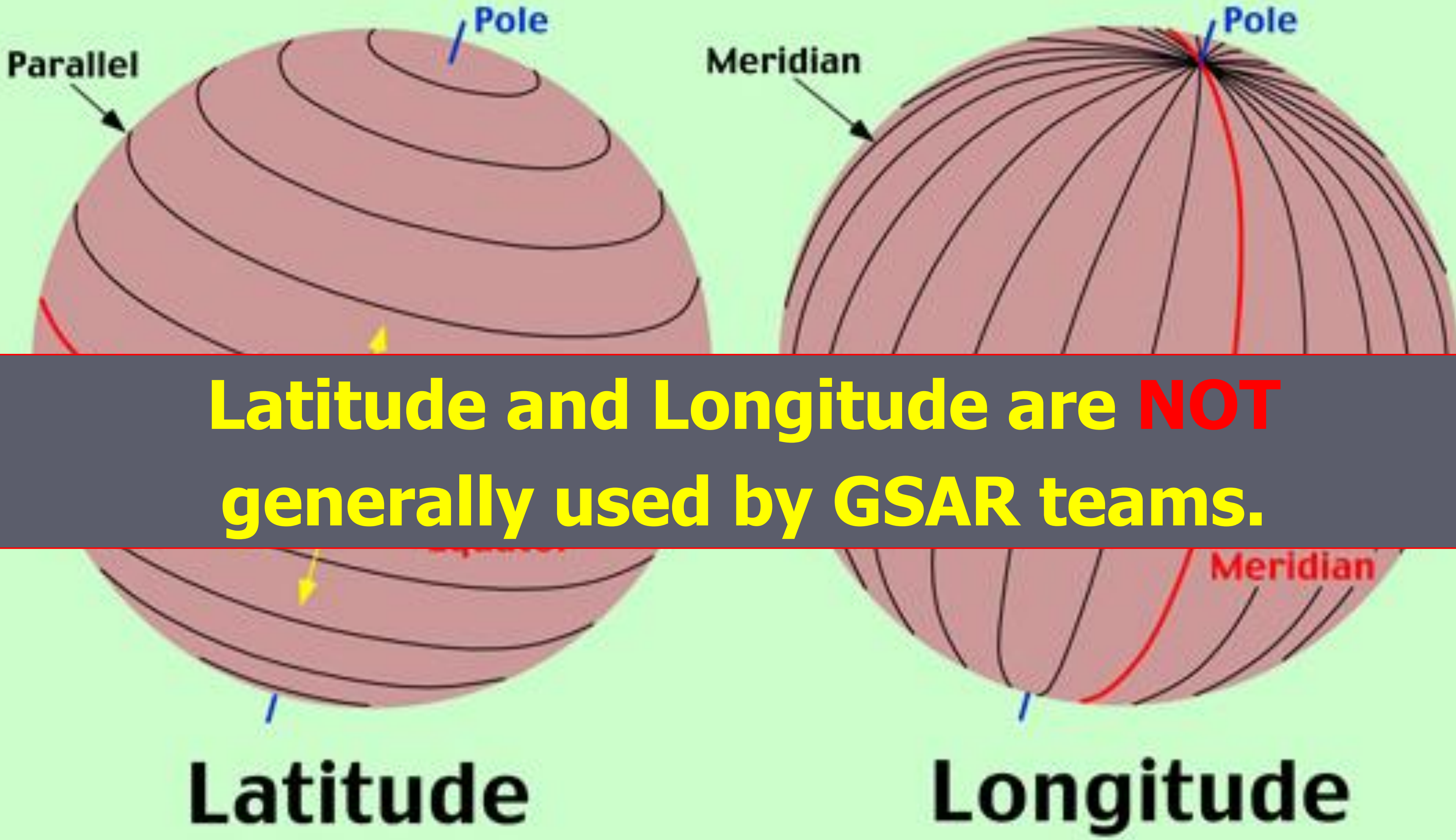
A) BUS and the SCHOOL:	**410 m**
B) SCHOOL and the CAMP:	**1200 m or 1.2 km**
C) CAMP and the BUS:	**1130 m or 1.1 km**
D) Waypoint #4 and the SCHOOL:	**710 m**

GRID REFERENCE SYSTEMS

- Topographic Maps have two types of grid reference systems:
  - **Geographic (Latitude and Longitude)**
  - **Universal Transverse Mercator (UTM)**

- SAR in Nova Scotia uses UTM

Latitude and Longitude are NOT generally used by GSAR teams.

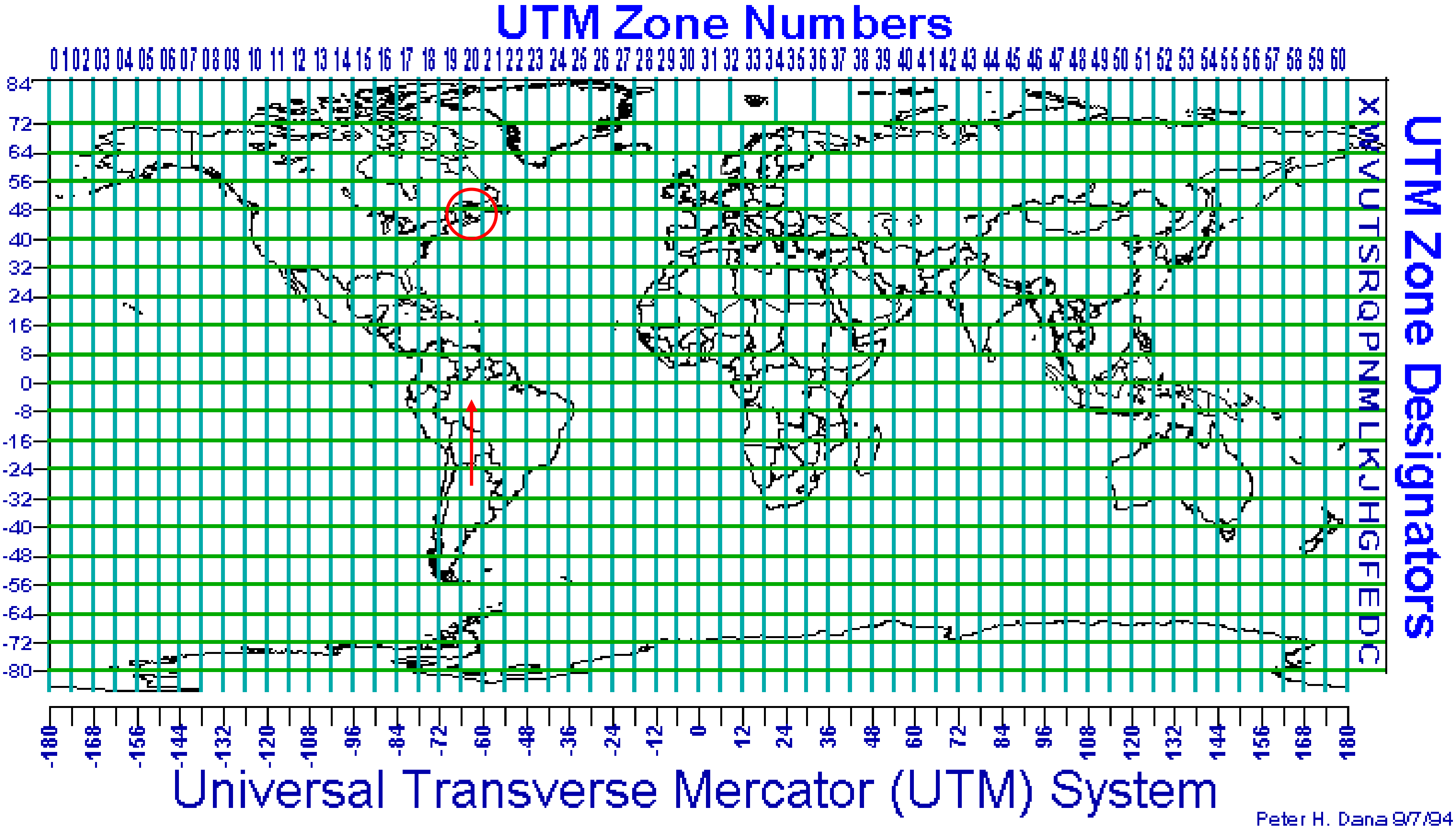


GRID REFERENCE SYSTEMS

- **Universal Transverse Mercator (UTM)**
  - The UTM grid is a ground based system.
  - The grid consists of a system lines forming squares over the entire map.
  - The area of a square depends on the map's scale.

GRID REFERENCE SYSTEMS

- **(UTM …cont'd)**
  - The entire UTM grid system is comprised of 100 x 100 kilometre blocks. The grid lines are numbered and printed along the borders of the map and at intervals on the map area.
  - Using the UTM system, any point can be designated to an increment of 1 metre.
  - The UTM system is commonly called the ***Military Grid Reference System***.

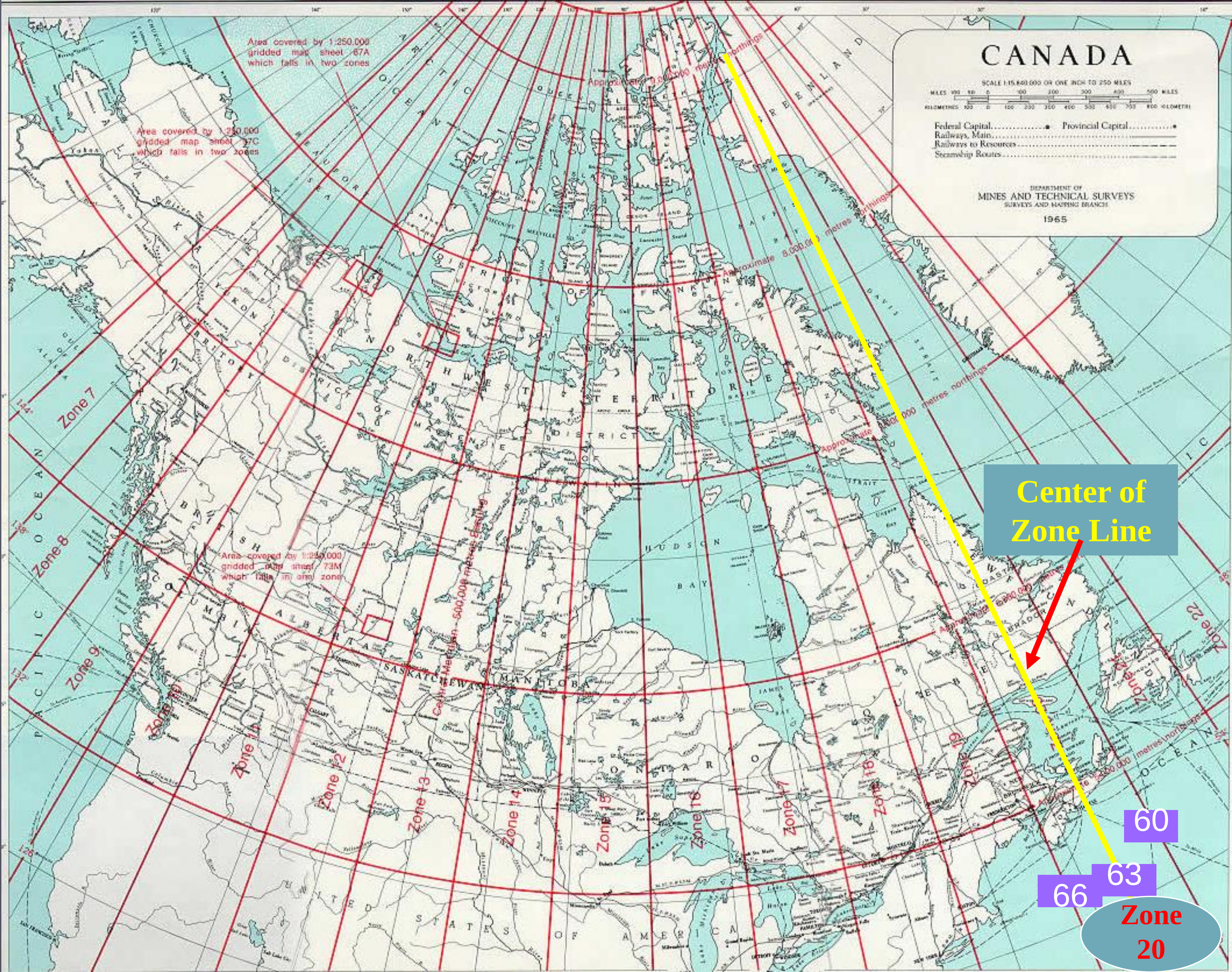

UTM Zone Numbers
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
84 72 64 56 48 40 32 24 16 8 0 -8 -16 -24 -32 -40 -48 -56 -64 -72 -80
X W V U T S R Q P N M L K J H G F E D C
UTM Zone Designators
-180 -168 -156 -144 -132 -120 -108 -96 -84 -72 -60 -48 -36 -24 -12 0 12 24 36 48 60 72 84 96 108 120 132 144 156 168 180
Universal Transverse Mercator (UTM) System
Peter H. Dana 9/7/94

GRID REFERENCE SYSTEMS

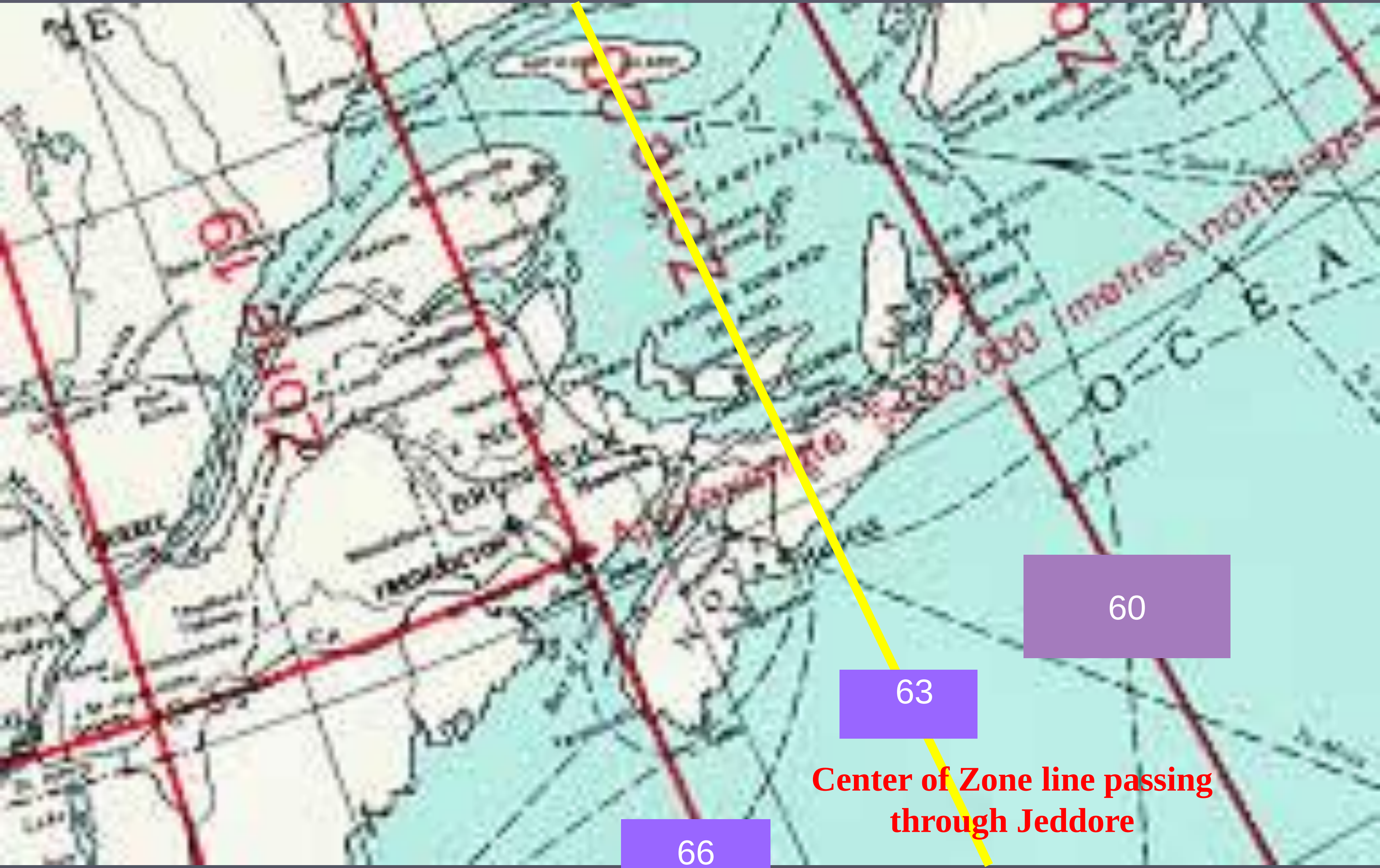
- **(UTM …cont'd)**
  - A grid map reference is given by a zone and pair of numbers (an Easting and a Northing). The zone for mainland Nova Scotia is 20 and does not have to be given.
  - A UTM map reference looks like: 476659E 4942592N
  - The Northing represents the distance from the Equator in meters.

GRID REFERENCE SYSTEMS

- **(UTM …cont'd)**
  - The Easting represents the distance from the centre of the zone arbitrarily set at 500000 meters
  - The Easting has 6 digits and the Northing has 7. The Easting is always read first.
  - Using a metric ruler and a 1:10000 map, you can determine the location of an object within 10 meters or better.


CANADA
SCALE 1:15,840,000 OR ONE INCH TO 250 MILES
Federal Capital
Provincial Capital
Railways, Main
Railways to Resources
Steamship Routes
DEPARTMENT OF
MINES AND TECHNICAL SURVEYS
SURVEYS AND MAPPING BRANCH
1965
Area covered by 1:250,000 gridded map sheet 87A which falls in two zones
Area covered by 1:250,000 gridded map sheet 97C which falls in two zones
Area covered by 1:250,000 gridded map sheet 73M which falls in one zone
Zone 7
Zone 8
Zone 9
Zone 10
Zone 11
Zone 12
Zone 13
Zone 14
Zone 15
Zone 16
Zone 17
Zone 18
Zone 19
Zone 21
Zone 22
HUDSON BAY
GREENLAND
DAVIS STRAIT
HUDSON STRAIT
BAFFIN BAY
LABRADOR
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
BRITISH COLUMBIA
YUKON TERRITORY
NORTHWEST TERRITORIES
DISTRICT OF FRANKLIN
DISTRICT OF MACKENZIE
PACIFIC OCEAN
ATLANTIC OCEAN
UNITED STATES OF AMERICA
Center of Zone Line
60
63
66
Zone 20

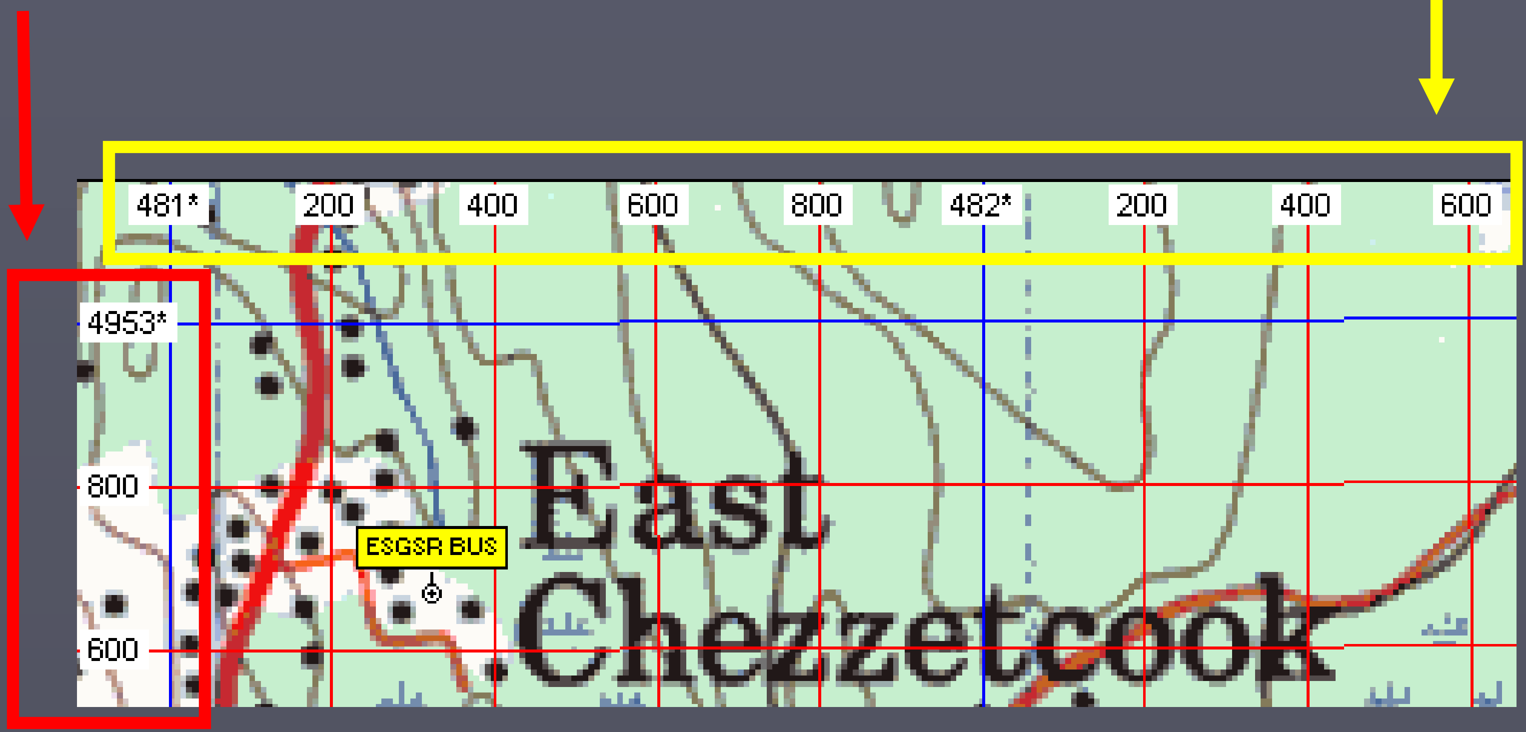
500,000E



500,000E

MAP CONVENTIONS

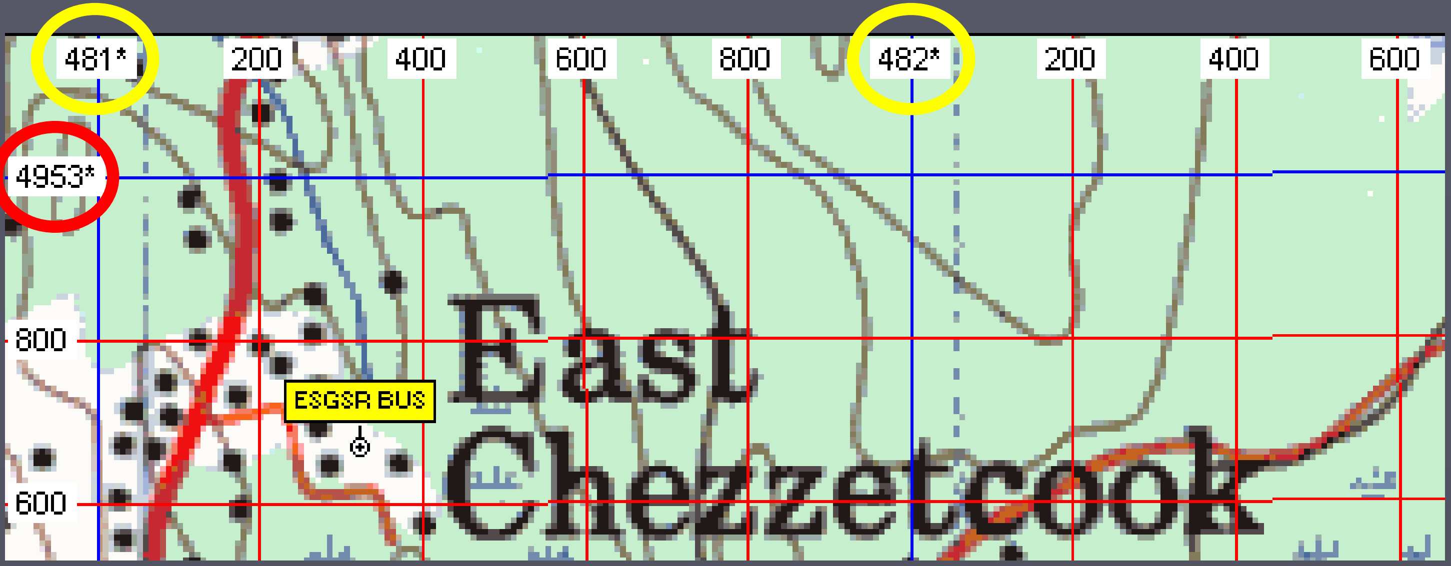
- Eastings run along the top of a map
- Northings run along the left side of a map



MAP CONVENTIONS

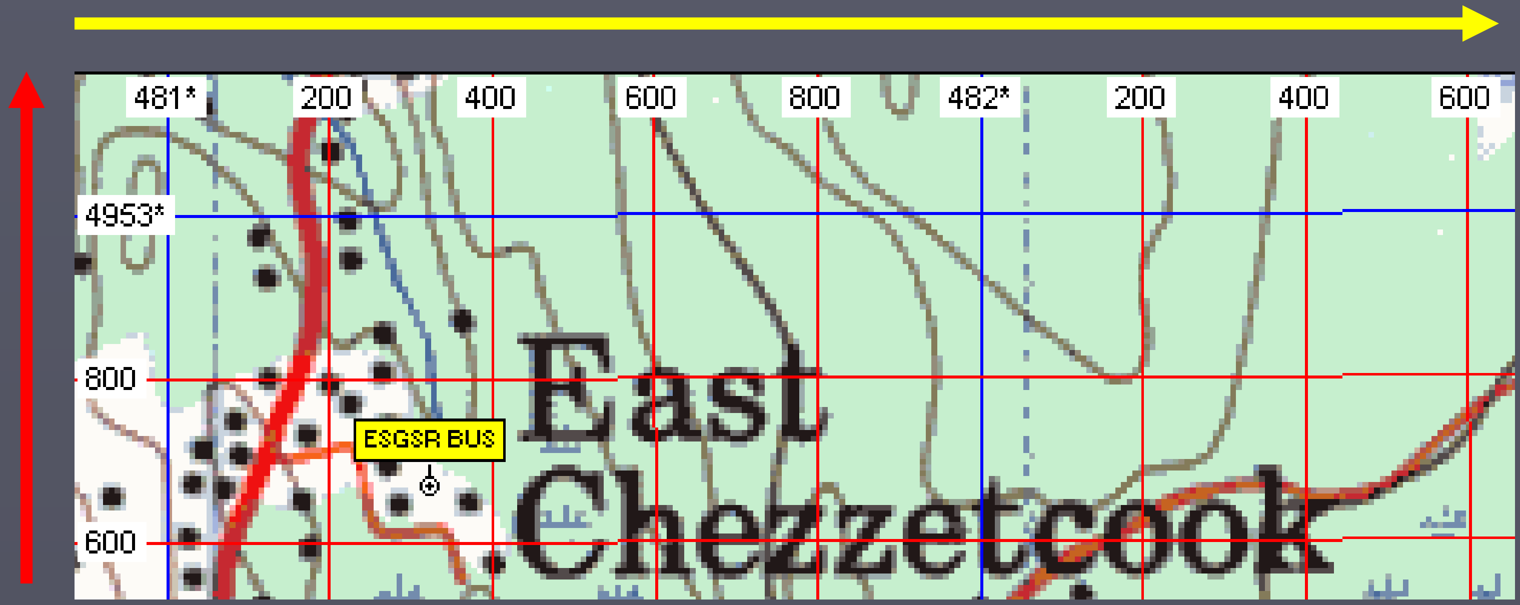
- On our searcher maps, Eastings and Northings on BLUE LINES end with an asterisk (*)

- The asterisk represents three zeros.
  - For example: 481* = 481<u>000</u>



MAP CONVENTIONS

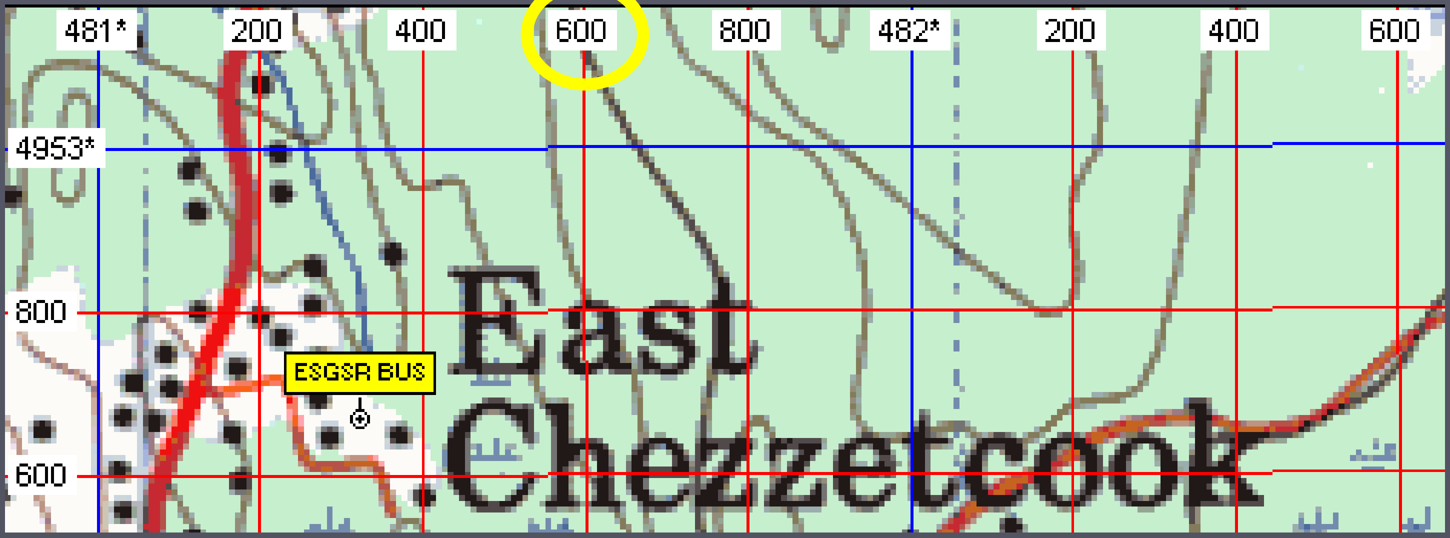
- Eastings increase left to right
- Northings increase bottom to top



MAP CONVENTIONS

- The numbers on the red lines show only the last three digits of their actual value
- For example, the 600 circled below represents:

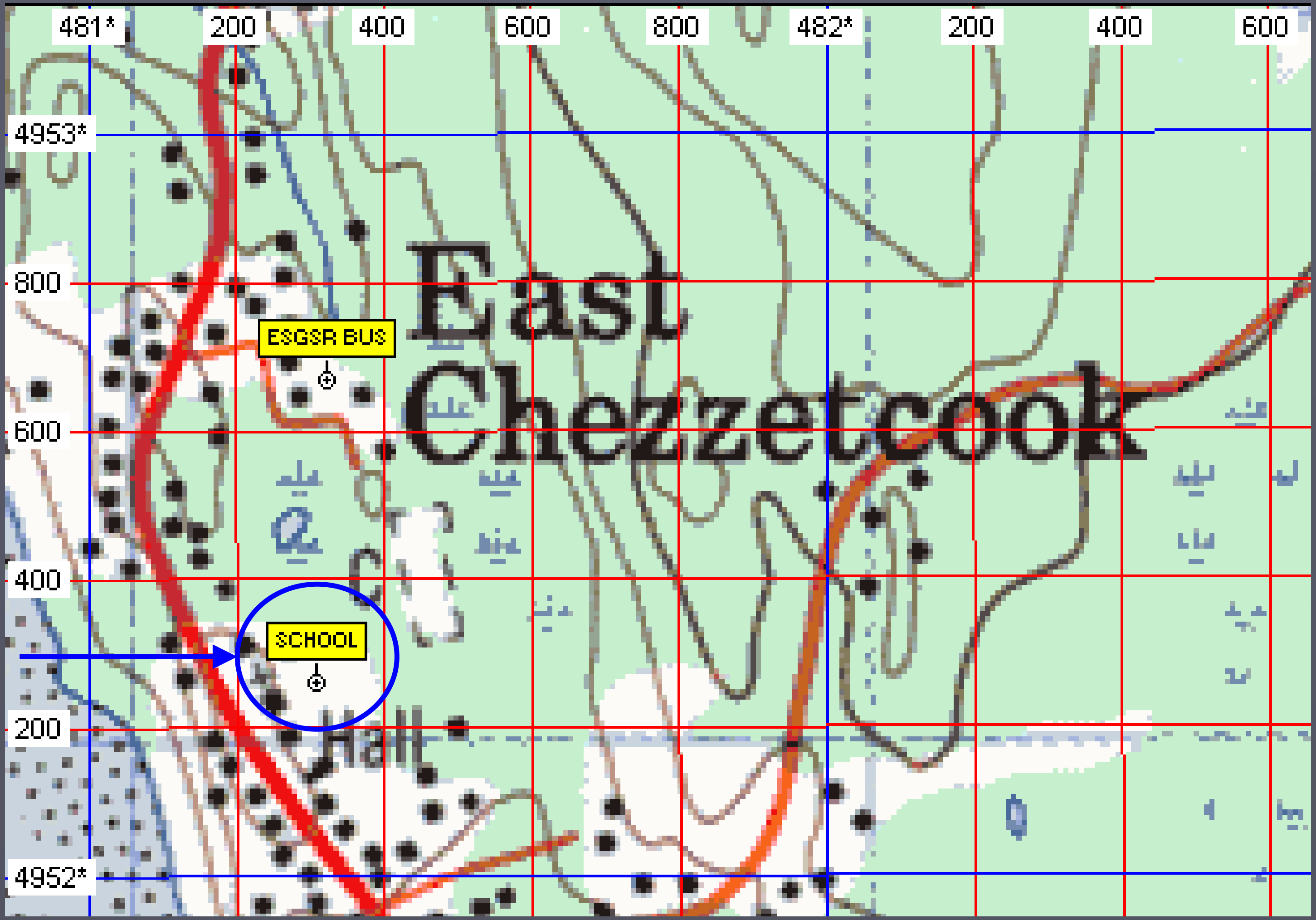
481600



CALCULATING GRID REFERENCES

Locate the map feature you want to generate a UTM grid reference for.

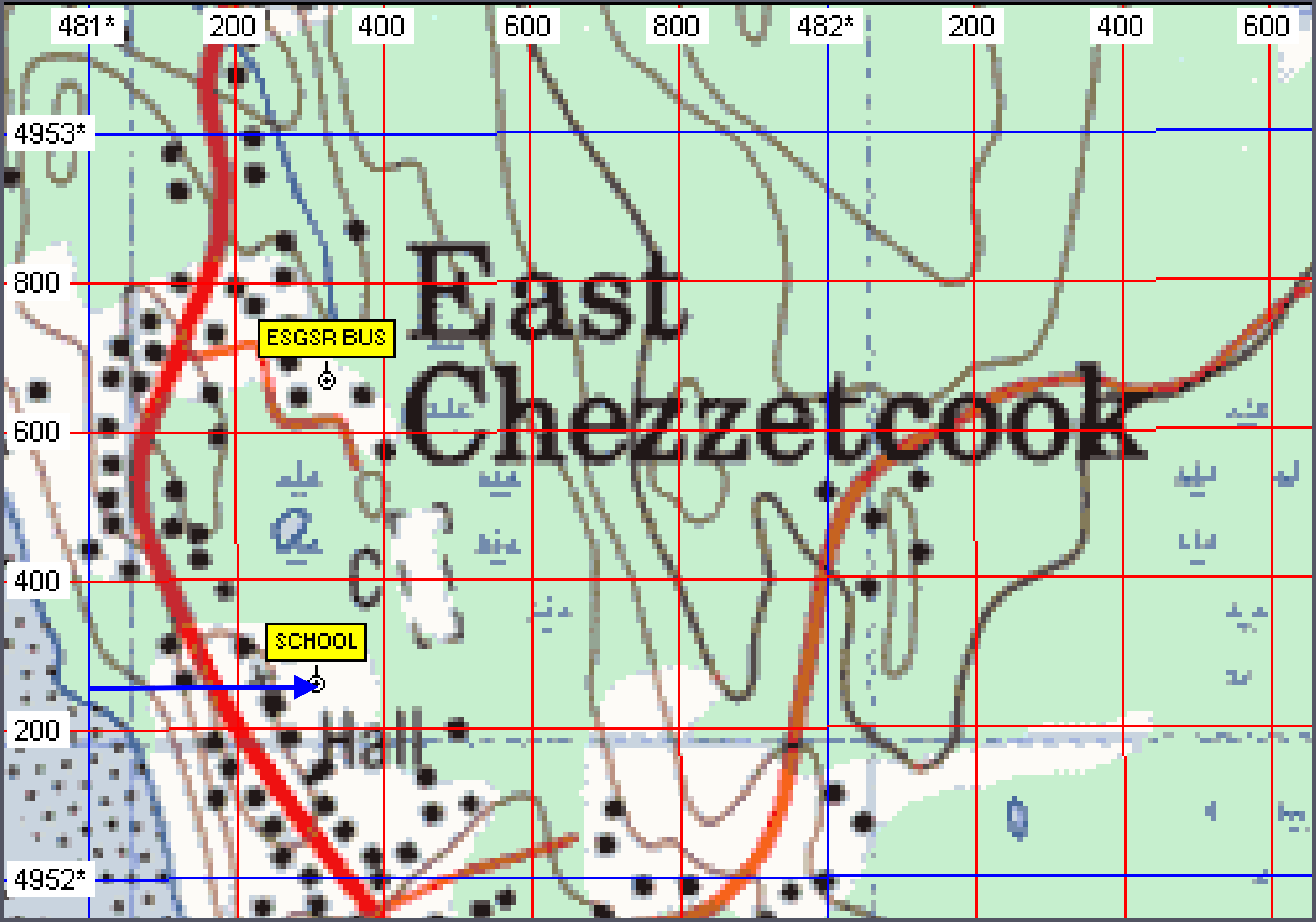
This example uses a 1:10000 scale map.



CALCULATING GRID REFERENCES

Determine the Easting

1. Measure (in mm) the distance from the BLUE LINE to left of feature to the feature itself.



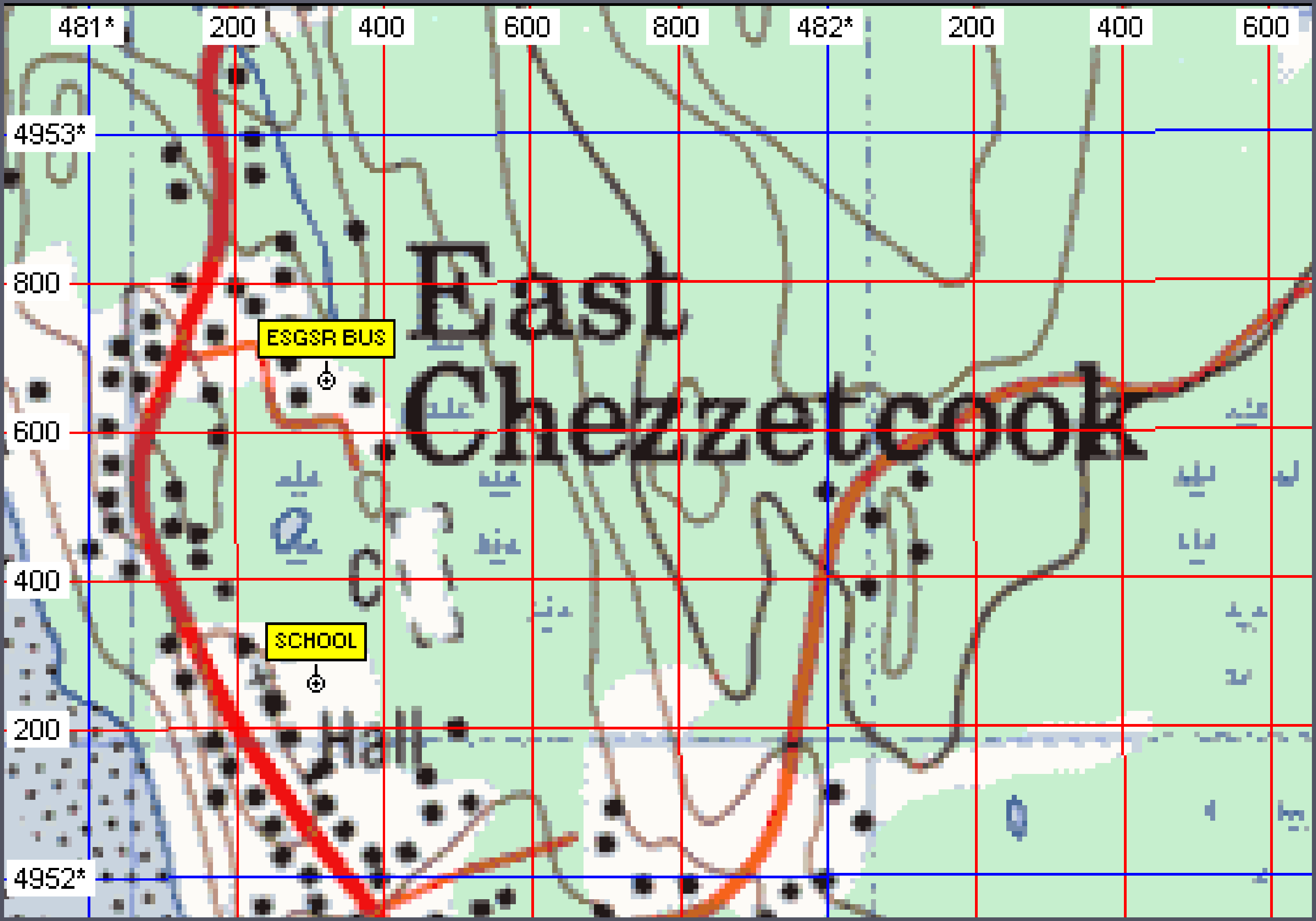
31 mm

CALCULATING GRID REFERENCES

<u>Determine the Easting</u>

2. Add a zero to the end of the measured distance of 31 mm:

31<u>0</u>

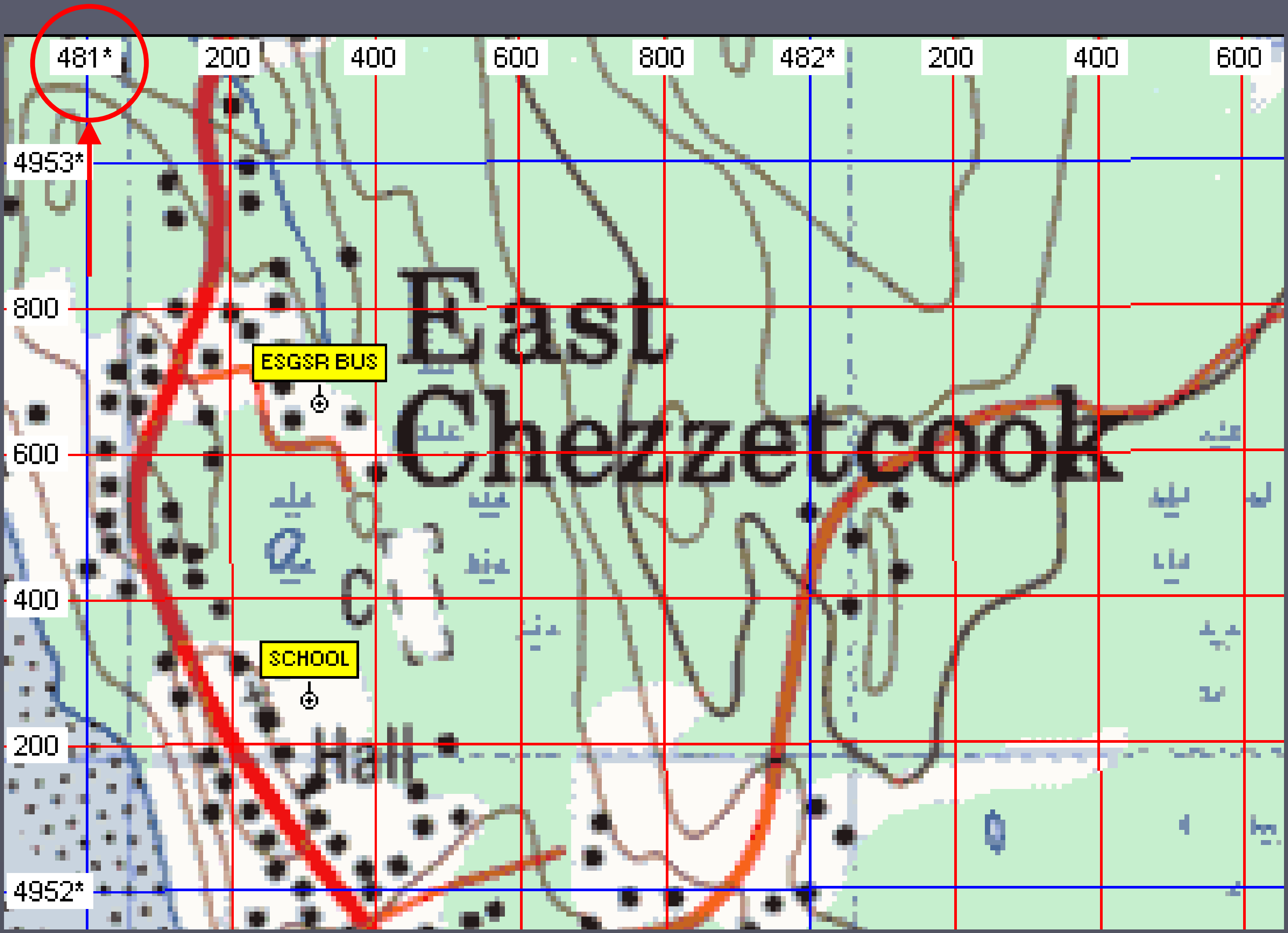


CALCULATING GRID REFERENCES

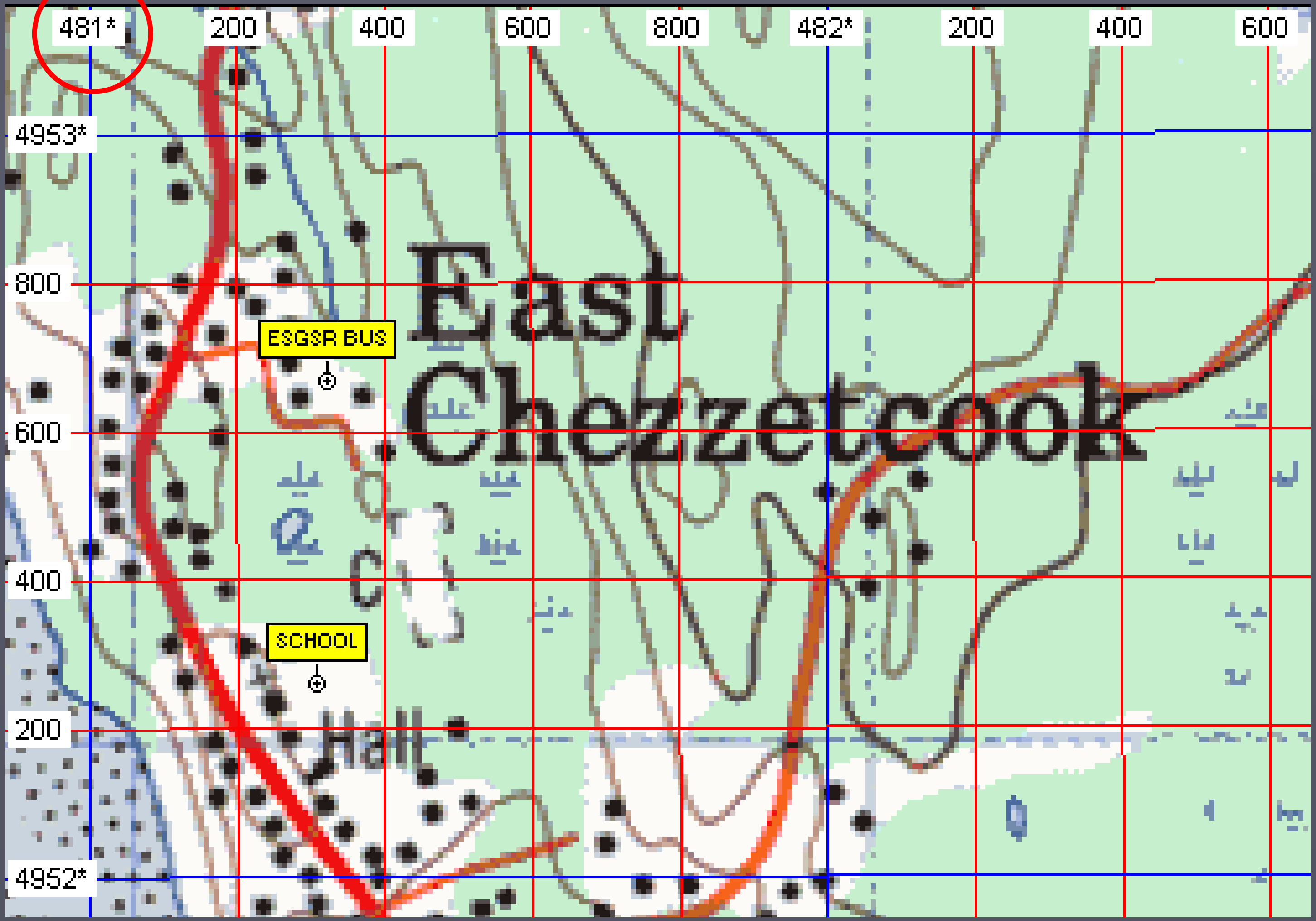
Determine the Easting

4. Locate the value of the BLUE LINE to the immediate left of the feature.

481*



CALCULATING GRID REFERENCES



Determine the Easting

5. Replace the * in 481* with the (310) to give the Easting:

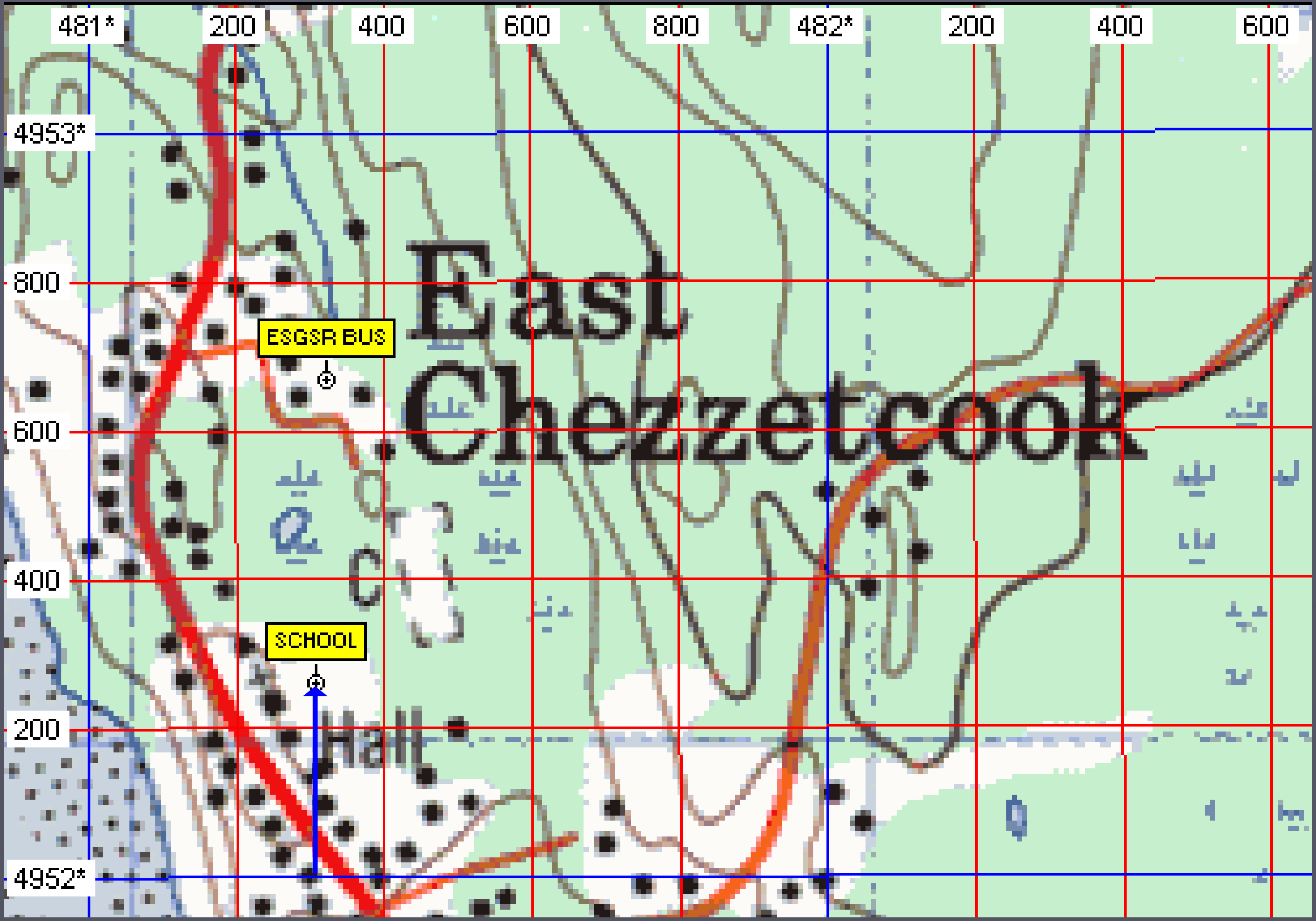
481<u>310</u>

CALCULATING GRID REFERENCES

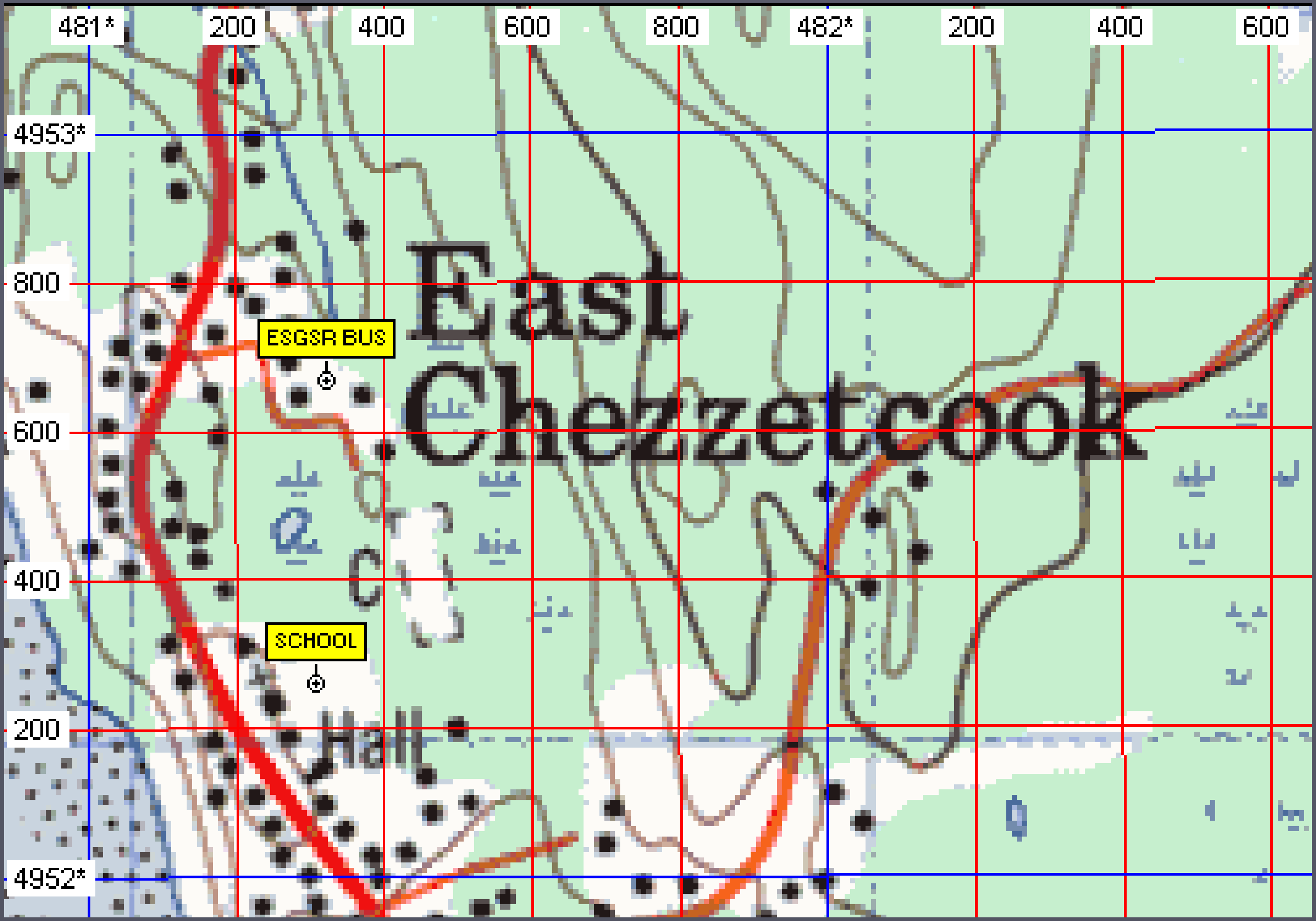
Determine Northing

1. Measure (in mm) distance from the BLUE LINE below the feature to the feature itself.

26 mm



CALCULATING GRID REFERENCES



Determine Northing

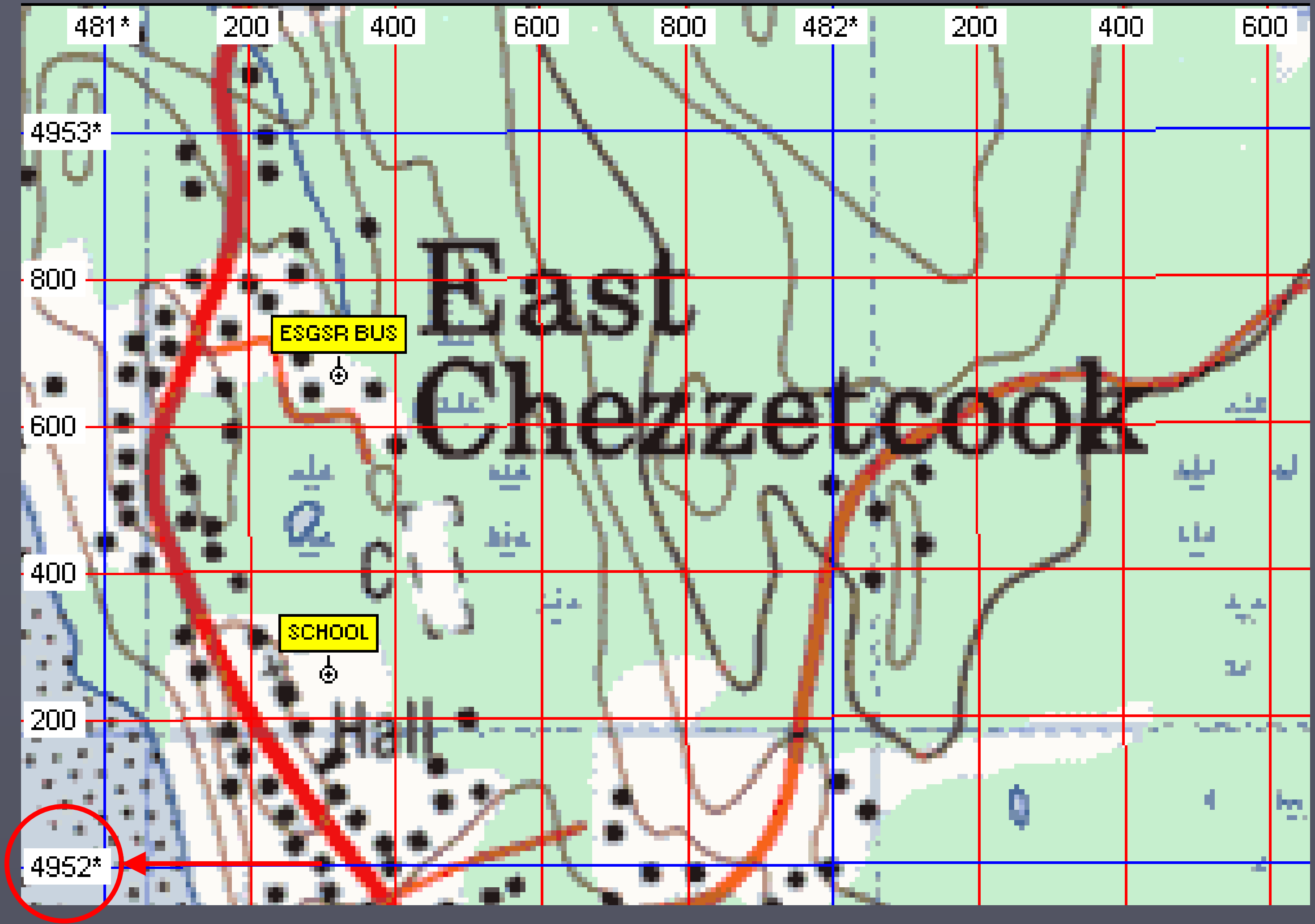
2. Add a zero to the end of the measured distance of 26 mm:

26<u>0</u>

CALCULATING GRID REFERENCES

<u>Determine Northing</u>

4. Locate the valueof the BLUE LINE below the feature.

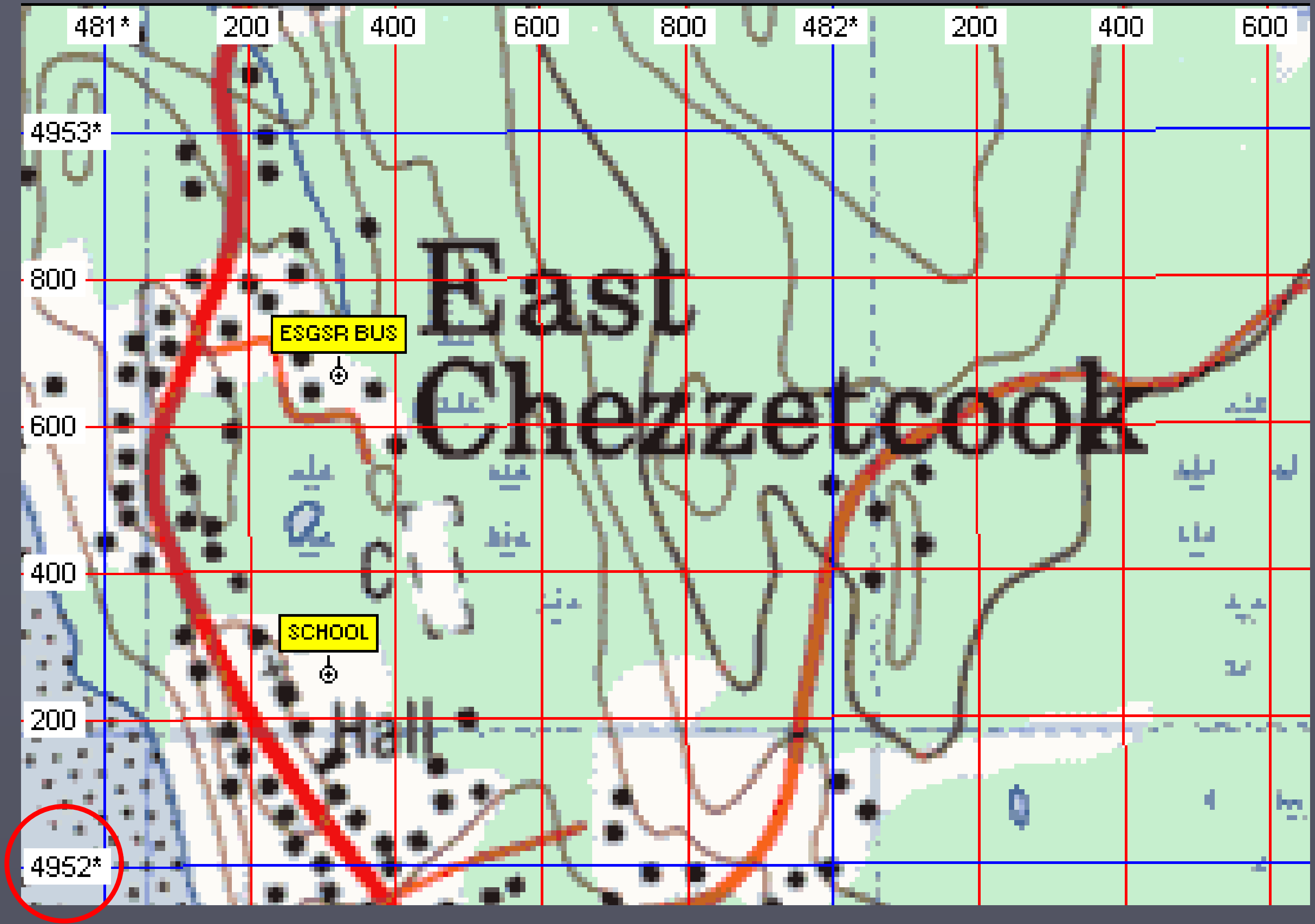


4952*

CALCULATING GRID REFERENCES

Determine Northing

5. Replace the * in 4952* with the 260 to give the Northing:



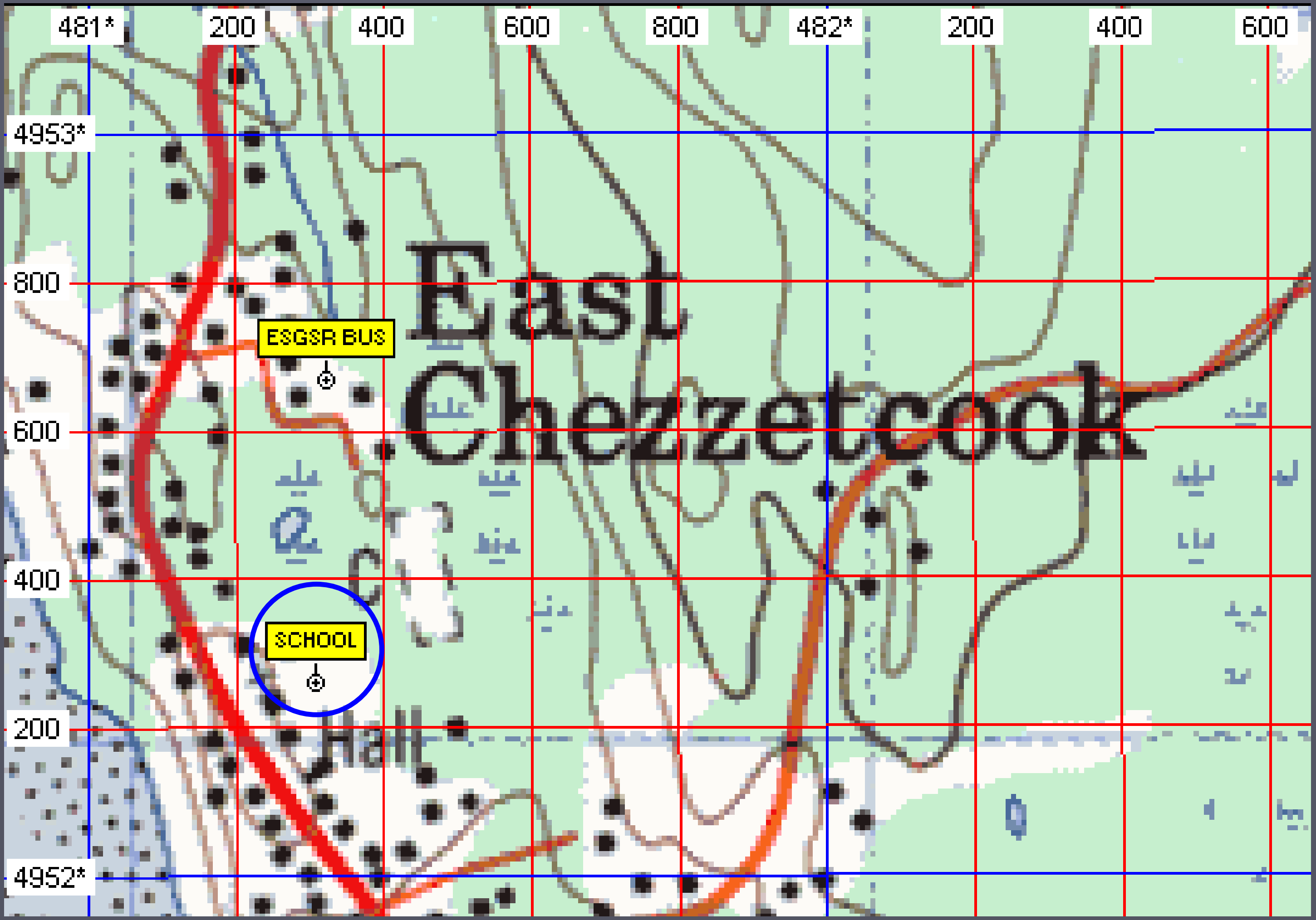
4952260

CALCULATING GRID REFERENCES

Putting the Easting and Northing together, you get the UTM grid reference for the School:

E 481310

N 4952260



UTM GRID REFERENCE EXERCISE

Using the provided 1:10000 Searcher’s map, determine the grid references for the following:

A) SCHOOL.

B) ESGSAR BUS.

C) CAMP.

D) Waypoint #4.

UTM GRID REFERENCE EXERCISE

ANSWERS

A) SCHOOL:	**481310 E 4952260 N**
B) ESGSR BUS:	**481320 E 4952670 N**
C) CAMP:	**482450 E 4952650 N**
D) Waypoint #4:	**482000 E 4952430 N**

DATUMS

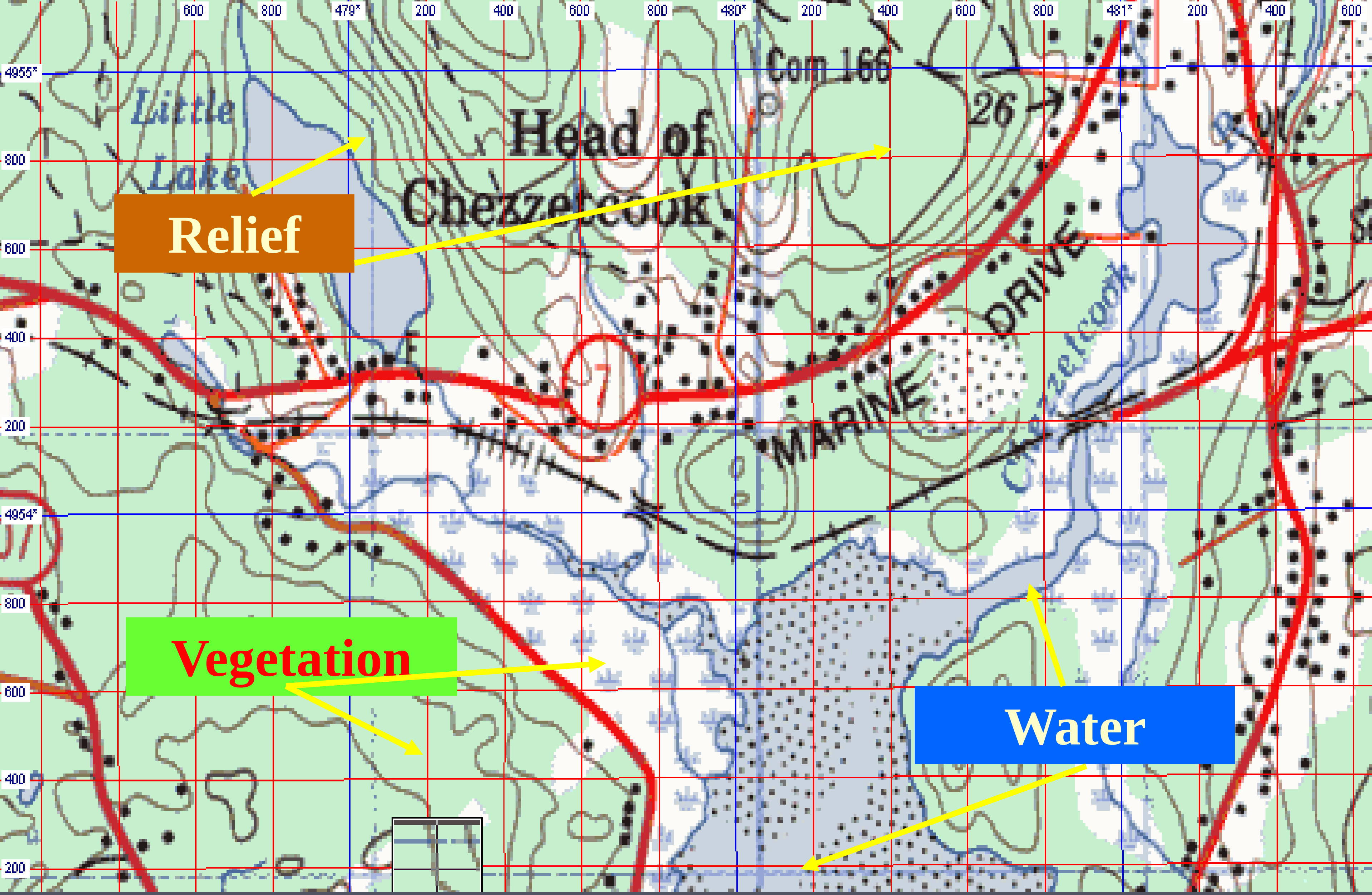
- Map grids are based on a series of accurately surveyed points called ***datums***, to ensure that the grids are consistent on all maps.
- Newer Nova Scotia maps use the NAD83 datum.
- Using the wrong datum can result in grid references being off by hundreds of meters.

DATUMS

- When entering grid references into a GPS, the user must ensure the datum of the GPS is set to the datum of the map.
- Map datums are located on the bottom margin of the map.
- Nova Scotia GSAR teams use the NAD83 datum.

MAJOR MAP DIVISIONS

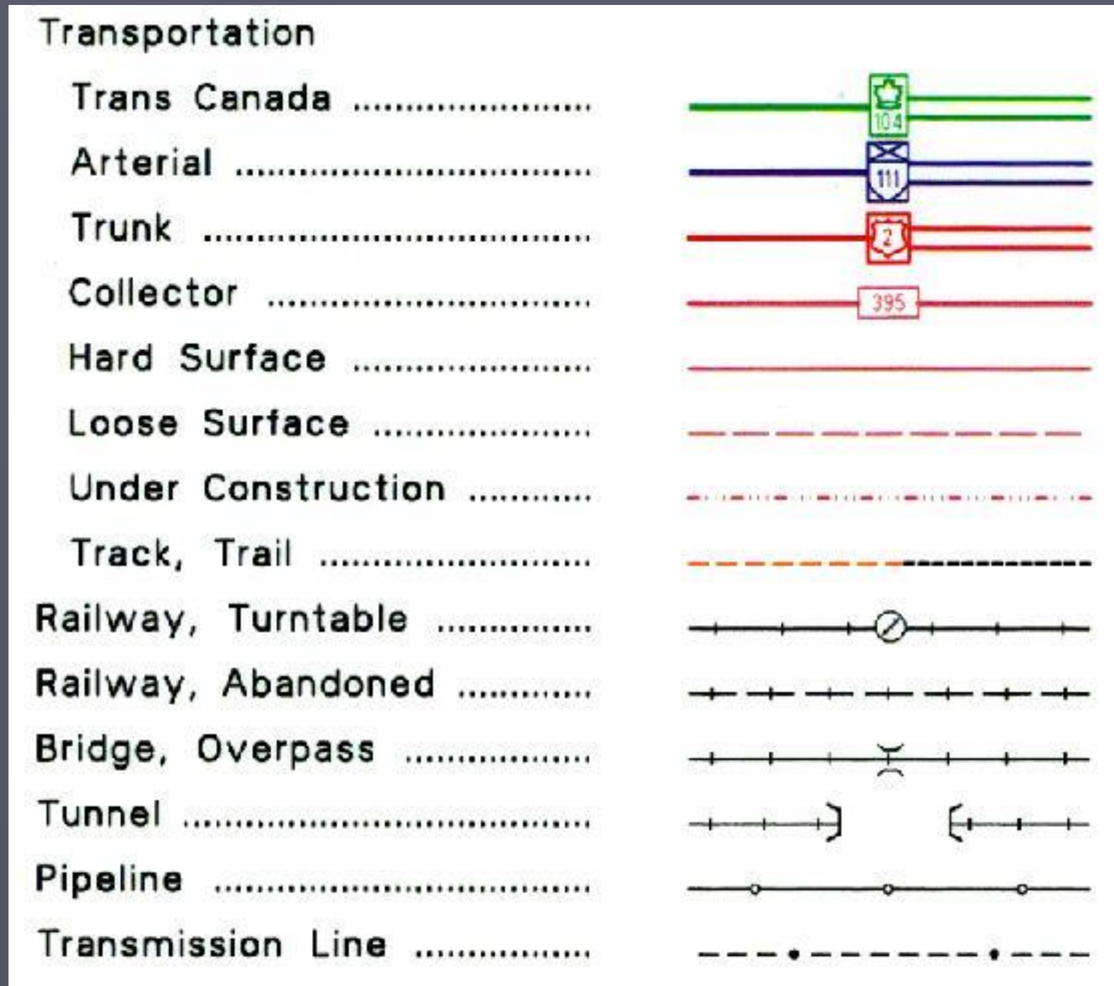
- Topographic maps have three major divisions:
  - **Vegetation**
  - **Water**
  - **Relief**



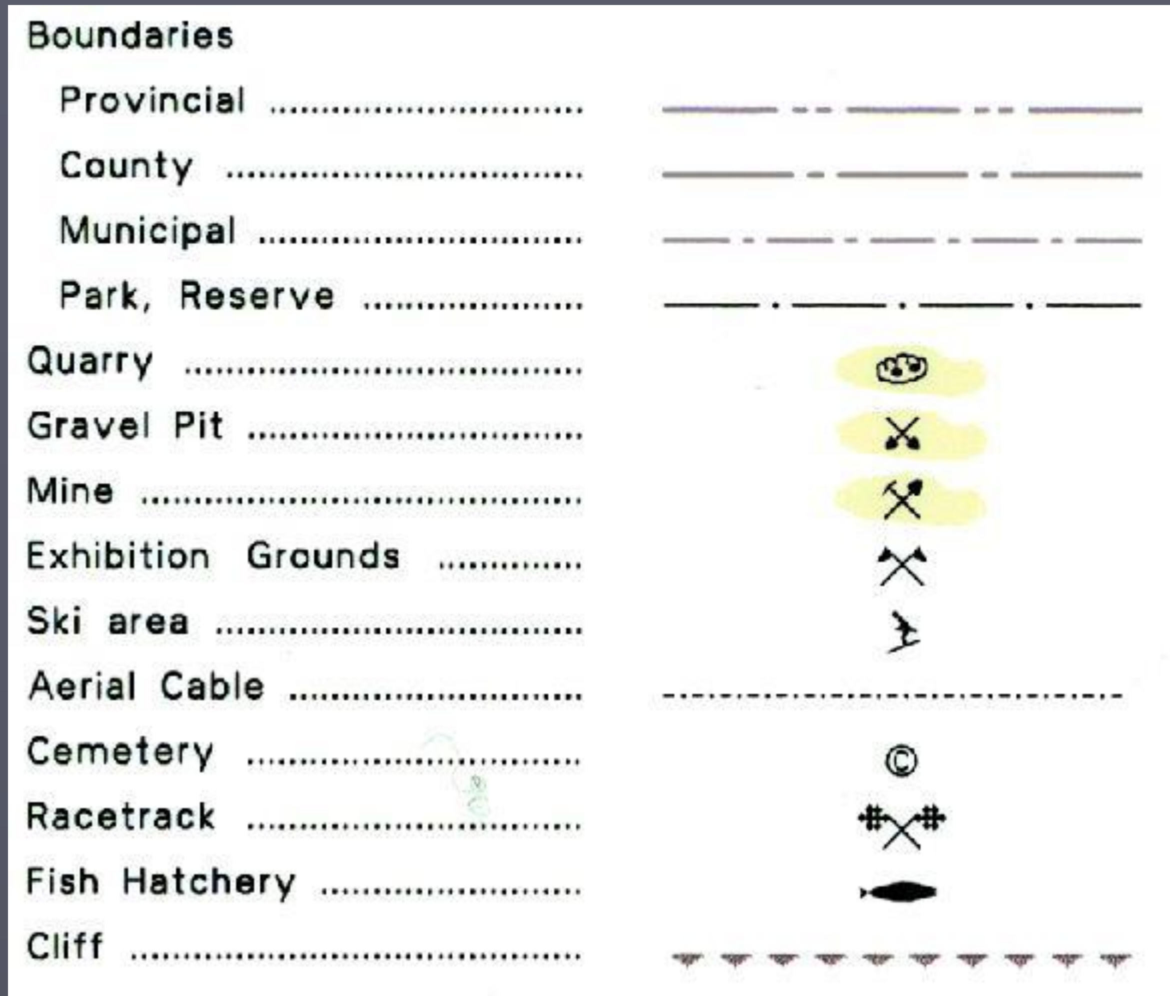
Example of Major Map Divisions

MAP SYMBOLS

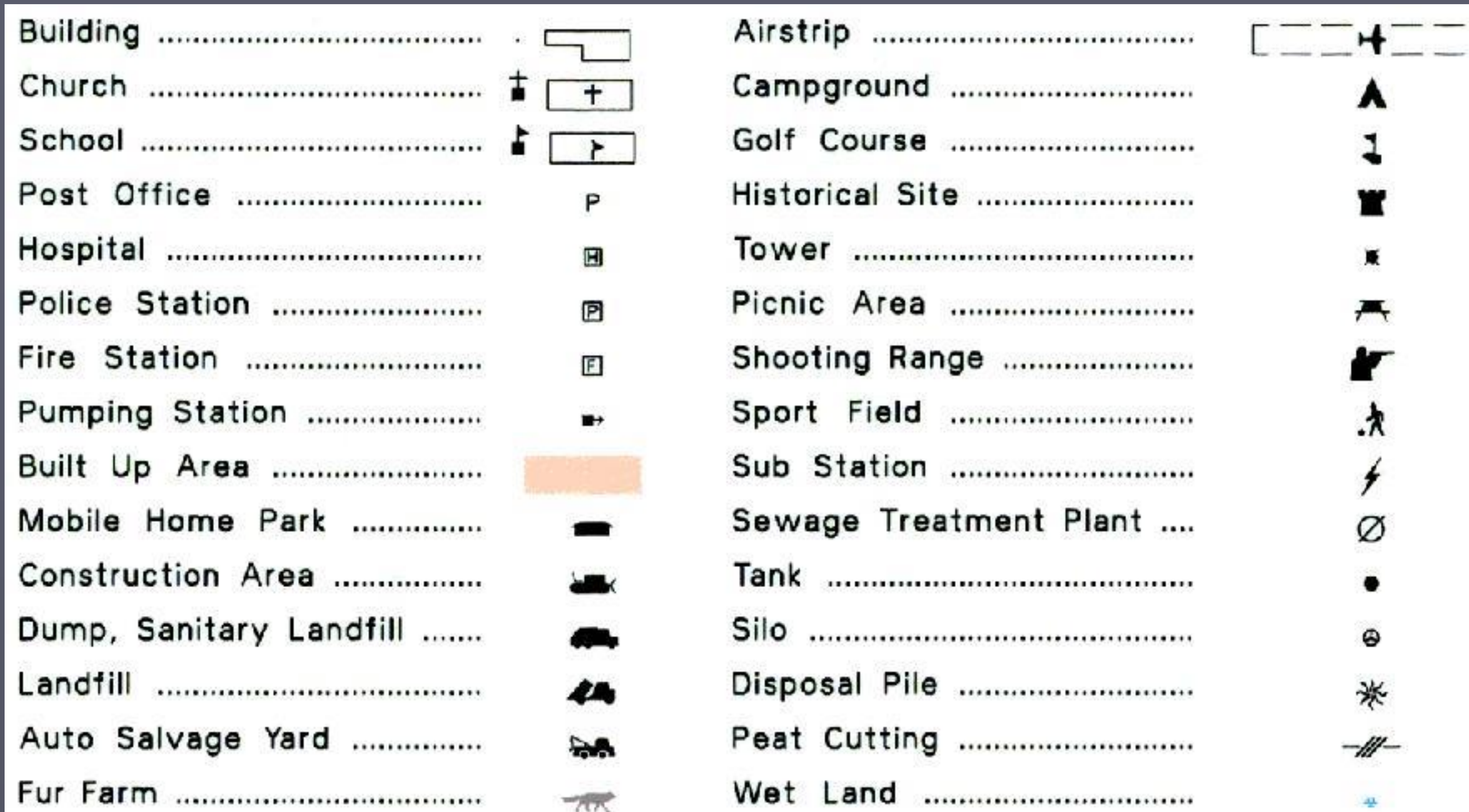
- Symbols are used on maps to represent features on the ground. The key to these symbols is either on the reverse side of the map or in the margin.
- All map symbols on Canadian topographic maps conform to the following colour code:
  - Black: human-made features
  - Blue: water
  - Green: forest or vegetation
  - Brown: elevation (contours)
  - White: open areas, field or snowfield
  - Red: highways
  - Orange: secondary or dirt roads
  - Pink: high population density areas
  - Purple: updated data



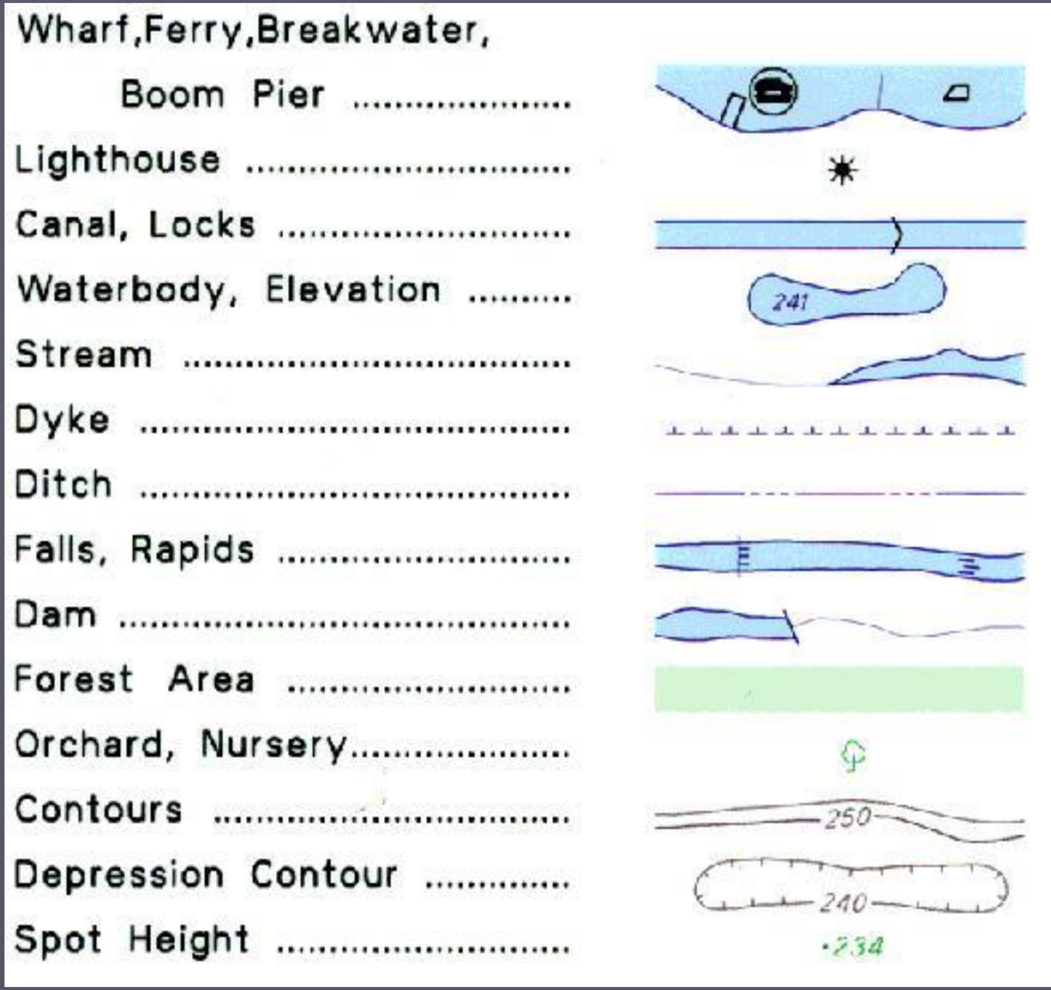
Sample map symbols…



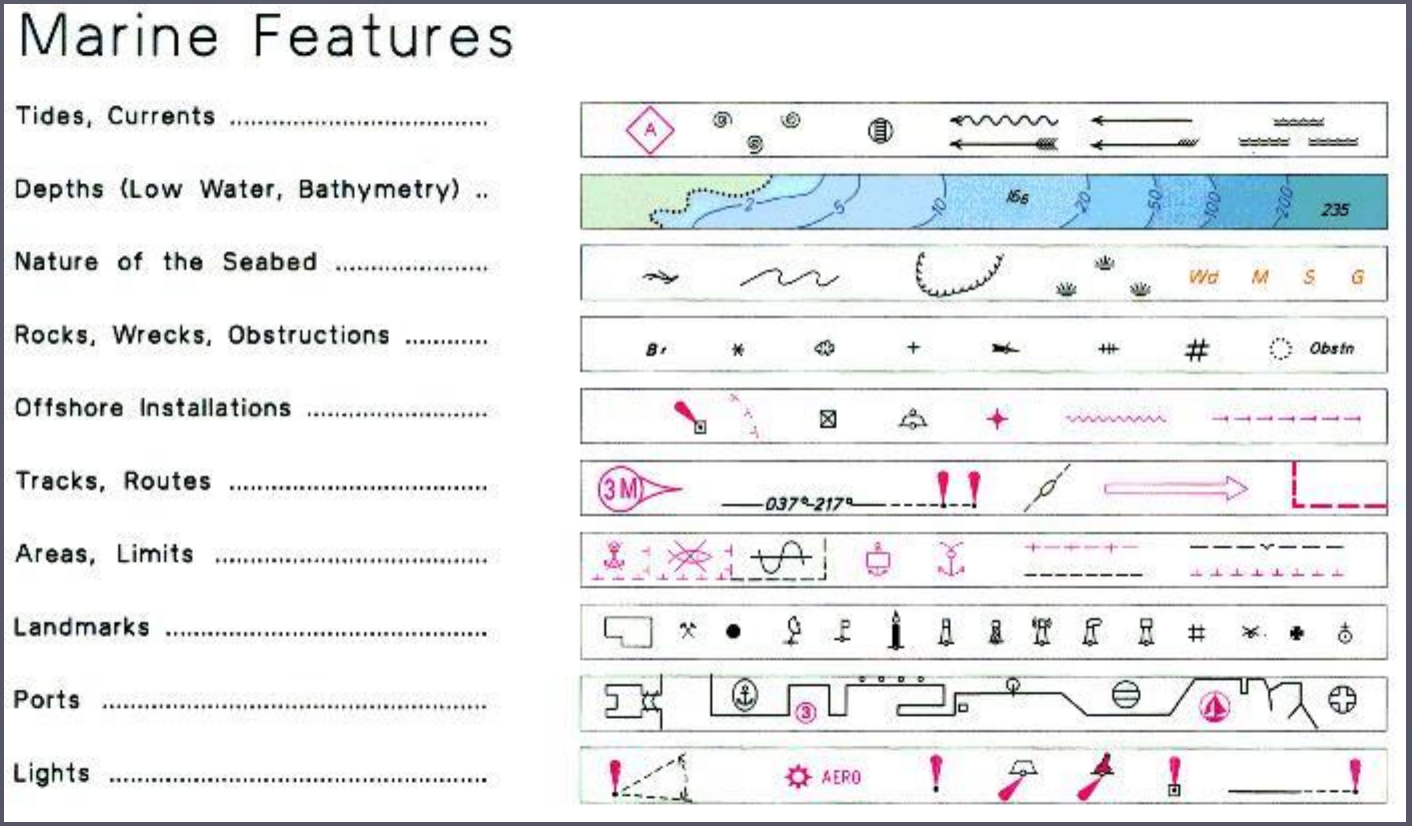
Sample map symbols…



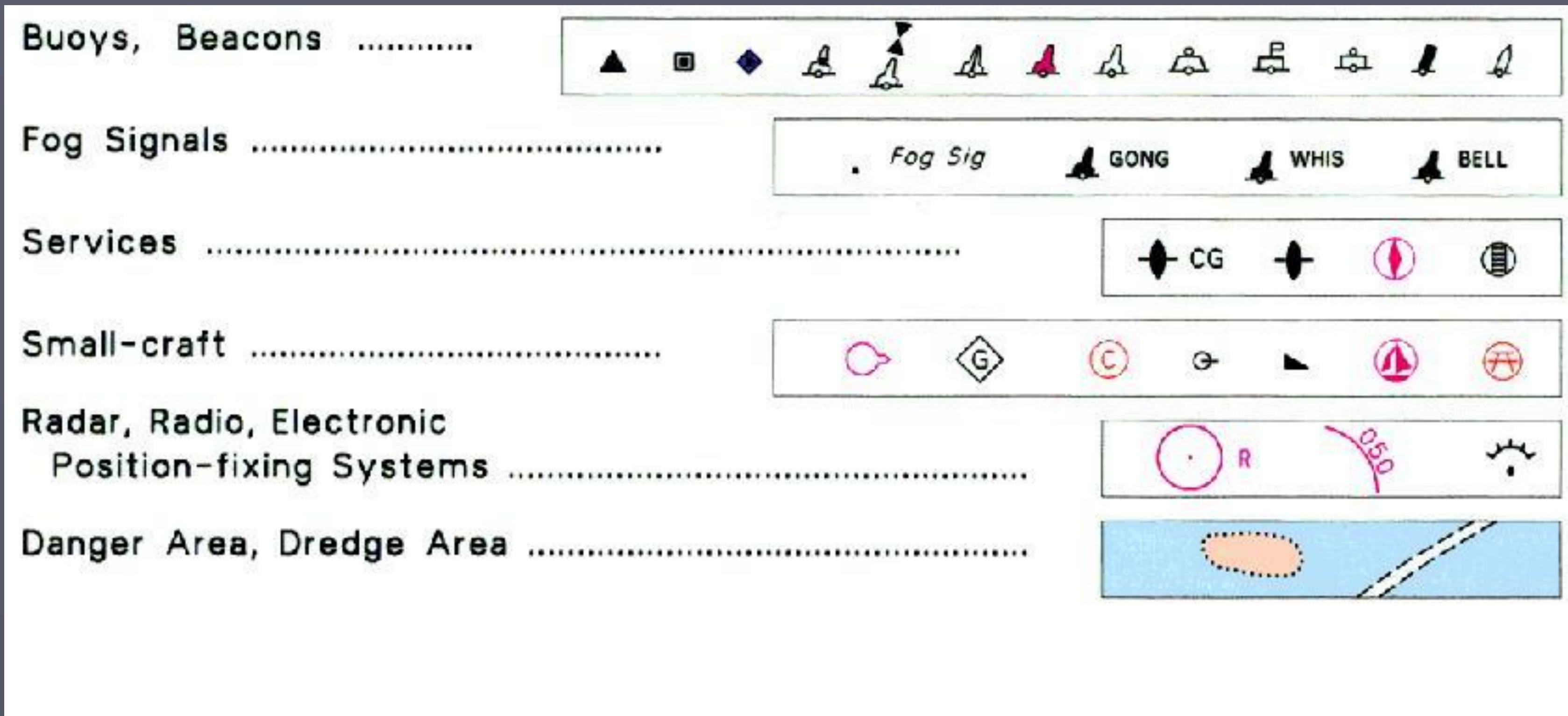
Sample map symbols…



Sample map symbols…



Sample map symbols…



Sample map symbols…

TOPOGRAPHIC CONTOURS

- On topographic maps elevation is indicated with *Contour Lines*.
- A *contour line* on a map is a line that connects points of equal elevation above sea level.
- The vertical distance between two contour lines is the *Contour Interval (C.I.)*.
- The contour interval is located on a map's margin.

TOPOGRAPHIC CONTOURS

- The contour interval for ESGSAR searcher maps is 10 meters.
- Contour lines are usually drawn with reference to sea level.
- On most topographic maps, every fifth contour line is printed darker for easy recognition and is locally labelled with its elevation. These are called *Index Contours*.

CONTOUR LINE RULES

1. All points on the same line are at the same elevation.
2. All contour lines close somewhere, although it may be outside the map at hand.
3. Contour lines never cross, except when they are representing an overhanging cliff in which case those beneath the overhang are dotted. On a vertical cliff several contour lines may become superimposed.
4. Contour lines never divide.
5. Contours are far apart on a gentle slope.

CONTOUR LINE RULES

6. Contours are close together on a steep slope.
7. Contours bend upstream in valleys and cross streams at right angles.
8. On level ground there are no contours.
9. An isolated closed contour has the same elevation as the next adjacent contour.
10. All points inside a depression contour are lower than the line.

CARDINAL DIRECTIONS

- The four cardinal directions on a map are:
  - North (at top of map)
  - South (at bottom of map)
  - East (at right of map)
  - West (at left of map)

THE MAGNETIC COMPASS

- The magnetic compass is an important aid for:
  - Taking bearings
  - Map orientation
  - Position location
  - Triangulation
  - Route finding, etc.

THE MAGNETIC COMPASS

- The magnetic compass works on the principle that the pivoting magnetized needle, will always point to the magnetic north.

- There are a variety of compasses available, ranging in price from a few dollars to hundreds of dollars.

PARTS OF A COMPASS

1. MAGNETIC NEEDLE:

- Points consistently towards the north magnetic pole.
- All measurements with the compass are therefore made relative to the magnetic north direction.

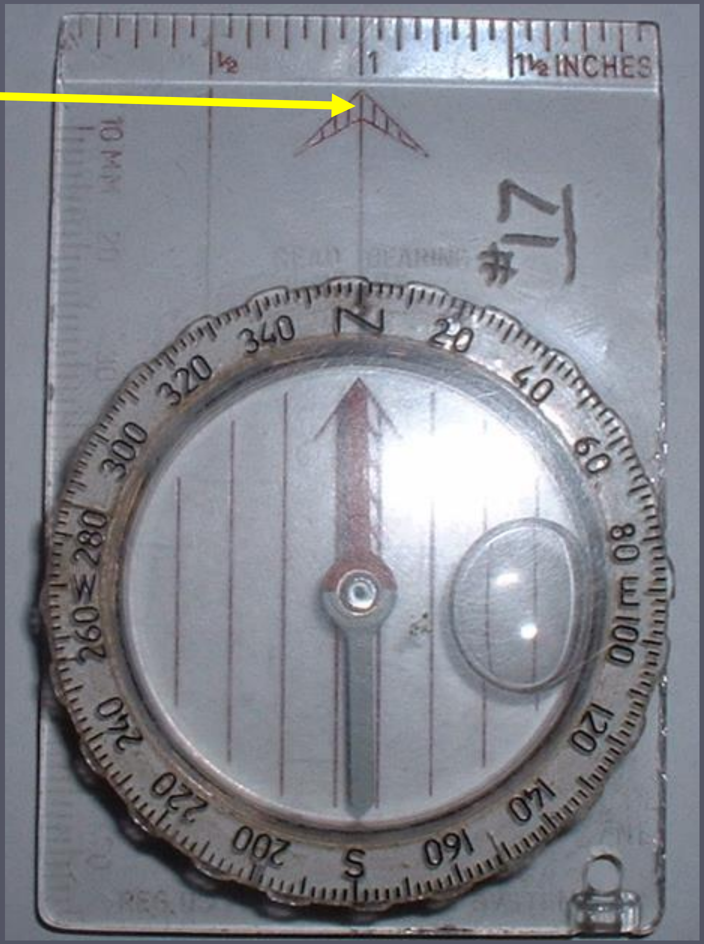
PARTS OF A COMPASS

2. <u>COMPASS HOUSING AND GRADUATED DIAL</u>:

- The compass housing is a sealed capsule which contains the magnetic needle. It is filled with a light oil so the needle comes quickly to rest.
- The outer ring of the housing is graduated in degrees from 0° to 360° in steps of 2 ° degrees.
- The north direction is indicated by the set of parallel (meridian) lines on the transparent base plate.
- The large black arrow which is also on the base plate can be rotated independently by means of a small screw in the graduated metal dial.

PARTS OF A COMPASS

3. **BASE PLATE AND DIRECTION ARROW**:



- Used in the bush to point out or obtain bearings.
- Used on a map to measure or plot bearings.
- Note that some compasses have sighting mirrors to aid in obtaining bearings in the field.

FACTORS AFFECTING COMPASS OPERATION

- The compass needle is magnetic and will be attracted toward any large iron or steel object or it will respond to local magnetic fields.
- If you are near a car, snowmobile, ATV, or outboard motor, especially if they are running, the needle may be way off.
- Radios, GPS units, knives, axes, clipboards and even metal belt buckles will affect the operation of the compass.
- If you are unsure of how far the local magnetic attraction of an object extends, simply move away from the object while watching the compass needle. When it no longer wavers towards the object, the compass is set for operation.

BEARINGS

- Bearings are angular measurements with respect to the position of the observer, and the position of a distant object or intended destination course.
- Bearings may be expressed in terms of:
  - Azimuths (used by Nova Scotia SAR teams)
  - Quadrants (not used by Nova Scotia SAR teams)

BEARINGS

- **AZIMUTHS**
  - Azimuths are bearings, expressed as angles, measured clockwise from north throughout the full range of the directional circle.
  - Azimuths range from $0^{o} – 360^{o}$.

MAGNETIC DECLINATION

- There are three primary references that are used to indicate direction:
  - **Magnetic North (on compass)** – the direction to the earth's north magnetic pole. This is where all compass needles point.
  - **True North (on globe)** – the direction to the earth's north geographic pole. All lines of longitude meet there.
  - **Grid North (on map)** – the direction indicated by the N-S lines on the grid which overlies the map. Grid north is slightly different than true north. Since this difference is so little, ***for GSAR purposes, grid north and true north are the same***.

MAGNETIC DECLINATION

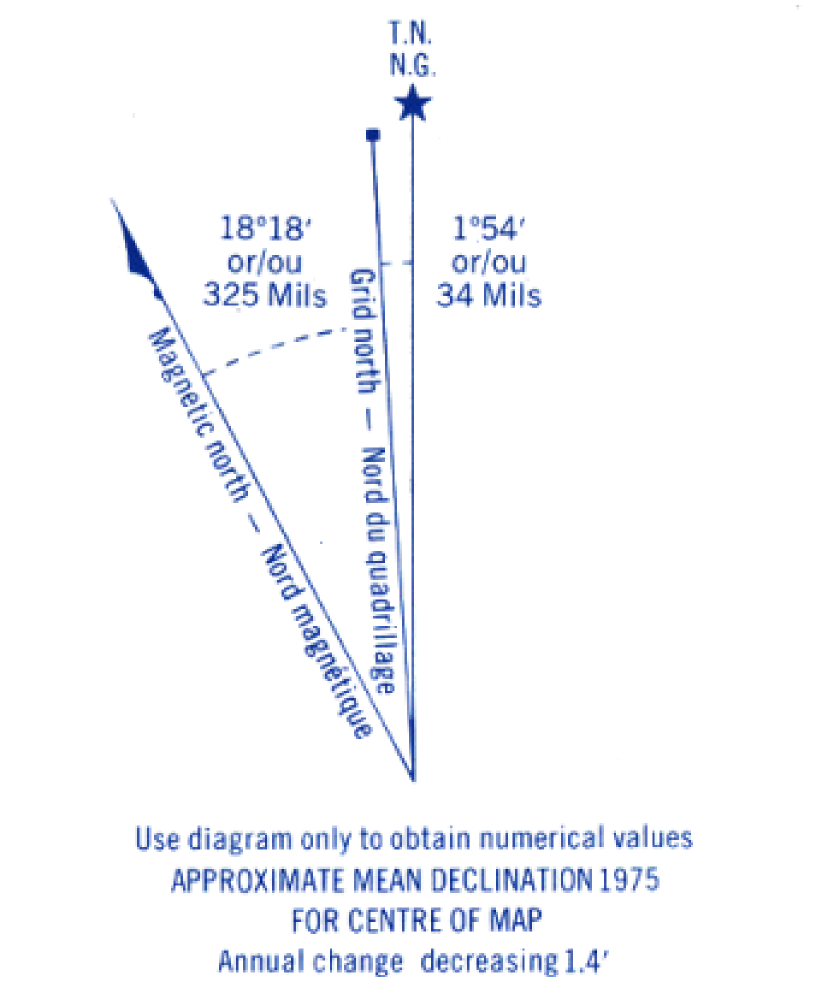
- The angular difference between true north and magnetic north is called ***Magnetic Declination***.

- All topographic maps display a declination diagram.

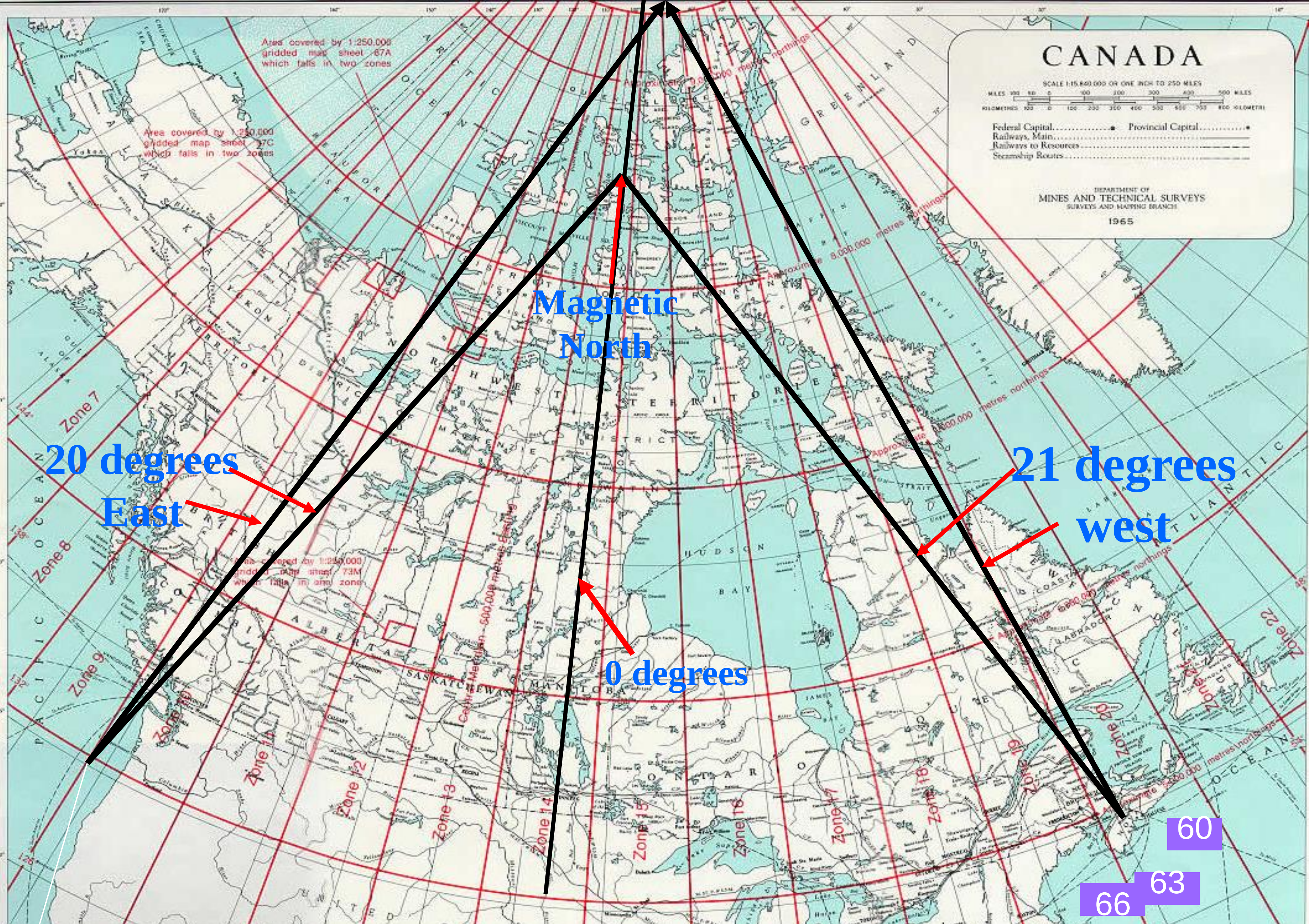
- Depending on your location, declination will be either East or West.

- In Nova Scotia declination is West.

MAGNETIC DECLINATION



Example of a Map’s Declination Diagram



Declination Across Canada

CONVERTING BEARINGS

- Whenever you take a bearing from a map and want to follow it with a compass, you must take into account the magnetic declination.

- The same holds true when you want to plot a bearing taken from your compass, onto a map.

CONVERTING BEARINGS

- The declination for the searcher maps used by ESGSAR is 21º West.

- During a search, bearings are always MAGNETIC.

- During a search, bearings given by the command centre (via radio and on taskings) include declination.

CONVERTING BEARINGS

- For West Declinations (ie. the Maritimes):

  - To convert a grid bearing (taken from a map) to a magnetic (compass) bearing:

    Add Declination

  - To convert a magnetic bearing (taken from a compass) to a grid (map) bearing:

    Subtract Declination

CONVERTING BEARINGS

EXAMPLE: Converting grid (map) bearing to a magnetic (compass) bearing.

Declination: 21 degrees West.

Grid bearing: 60 degrees

Magnetic bearing = Grid bearing + 21

Magnetic bearing = 81 degrees

CONVERTING BEARINGS

EXAMPLE: Converting magnetic (compass) bearing to a grid (map) bearing.

Declination: 21 degrees West.

Magnetic bearing: 90 degrees

Grid bearing = Magnetic bearing - 21

Grid bearing = 69 degrees

CONVERTING BEARINGS EXERCISE

Convert the following bearings:

1. Declination: 21^{o}W
Magnetic bearing: 264^{o}
Grid bearing: **???**

2. Declination: 21^{o}W
Grid bearing: 167^{o}
Magnetic bearing: **???**

3. Declination: 21^{o}W
Grid bearing: 69^{o}
Magnetic bearing: **???**

4. Declination: 21^{o}W
Magnetic bearing: 10^{o}
Grid bearing: **???**

CONVERTING BEARINGS EXERCISE

ANSWERS

1. Declination: 21^{o}W
Magnetic bearing: 264^{o}
Grid bearing: **243^{o}**

2. Declination: 21^{o}W
Grid bearing: 167^{o}
Magnetic bearing: **188^{o}**

3. Declination: 21^{o}W
Grid bearing: 69^{o}
Magnetic bearing: **90^{o}**

4. Declination: 21^{o}W
Magnetic bearing: 10^{o}
Grid bearing: **349^{o}**

DETERMINING BEARINGS FROM A MAP

- To follow a route in the field between two points on a map, the direction (bearing) between these points must be determined first.

- This can be accomplished by using the compass as a protractor to determine the bearing.

DETERMINING BEARINGS FROM A MAP

The following 5 steps outline the procedure for determining a bearing with a compass:

1. With a sharp pencil, lightly draw a line between the departure and destination points.
2. Align the long edge of the compass along the line with the direction of travel arrow point towards the destination point.

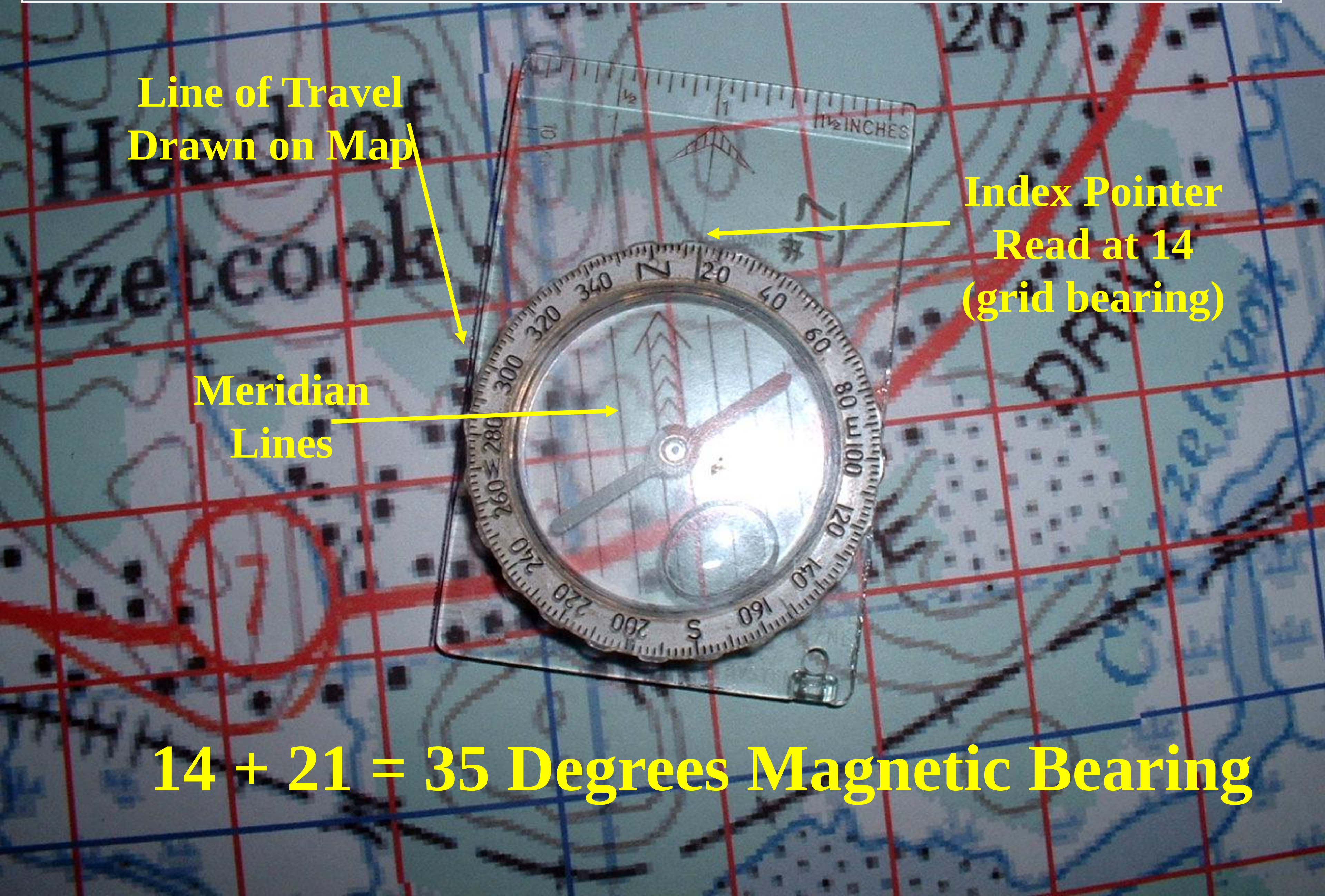
DETERMINING BEARINGS FROM A MAP

3. Holding the compass in this position, rotate the compass housing until the meridian lines on the base are aligned with the north-south grid lines on the map, with the orientating arrow pointing north.

4. Read the bearing on the compass housing at the index pointer. This is the grid bearing.

5. Add the declination(21) to the grid bearing to determine the magnetic bearing.

Determining A Bearing From the Map



14 + 21 = 35 Degrees Magnetic Bearing

DETERMINING BEARINGS FROM A MAP

EXERCISE

Using the provided Searcher Map, determine the magnetic bearings for the following:

A. From SCHOOL to ESGSAR BUS.
B. From ESGSAR BUS to CAMP.
C. From CAMP to waypoint #4.
D. From waypoint 4 to SCHOOL.
E. From ESGSAR BUS to SCHOOL.

DETERMINING BEARINGS FROM A MAP

ANSWERS

A) SCHOOL to ESGSAR BUS: 20° magnetic

B) ESGSAR BUS to CAMP: 110° magnetic

C) CAMP to Waypoint #4: 262° magnetic

D) Waypoint 4 to SCHOOL: 274° magnetic

E) ESGSAR BUS to SCHOOL: 200° magnetic

TAKING A COMPASS BEARING

- To determine the bearing of a particular object or direction in the field, perform the following steps:

1. Hold the compass steady and level at chest height, and point the direction of travel arrow in the direction of an object or in the direction that you want to travel. This can also be done using the sighting mirror.

2. Rotate the compass housing until the orienting arrow is under and parallel to the coloured end of the magnetic needle **(*Put the Red in the Bed*).**

3. The bearing is now set on the compass and may be read at the index pointer.


Direction of Object
Read the Index Pointer (280)
"Put the Red in Bed"

FOLLOWING A BEARING

- To follow a given bearing in the field, perform the following steps:

  1. Rotate the compass housing so that the desired bearing corresponds to the index pointer.

  2. Hold the compass steady and level, and turn your entire body until the orienting arrow is under and parallel to the coloured end of the magnetic needle **(*Put the Red in the Bed*).**

  3. The direction of travel arrow now points in the desired direction.

  4. To travel on the bearing, sight a distant object on the route, put the compass away and walk towards it. When this is reached, sight another landmark along the route and continue to your destination.


Direction of Travel

BACK BEARINGS

- A back bearing is the 180^o opposite of a bearing.
- A back bearing is used to return to one's starting position, by traveling backwards along the original bearing.
- Examples: The back bearing of 35^o is 215^o. The back bearing of 290^o is 110^o.


Direction of Travel
Back Bearing
280-180 = 100

MAP ORIENTATION

- A map is ***“orientated”*** when it is turned by the map reader to correspond with the ground it represents.
- The following describes two methods for orientating a map:

  1. **Compass Method**

     - Set compass to North
     - Place orientating lines on compass parallel to North on the map.
     - Rotate map until ***“red goes in the bed”***.

MAP ORIENTATION

2. Distant Objects Method

- Find two objects/natural landmarks that are also distinct on the map.
- Stand between the two objects.
- Orientate the map to line up with the objects.

BASIC COMPASS NAVIGATIONAL TECHNIQUES

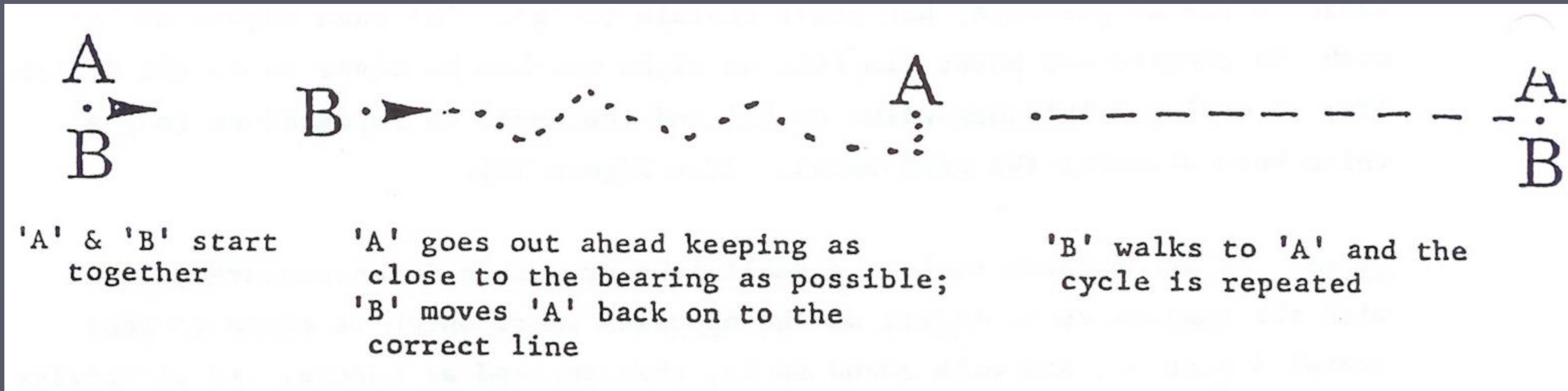
1. Open Bush Navigation

- In open country where visibility extends to 50m or more, accurate navigation is best achieved by sighting on an object (ie. tree, boulder, etc.) in the correct direction and as far away as possible.
- Keep an eye on this object and walk towards it. The more distinctive the object, the easier it will be to identify especially if you lose sight of it for a while.
- Once you have reached the object, stand close to it and sight on another, further along the line of travel.
- In this manner you can walk comfortably in between checkpoints without constantly referring to the compass.

BASIC COMPASS NAVIGATIONAL TECHNIQUES

2. Thick Bush Navigation – “Leapfrogging”

- If bushes and trees are close together, it is not possible to travel as in open bush.
- With a minimum of two people traveling together, person “A” goes out ahead as far as possible, but still visible to person “B”.
- “B” then sights on “A” with the compass and moves that person left or right so that they move on to the desired line of travel.
- “B” then walks to “A” and the cycle is repeated as long as thick bush obscures the path ahead.
- This method is also useful for night navigation or navigation during conditions of low visibility (ie. snow and fog)

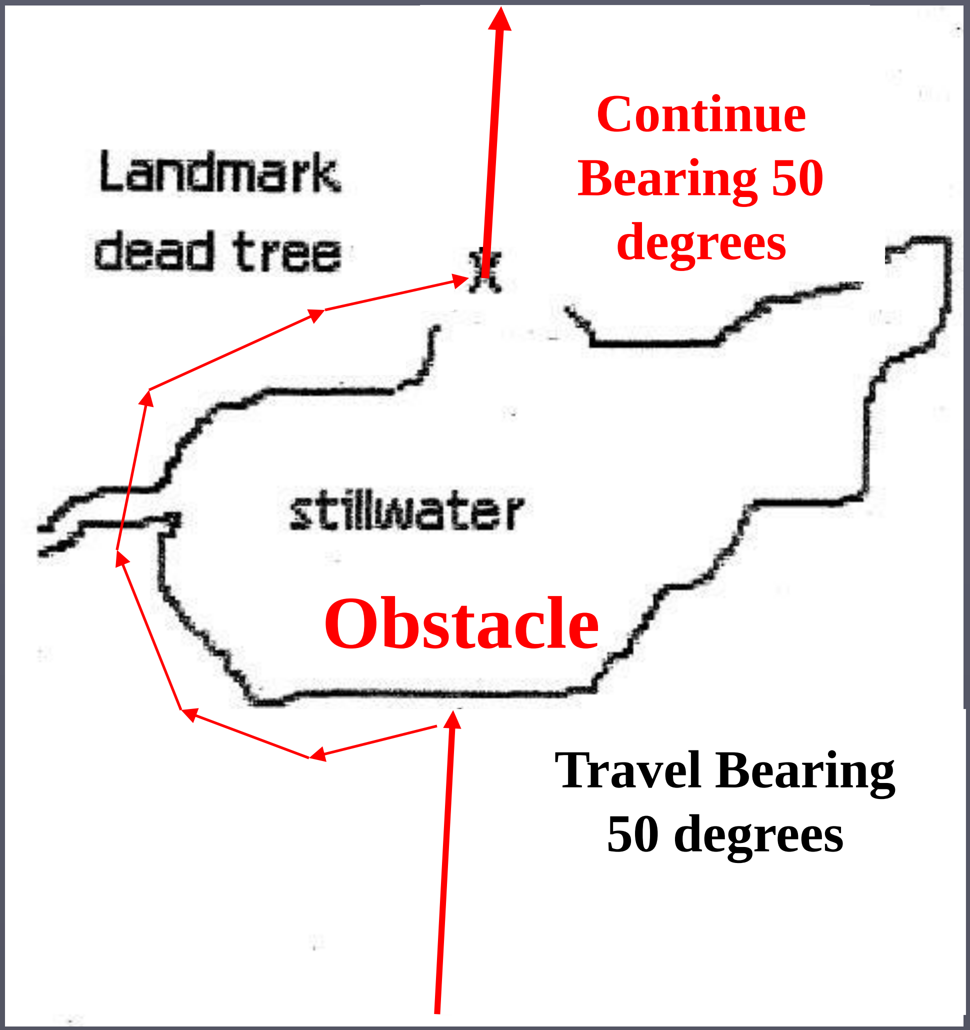


The "leapfrog" navigation technique

BASIC COMPASS NAVIGATIONAL TECHNIQUES

3. Navigation Around Small Obstacles

- If an obstacle such as a small pond or bog is encountered, sight with the compass on an object on the opposite side which is close to your direction of travel.
- Walk around to that object and proceed as before.

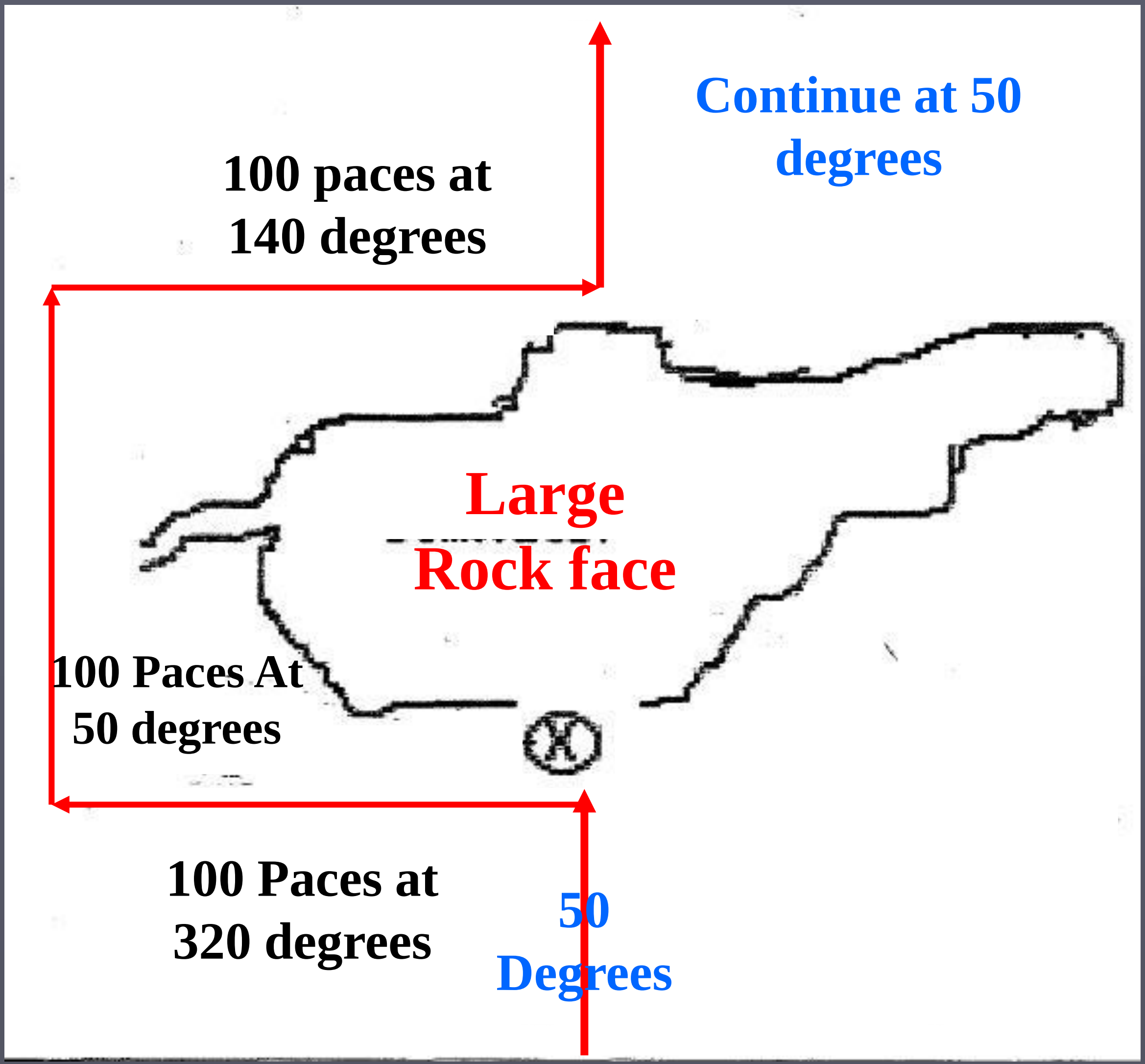


Navigating Around a Small Obstacle

BASIC COMPASS NAVIGATIONAL TECHNIQUES

4. Navigation Around Large Obstacles – "Offsetting"

- When a large obstacle is encountered that can not be sighted across, it may be necessary to divert the traverse to avoid the obstacle.
- Walk at a right angle to the traverse direction far enough to avoid the obstacle, counting paces.
- Turn back to the traverse direction and walk past the obstacle.
- Turn a right angle in the opposite direction and walk back towards the original line of travel, counting the same number of paces as before.
- You should now be on the original traverse line and ready to proceed forward.



Using an “offset” to navigate around a large obstacle

DISTANCE MEASUREMENT IN THE FIELD

- **Pacing**
  - When accurate measurement is necessary, as in grid searches or plotting trails, and no GPS is available, pacing is the most practical method available.
  - Measuring distance accurately by pacing requires experience.
  - Every person has a different pace length and the size of their step will vary depending on speed and the type of ground they are traveling on.

DISTANCE MEASUREMENT IN THE FIELD

- **Pacing (cont.)**
  - To obtain pace information, measure out 100 meters and count the number of paces required to walk this distance.
  - Repeat the route until the number of paces becomes consistent.
  - Try this exercise in a variety of locations as pacing changes depending on the terrain.

DISTANCE MEASUREMENT IN THE FIELD

- **String Boxes**
  - A string box is a plastic belt case containing a spool of thin string and a measuring device which registers as the string is let out.
  - The user simply ties the string at the starting point and can then read the counter at any time to determine how far they have traveled.
  - This method is more exact than pacing if a reasonably straight line can be maintained.

END OF CLASSROOM SESSION

It's time to get outside and practice!!