Rural Firefighting

Study Guide

Using maps

RFUM1

EMQUAL
EMERGENCY MANAGEMENT QUALIFICATIONS

NATIONAL TRAINING

Status of this Document

This document is issued by the National Rural Fire Authority.

What this means:
It is written to comply with:

- Other National Training Material
- Rural Fire Authority best practice.
- Forest and Rural Fires Act 1977
- Fire Service Act 1975
- Health and Safety and other relevant legislation
- New Zealand Qualifications Authority requirements
- Emergency Management Qualifications (EMQUAL).

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Contents

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Study Guide Introduction

Overview	This study guide is supporting material for Use maps to locate and plan a navigation route to a vegetation fire, unit standard 14565 (version 3).
Course objectives	The objectives of this course are that you will be able to: • demonstrate knowledge of navigation tools used by a fire and rescue service provider • identify and report a location using maps • select a route for navigation to a vegetation fire.
Theory	There is an accompanying workbook with exercises on the subject matter. The study guide and workbook are taught by distance education.
How this is assessed	There is a practical assessment for this course. You will be assessed on the theory outlined in this study guide. Completion of the workbook will also be used as contributing evidence towards awarding the unit standard. As each trainee's practical experience differs you will need to check with an approved assessor and discuss the requirements for you to achieve the unit standard.
Additional information	For a comprehensive set of definitions see the Rural Fire Management Glossary of Terms at www.nrfa.org.nz.

Section 1:Introduction to Maps

What is a map?

A map is a graphic representation of a portion of the earth's surface drawn to scale, as seen from above. It uses colours, symbols and labels to represent features found on the ground.

Why are maps important?

A map provides information on the existence, location, and distance between ground features, such as populated places and routes of travel. Variations in terrain, natural features, and may include vegetation cover.

Standard maps provide a common source of information that aids communication between agencies.

For example maps can help you:

- identify and report the location of a fire
- plot location and spread of a fire, and assist with the calculation of fire spread
- navigate to and from a fire

How reliable are maps?

While natural features remain relatively undisturbed, artificial features are subject to constant change, and therefore the information on a map must be completely revised at regular intervals.

It is important to note the date when the map was produced or revised. This will tell you how current the information is. Maps become outdated and require periodic updates in new editions.

What different types of maps are there

Not all maps are the same. Each type of map gives a particular sort of information but can be used for a range of purposes.

Note

Chatham Islands use a different map projection to the rest of NZ and the coordinates on a Chatham Island sheet do not relate to mainland NZ.

Topographical map

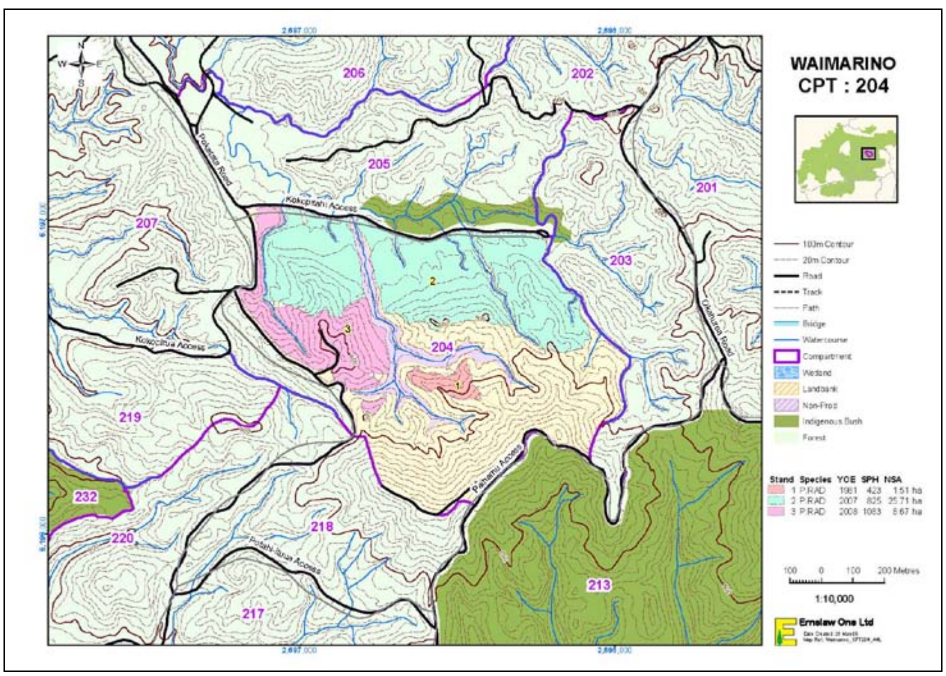
Topographic maps show terrain through the use of contour lines and features which exist on the ground.

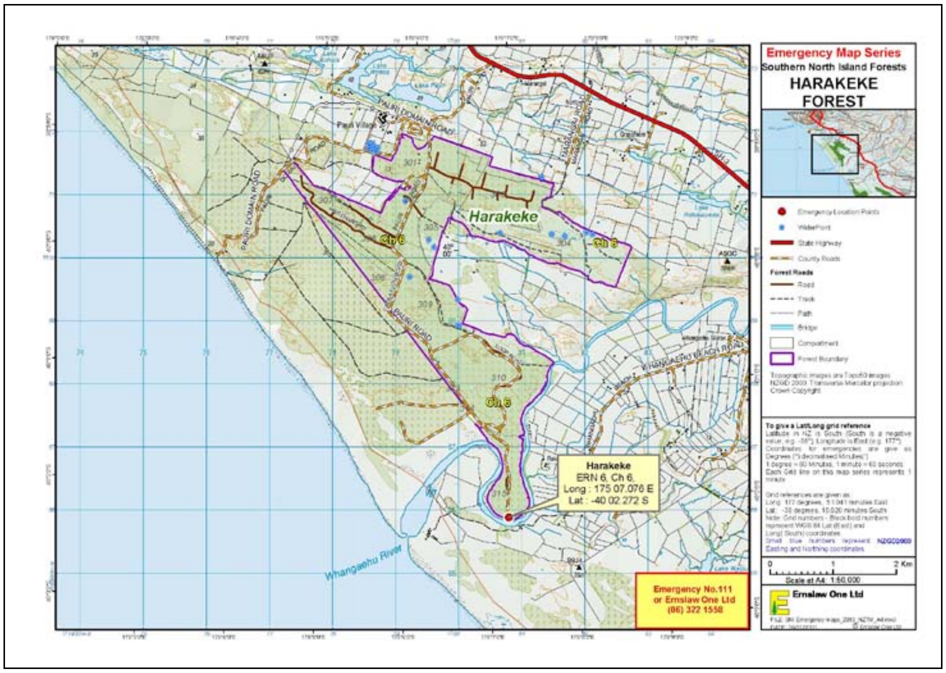
In New Zealand the Topo50 series Topographical 1:50 000 scale is the main topographical series map in use by fire authorities. Topo50 was introduced in 2009 and replaces the old NZMS260 series maps.

The NZMS260 series numbered sheets from A to Z (west to east) and 1 to 50 (north to south). The Topo50 series is indexed using 2 letters followed by 2 numbers.

Forest Compartment Map and Forest roading/emergency maps

Below are two examples of maps used by Forestry.





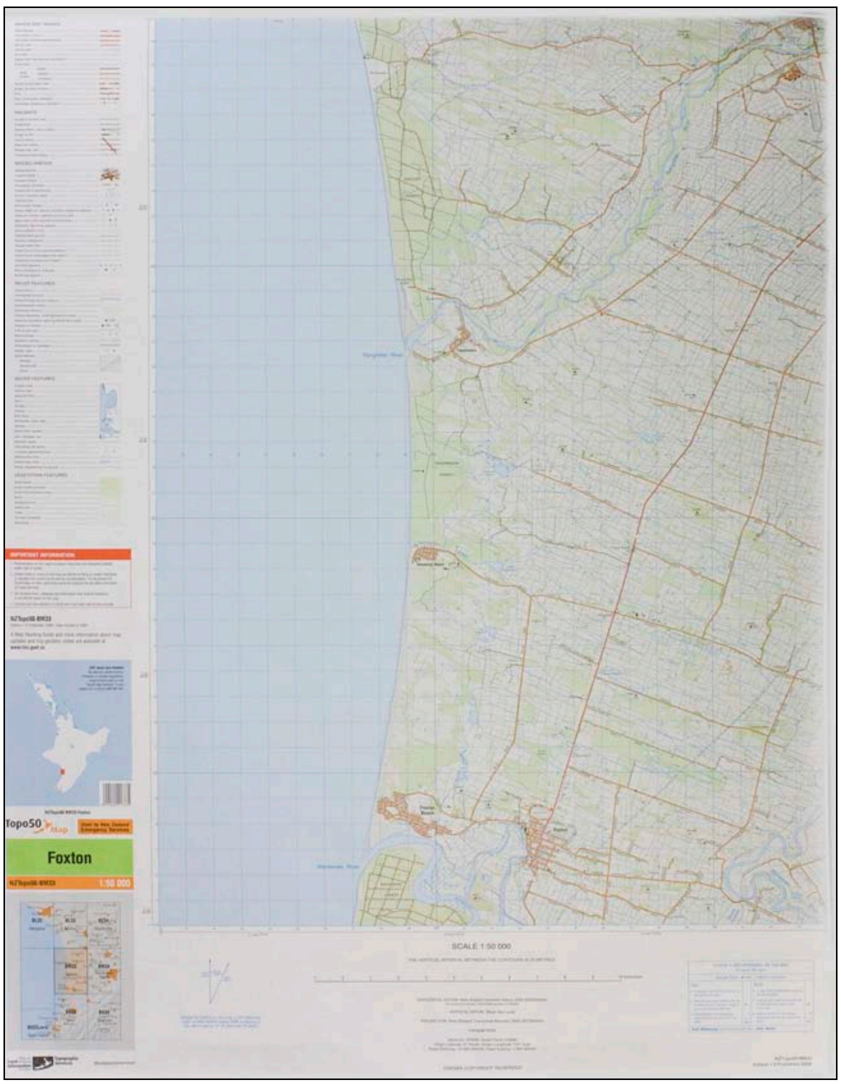
Cadastral Maps

A cadastral map contains property boundaries for a specific area. It is important to use these maps if you need to determine the best way for vehicles and equipment to gain access to fenced areas. Property owners will need to be contacted or informed.

Section 2: Map Legend/Information

All map users should be familiar with the information available in written and pictorial form around the edges of the map.

There are notes regarding the amount of magnetic declination in the area covered by the map, instructions on how to give a grid reference, an index to adjoining sheets, a linear scale and a sample of all the conventional symbols that may be used on the map.



Introduction

The following relates to the margin information on the topographical map.

Map Legend (key)

The reference area on a map that lists and explains the colours, symbols, line patterns, shadings, and annotation used on the map.

Legends describe map symbols (*conventional signs*) and are purely representative.

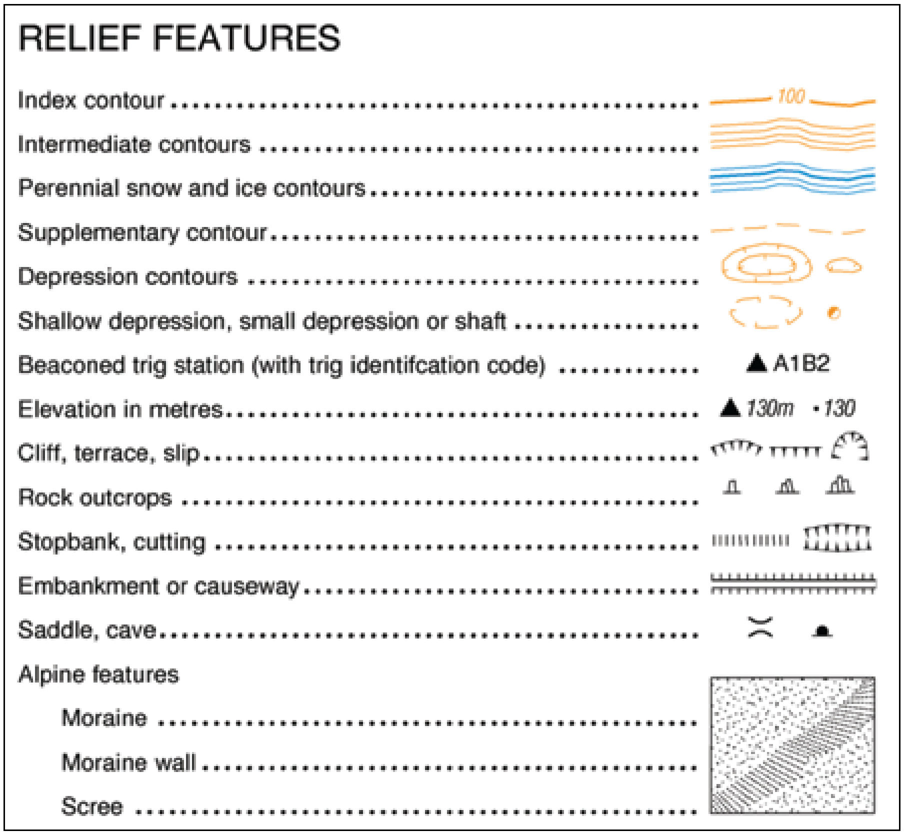
Map symbols (the legend)

Maps use symbols to represent features on the ground. These features include roads, tracks, rivers, lakes, vegetation, fences, buildings, power lines etc.

Given the size of a map, it is not possible to show all features on the ground. Large scale maps show more detail and a larger number of features.

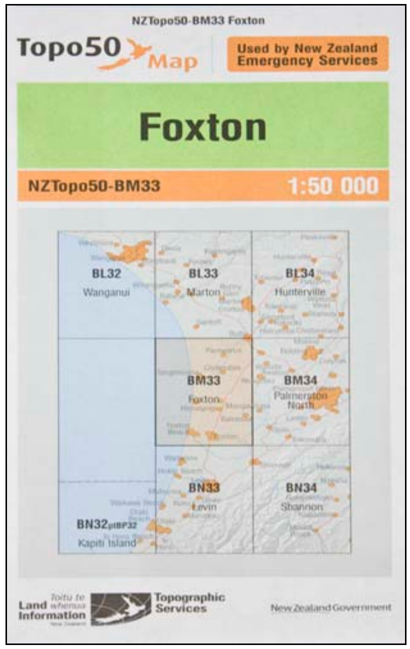
Depending on the scale of the maps, features may have to be offset so they can be clearly shown on the map, e.g. a roadway and a railway line may have to be separated horizontally so they don't overlay each other.

While most symbols are easily recognised as the features they represent, you always refer to the map's legend.


RELIEF FEATURES
Index contour
100
Intermediate contours
Perennial snow and ice contours
Supplementary contour
Depression contours
Shallow depression, small depression or shaft
Beaconed trig station (with trig identifcation code)
A1B2
Elevation in metres
130m
130
Cliff, terrace, slip
Rock outcrops
Stopbank, cutting
Embankment or causeway
Saddle, cave
Alpine features
Moraine
Moraine wall
Scree

Map Title

The title may be the name of an important town or an area of the map NZTopo50 –BM33 **Foxton.**



Map Reference

New Zealand mapping service map number and a sheet number. **NZTopo50 –BM33** Foxton.

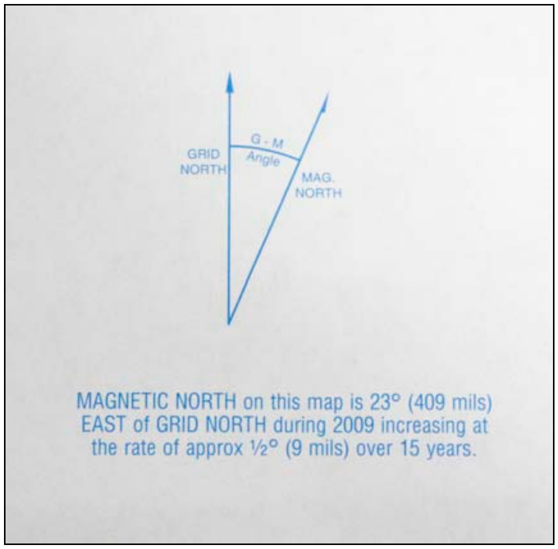
Index to adjoining map

This is the index to adjoining maps. This shows the relationship between this map and the maps that adjoin it. For example BM34 is an adjoining map to BM33.

Magnetic Variation (North Point Diagram)

Located below the legend there is a diagram showing the direction of grid and magnetic north for a particular year and latitude. The annual change in magnetic north is also given.

For all practical purposes the magnetic declination throughout New Zealand can be taken as 23˚.


G - M
Angle
GRID
NORTH
MAG.
NORTH
MAGNETIC NORTH on this map is 23° (409 mils)
EAST of GRID NORTH during 2009 increasing at
the rate of approx ½° (9 mils) over 15 years.

North Points

As mentioned earlier, north points are part of the marginal information usually found on the side margin of topographical maps. It is important to realise that there are three north points:

True North (TN)

Grid North (GN)

Magnetic North (MN)

True north (TN)

True north is the direction of the geographical position of the North Pole from an observer's position anywhere on the earth's surface. In map reading and navigation. Grid North is more easily found and is very close to True North, hence Grid North is used in preference.

Grid north (GN)

Grid north is the direction in which the north south grid lines (eastings) point to at the top of the map. Since the grid lines are parallel and they are drawn on a map it is very convenient to use them for measuring distances and calculating bearings.

Magnetic north (MN)

The earth being a very large magnet has a north and south pole like any other magnet. Therefore a magnetic field exists between the magnetic north and magnetic south poles. *Magnetic north* is generally accepted as the direction that a freely suspended compass needle will point to when only affected by the earth's magnetic field.

Grid Reference Block

This block contains information on how to calculate a six figure grid reference. A grid reference allows features to be identified and their position calculated.

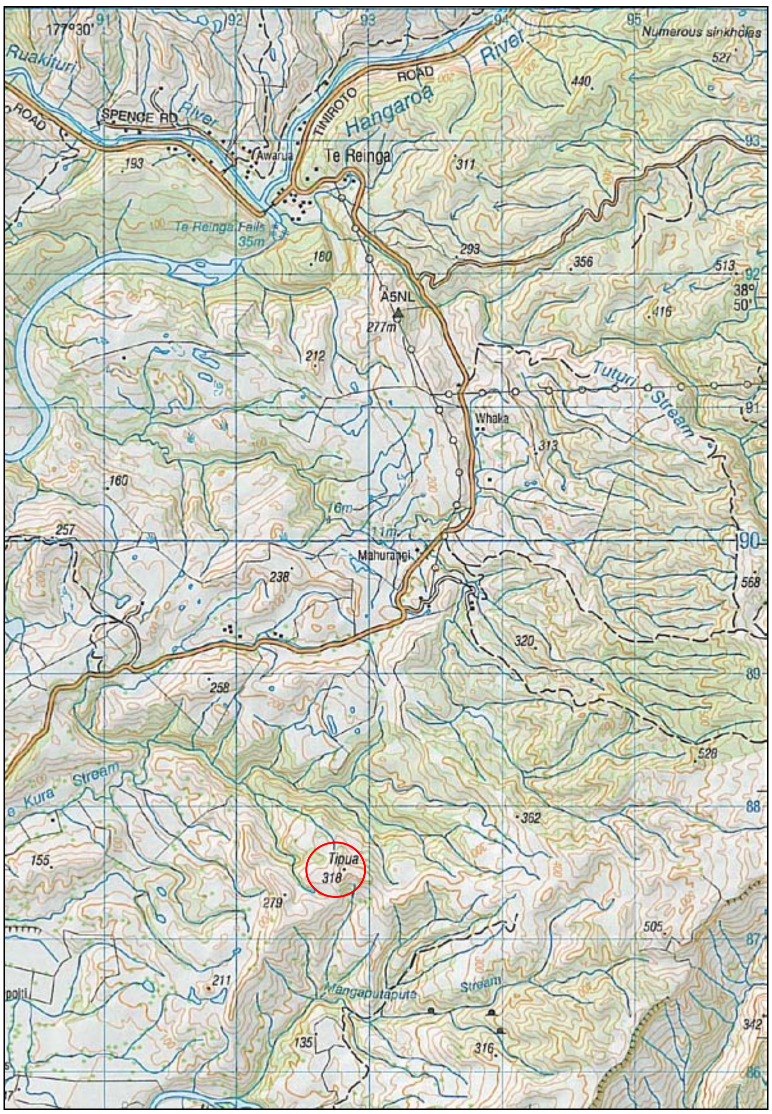
The simplified way of expressing the full grid coordinate is to specify the sheet number and a six figure grid reference. Remember to quote the sheet number as the six figure grid reference is not unique to a single map.

TO GIVE A GRID REFERENCE ON THIS MAP
(To nearest 100 metres)

Sample Point: · *Tipua (1992823E 5687522N)*

East		North	
1. Locate the first VERTICAL grid line to the LEFT of the point.		4. Locate the first HORIZONTAL grid line BELOW the point.	
2. Read the grid values labelling the line in either the top or bottom margin or across the middle of the map.	92	5. Read the grid values labelling the line in either the left or right margin of the map.	87
3. Estimate tenths of a grid square eastwards from the grid line to the point.	8	6. Estimate tenths of a grid square northwards from the grid line to the point.	5
	928		875

Grid Reference (Quote sheet number first): **BH41 928875**



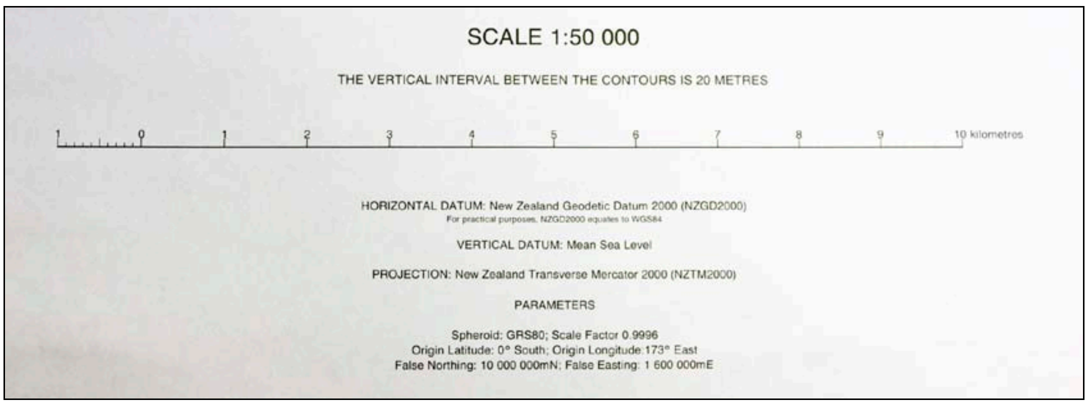
Note

Sample Point Tipua (1992823E 5687522N). The six figure grid reference is taken from the middle three numbers shown on the Topo50 map in this case 928875.

How to work out grid references are shown in detail, later in the study guide

Scale

The scale of a map shows the relationship between distances on the map and distances on the ground. This relationship is constant in whatever direction the distances are measured.



Contour lines

Contour lines show relief on maps. They not only represent height but also shape on the ground. Topo50 maps show 20m elevation contour lines. For example, if there are many contour lines close together, the terrain is steep. Contour lines that are far apart indicate land with gradual slopes.

Production Information

This identifies the agency or organisation responsible for producing the map.

Edition

The date of the edition is only an indication of the latest update to the map. The representation of many features on the map may date from a much earlier time. In particular vegetation cover, landslides, and stream channels may be well outdated.

Section 3: Map Scale and Measuring Distance

Map Scale

By using a map scale you can work out how far apart two points on a map are on the ground. This relationship is constant; in whatever direction the distances are measured.

In words e.g. one centimetre to one kilometre – that is one centimetre on the map represents one kilometre on the ground

As a linear scale or a scale bar this can be used to determine the distance between two points on the map.

In numbers written as a ratio, for example 1;50 000; or as a representative fraction, or example 1/50 000.

The Topo50 maps are at a scale of 1:50 000.

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Scale	Ground distance of 1 cm on the map	Ground distance of 1 cm on the map
1:25 000	250 m	0.25 km
1:50 000	500 m	0.5 km
1:100 000	1000 m	1.0 km
1:250 000	2500 m	2.5 km

In the case below, one centimetre on the map represents 50 000 centimetres, or 500 metres, on the ground. The distance between Trigs A582 and MQZG on the following map is measured at 9 cm at the map scale, which equates to 4.5 km on the ground.

Note

Grid (blue lines) are 1 km apart.

The larger the scale of a map, the smaller the area that is covered and the more detailed the graphic representation of the ground. For example, small scale mapsTopo250 (1:250 000) are good for long distance vehicle navigation, which larger scale maps Topo50 (1:50 000) are ideal for travel on foot.

Measuring distances on a map

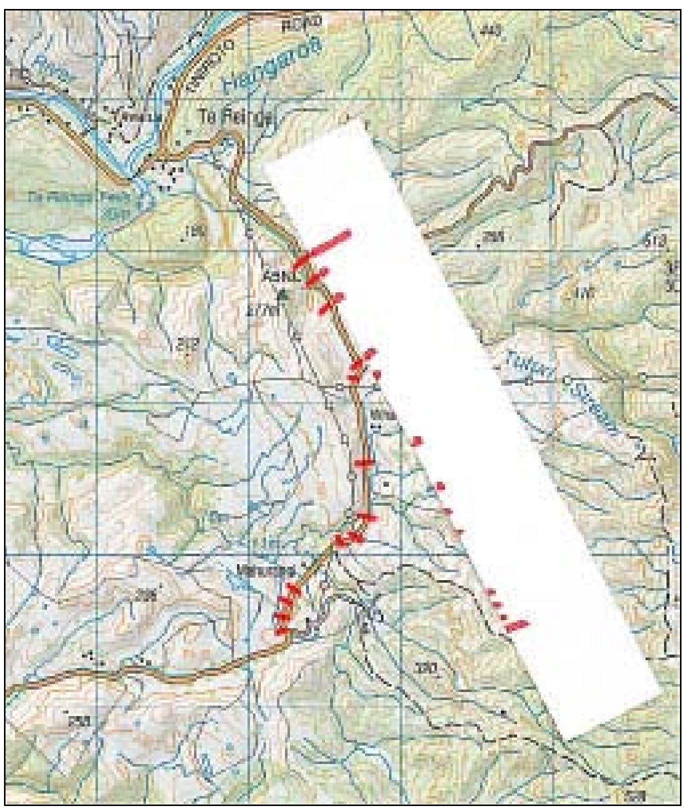
Measuring straight lines

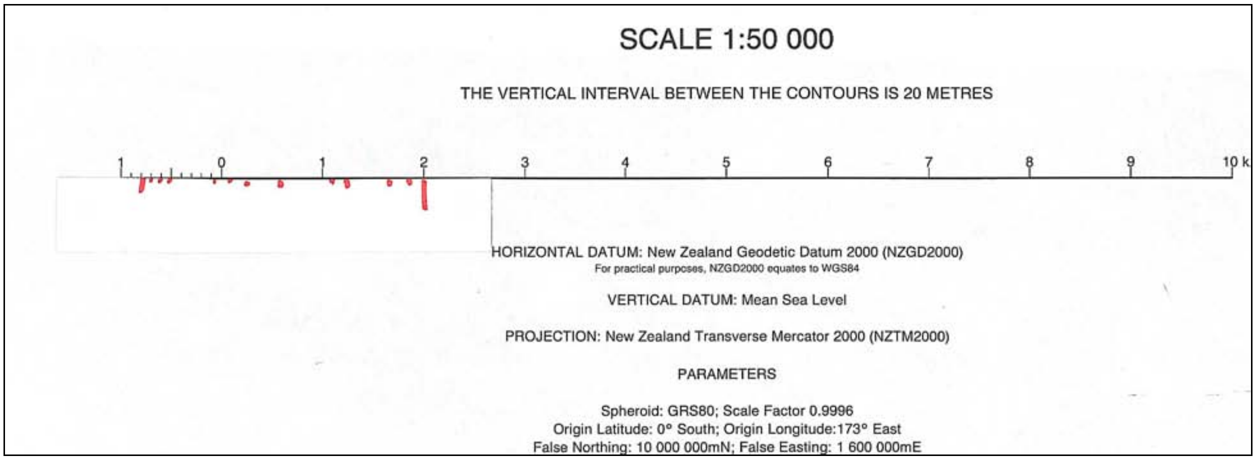
To measure a straight line distance between two points, use a scale bar or linear scale and a piece of paper, ruler or string.

Measuring curved lines

Follow these steps to measure the distance between two points when there are bends and curves.

Step	Action
1	Place a piece of paper or ruler on the map and mark off the starting point on the edge of the paper
2	Move the paper so that its edge follows the bends and curves of the road
3	Mark off the end point on your sheet of paper then place the paper on the linear scale and read off the distance.





Note

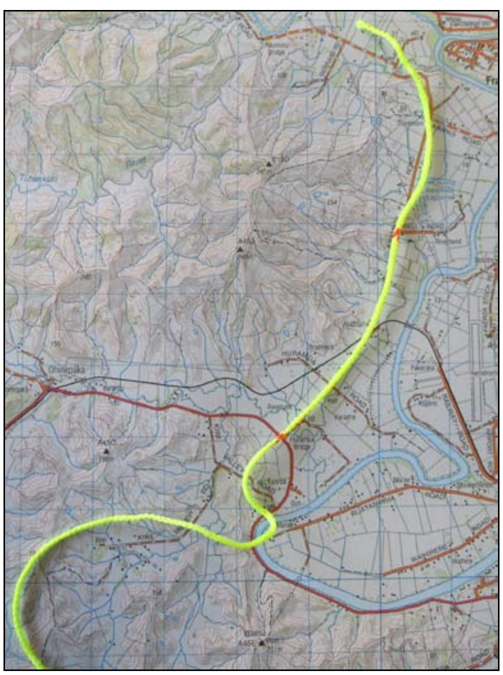
When using a ruler measure the distance using cm. Convert this to distance on the ground by multiplying by the scale factor. For example the map scale is 1:50 000 is 1 cm represents 0.5 km.

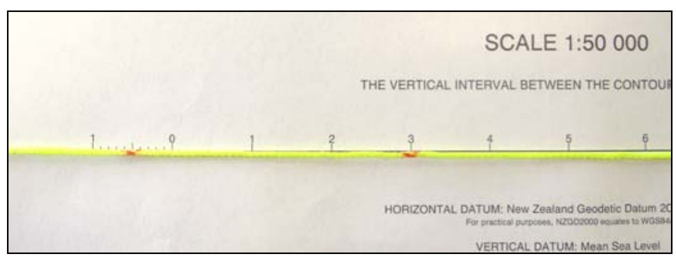
If you measure 3.6 cm using the ruler 3.6 x 0.5 = 1.8 km.

String Method

Using string is the easiest way to measure curves.

Step	Action
1	Lay the string along the line following the curve and mark the start and finish points.
2	Place the string on the linear scale and read the distance.





Convert centimetres to metres and kilometres

A map scale of 1:50 000 means 1 cm on the map represents 50 000 cm on the ground.

To convert from cm to m move the decimal point two places to the left.
To convert from m to km move the decimal point three places to left.

For example: 50 000 cm = 500 m = 0.5 km.

To convert from cm to km move the decimal point five places to the left.

Examples

If you have a 1:50 000 scaled map 1 cm on the map equals 0.5 km on the ground. Simply multiply the distance measured on the map by 0.5.
3.6 cm measured on the map x 0.5 = 1.8 km on the ground.

If you have a 1:100 000 scaled map 1 cm on the map equals 1 km on the ground so multiply the distance measured on the map by 1.
3.6 cm measured on the map x 1 = 3.6 km on the ground.

Section 4: Grid References

If you look at a map probably the first thing that strikes you is a network of lines, some running north to south, others west to east, resulting in a grid of small squares all over the map.

These lines are known as grid lines and their purpose is to make map references possible. They make no difference to the construction of the map and if they were removed the map would not suffer in any way, but the grid lines are superimposed in order that it may be possible to give a reference to a desired point.

The distance between the lines is dependent on the scale of the map. The relationship between the space separating grid lines and distance on the ground is given in the scale located in the margin of the map. For example the space between adjacent lines on a 1:50 000 topographical map is two centimetres. The corresponding distance on the ground is 1000 metres or 1 kilometre.

Grid lines are numbered at the map boarder. Every tenth line is thicker and is also numbered at various places along its length.

Official LINZ maps are printed so grid north points to the top of the sheet. One set of grid lines runs north-south, while the other runs west-east. The position of a point on the map is described as its distance east from a north-south line and its distance north of an east-west line.

Eastings and Northings

Grid lines are also called:

Eastings- these are the vertical lines running from top to bottom (north to south). They divide the map from west to east. Their values increase towards the east; and

Northings- these are the horizontal lines running from left to right (west to east).; They divide the map from north to south. Their values increase towards the north.

The square forms by intersecting eastings and northings are called grid squares. On Topo50 maps each square represents an area of 100 hectares or one square kilometre.

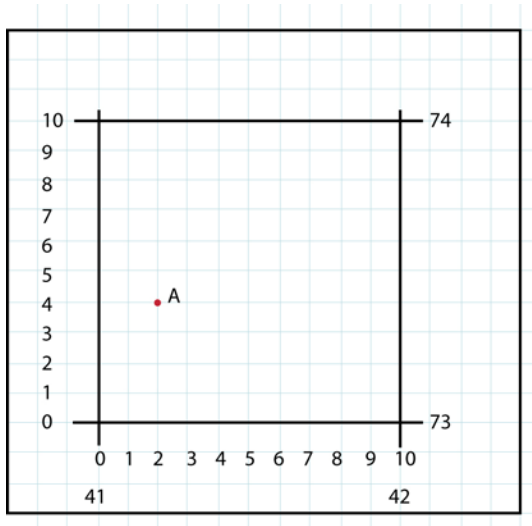
Six figure grid reference

The six figure grid reference is used to indicate the position of an object in a square, **quoting the eastings reference followed by the northing reference**. This needs to be preceded by the appropriate map title number otherwise there is no context for the grid reference.

To do this imagine each grid square divided into tenths then estimate which tenths the object is in.

A way of remembering this is ‘Crawl before you climb’

The point ‘A’ is in the small square 41.2 east and 73.4 north, in other words, easting 412 and northing 734. Consequently the six figure grid reference to ‘A’ is 412734.



Note

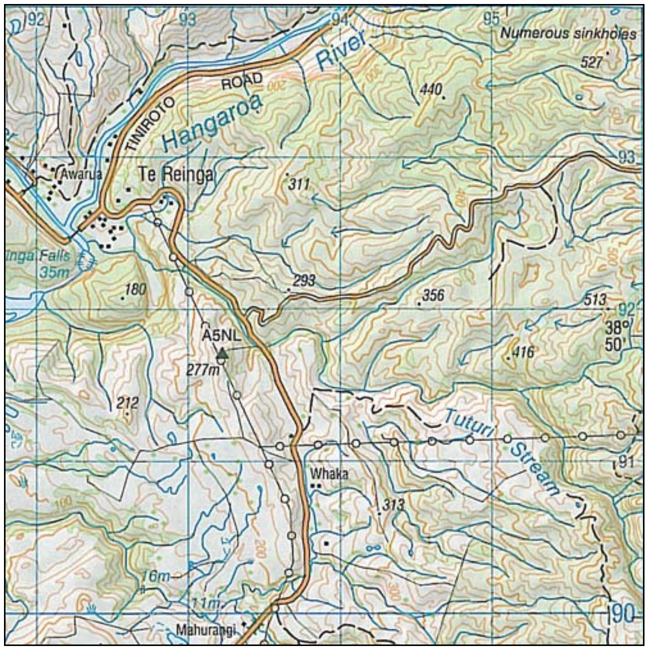
If a grid reference starts with a zero, remember to include it.

Full Grid

A full grid coordinate to the nearest 100 m can also be given by a seven figure easting and northing for the example above.

Identifying a feature

Examine the map below and locate point A5NL.



Step	Action
1	First count from west to east until you come to the vertical line immediately before A5NL. This is line **93**.
2	Estimate how far across the small 1km square A5NL is. To do this you must mentally divide the small square into 10 still smaller divisions. A5NL is about **3** of these small divisions across. The position of A5NL from west to east is now fixed and you need to do the same thing from south to north.
3	Counting upwards along the horizontal lines, the one before A5NL is **91**.
4	Estimating again A5NL appears to be **7** tenths of the way up the small square.
	The full reference to A5NL is therefore 933917. The third and last figures are the ones which have been estimated and for these figures a slight amount of error is allowable.

Global Positioning System (GPS)

The GPS is one of a number of GNSS (Global Navigation Satellite system) and has been developed by the USA's Department of Defence. It is widely used for civilian navigation and positioning, surveying and scientific applications, and although an excellent tool, it is best used with a map.

GPS receivers have many useful features for navigation, such as the ability to store positions and determine speed and direction of travel (which are beyond the scope of this guide). Provided it is used correctly, a comparatively inexpensive, hand-held GPS receiver can provide positions with accuracy better than 15 m and often at the 5 m level.

Section 5: Interpretation

Shape of the ground

The shape of the landscape is particularly important in emergency response. The shape of the ground can:

- be used to predict the likely perimeter, that is the boundary and shape of the fire
- show you what locations are suitable for observing the fire or incident
- help indicate a suitable location for a forward control point
- be used to select where fire breaks may be placed to stem the path of a fire
- determine pathways for safe access to an incident
- help determine where you are
- determine the path for a safe escape from a fire or other emergency situation

The following information about the landscape can also assist emergency personnel.

Ridge Lines

Lines along a hill, range of hills or mountains.

Aspect

The direction a slope faces. For example, northerly and westerly facing slopes tend to be drier and warmer than southerly and easterly facing slopes.

Density and types of vegetation

These can be shown on a map by shading and symbols described in the legend at the side of the map. It is important to note that the information regarding vegetation is only a broad indication of vegetation types and may also be no longer be accurate.

Contour lines

Topo50 maps show 20 m contour lines. These lines, which join points of equal height, represent the relief in the terrain depicted. For example, if there are many contour lines close together, the terrain is steep. Contour lines that are far apart indicate land with gentle slopes.

Relief Shading

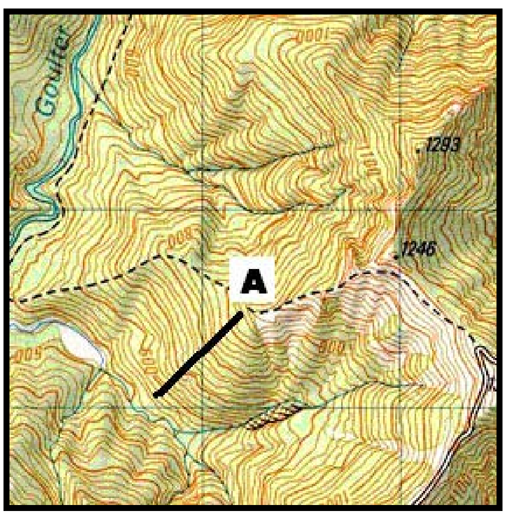
In addition to contour lines, relief shading helps you visualise the terrain. Hills and valleys are shaded as if they were illuminated from the north-west.

It's not always easy to tell which is the top of the slope and which is bottom without looking at the contour figures. A general idea of which way the slopes run can be obtained by looking at other features such as rivers, lakes and streams.

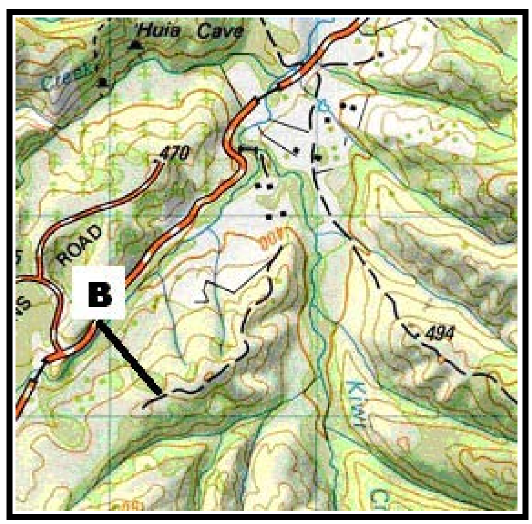
Contours

Definition

Contour lines are thin lines drawn on a map (usually in red or orange), each line joining up points of equal height above sea level. Against these lines in the same colour is written a figure that indicates the height of the line above sea level.



– A steep slope is shown by the thick line labelled A.



A gradual slope is shown by the thick line labelled B.

Things to note

Some indicators when reading contours to consider:

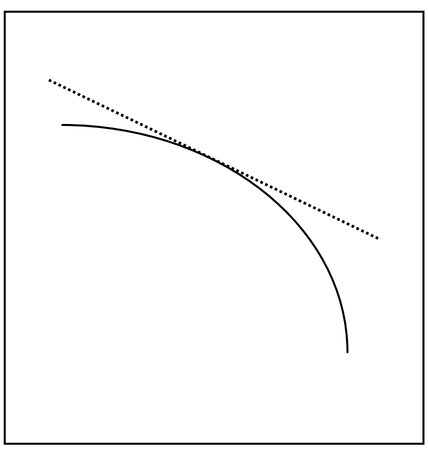
- contour lines close together show steep slopes
- contour lines far apart show gradual slopes
- contour lines evenly spaced show uniform slope
- if the spacing decreases when going from high to low, the slope is convex
- if the spacing increases when going from high to low, the slope is concave
- if unsure whether the shape on the map is convex or concave, the first thing to do is make your mind up on which way the slope runs. Next begin at the bottom of the slope and see how the contour lines are spaces then apply the rules above.

Slope indicator

It's not always possible to tell which is the top of the slope, and which is the bottom without looking at the contour figures. A general idea of which way the slopes run can be obtained by looking at other features such as rivers, lakes and streams.

Convex Slopes

A convex slope bulges outwards. It will start steeply from the bottom and become more gradual at the top. Remembering contour lines are closest together where the hill is steepest; the contours on a convex slope will be closer together at the base and wider apart at the top.



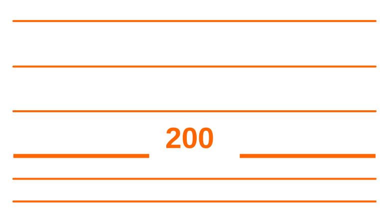
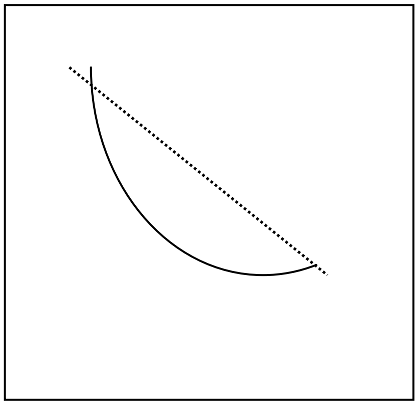


Fig 5.4 View of contours for a convex slope

Concave slopes

A concave slope curves inwards. A concave slope starts gradually and becomes steeper at the top hence contour lines will be wide apart at the bottom and close together at the top.



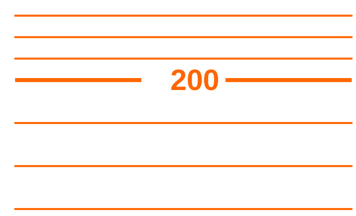


Fig 5.6 View of contours for a concave slope

Using a map to select a suitable route

Determining an appropriate route to and from an incident requires that you study the features of a map carefully. This will involve examining the shape of the ground by contours, vegetation and features such as tracks and roads.

When looking at the map and determining a route for vehicles and equipment you will need to think about:

- type of roads and tracks and types of vehicles using them
- steepness of slope
- bridges or crossings that heavy vehicles are unable to cross

On foot you will need to avoid, if possible:

- steep slopes
- heavy vegetation
- ravines or deep gullies that will slow progress
- routes that will go past the head of the fire or likely path of the fire

Section 6: Navigation Aids

Introduction

Navigation Science of determining location, distance travelled, course and distance to next destination.

Categories Navigation aids are generally grouped into those for:

- position finding
- direction finding
- measuring distance

Skills required The fundamental skills required by any navigator are the ability to:

- read maps
- calculate location(s)
- take and follow a bearing
- measure distances on the map as well as on the ground

For most purposes simple direction references will be adequate.

The degree system

In the degree system the circle is divided in to 360 degrees, zero or 360 degrees being the north point.

- the four quadrants of the circle are each 90 degrees and therefore the east, south and west points are at 90, 180 and 270 degrees respectively
- each degree can be further divided into 60 minutes and each minute into 60 seconds
- whilst degrees are normally marked ^{o} , minutes are marked as ‘ and seconds are marked ”

During normal map reading and navigation activities the subdivisions are too small for practical use and measurements. In typical NZ hill country accuracy of ± 10 degrees is quite sufficient. More accuracy is usually only required when determining bearings to far distant objects. Most modern compasses do not allow accuracy to any more than ± 2 degrees.

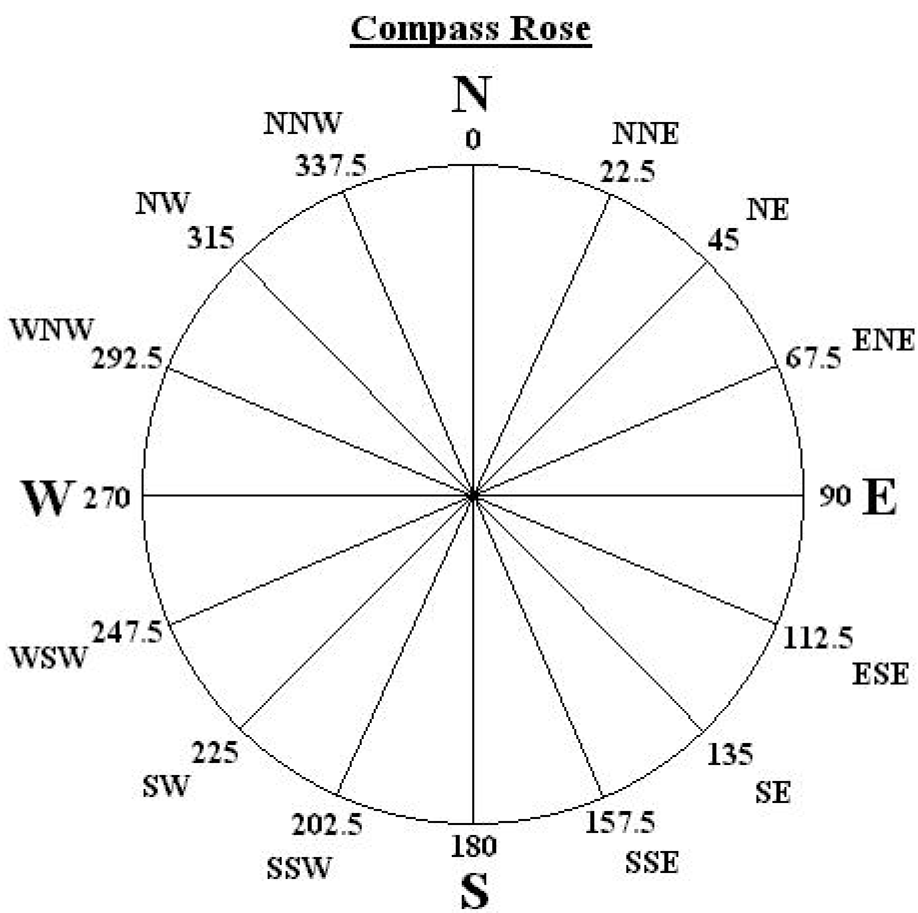


Figure 1 – Compass Rose and bearing guide

Compass point bearings are given directly e.g. NW or NNW etc from magnetic north.

Bearings

Definition

A bearing is the angle measured clockwise that a line makes with a fixed zero line.

Purpose

The term *bearing* is used to indicate a relative direction.
The purpose of a bearing is to give an accurate indication of the direction from one point to another.

Bearings are always measured **clockwise from the north:**

- bearings of any direction to the east of the North South line fall between 0 º and 180 º
- bearings of any direction to the west of the North South line fall between 180 º and 360 º

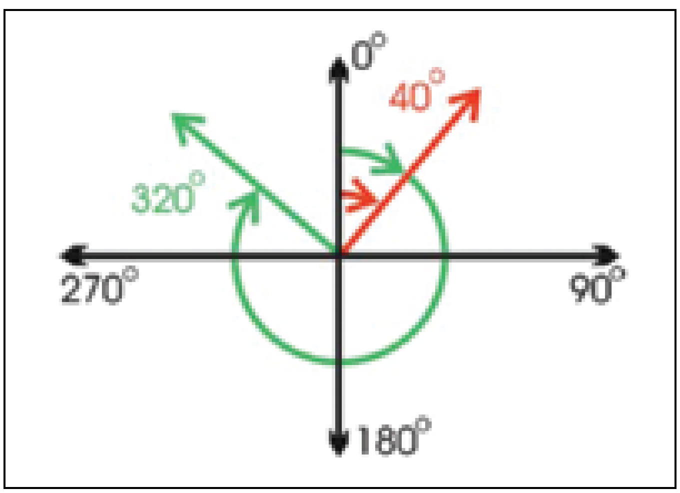
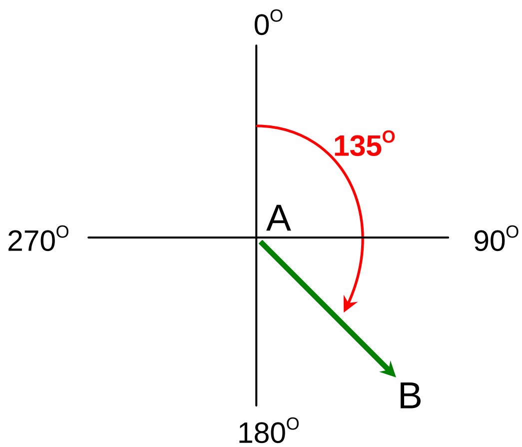


Figure 1 – Illustration depicting bearing of 40º and 320º from True North (map north) º

Example one

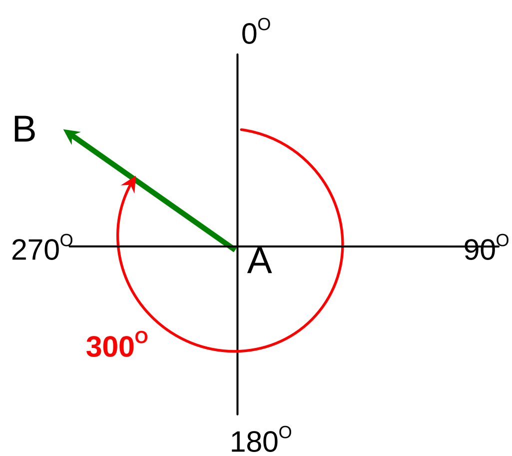
Figure below shows an example of measuring a bearing:

- You are standing at point A and want to measure the bearing to point B
- Starting from zero the angle round to the line AB is 135^o so the bearing is 135^o



Example two

Figure 2 shows an example of measuring a bearing to the west of the north south line:
The angle to line AB is now 300^o so the bearing of line AB is 300^o. The point bearing would be WNW.



Convert grid to magnetic bearings

Compass bearings (i.e. magnetic bearings taken on the ground) must be converted to grid bearings before they can be plotted on a map.

Conversely, *grid bearings* taken from a map have to be converted to magnetic bearings before they can be used on the ground.

To convert a grid bearing to a magnetic bearing or to convert a magnetic bearing to a grid bearing is a simple method of adding or subtracting the magnetic variation.

To convert a magnetic bearing to a grid bearing ***ADD*** *the magnetic variation, (MGA - Magnetic to Grid Add).*

Example

Here's an example of converting a magnetic bearing to a grid bearing using the magnetic variation calculation from above:
We have measured a magnetic bearing from the Incident Control Point to the fire as 236^o.

- The magnetic variation is 23^o
- Grid bearing = 236^o + 23^o
  = 259^o which is approximately 260^0
- This means we would plot a bearing of 260^o on the map

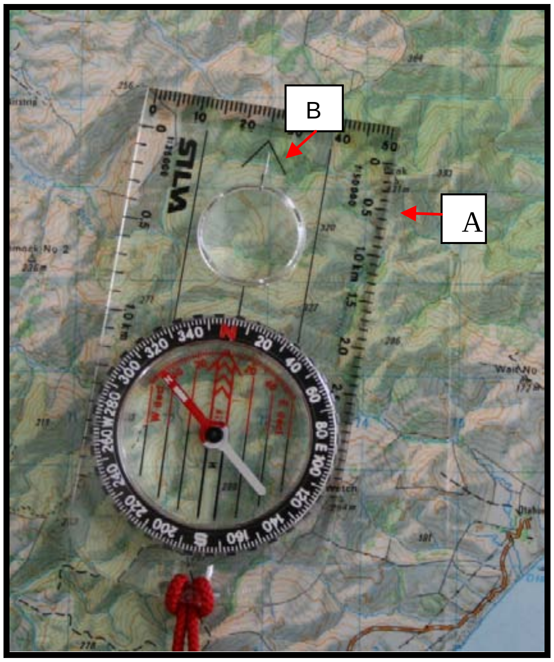
To convert a grid bearing to a magnetic bearing ***SUBTRACT*** *the magnetic variation, (GMS- Grid to Magnetic Subtract).*

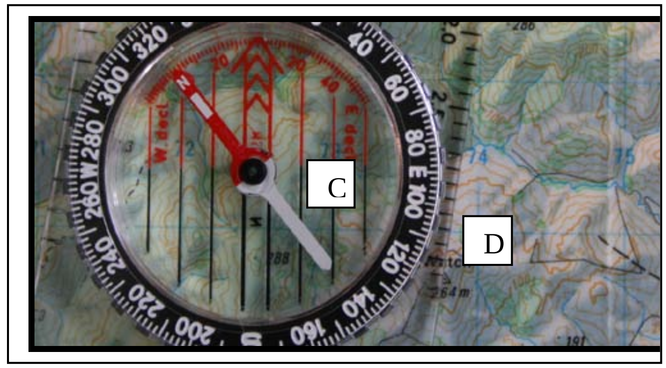
Example

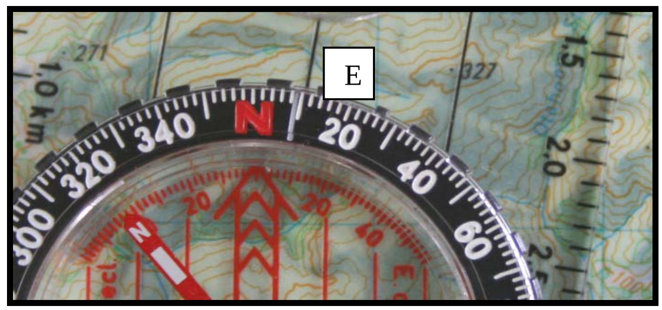
We have measured, on the map, a grid bearing from the Incident Control Point to the fire as 260.5^o.

- The magnetic variation is 23^o
- Magnetic bearing = 260^o - 23^o
  = 237^o which is approximately 23^o
- This means we would walk on a bearing of 237^o using a compass

Calculating a grid bearing



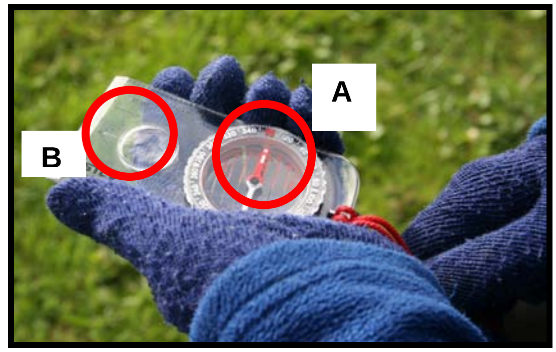




Step	Action
1	Place the long edge of the compass plate (A) along the desired direction on the map. Make sure the direction of travel arrow on the compass plate (B) points in the direction you wish to travel (from b-a).
2	Turn the compass housing so the meridian lines (C) are parallel with the vertical grid lines on the map (eastings) (D).
3	Read the grid bearing on the graduated dial against the lubber line (E). Remember that the bearing calculated is a grid bearing. To follow this bearing using the compass you must convert to a magnetic bearing using the procedure in the previous section.

Cross country navigation

To set a magnetic bearing on a base plate compass for cross country navigation.



Step	Action
1	Set the magnetic bearing on the compass by rotating the compass housing until the required bearing on the graduated dial is in line with the lubber line.
2	Hold the compass level in the palm of your hand with the direction of travel arrow pointing to the front.
3	Rotate your entire body keeping the compass pointing to the front until the red end of the compass needle is directly above the orienting arrow (A) then the direction of travel arrow is pointing along the required magnetic bearing (B).

Feature on ground

To take magnetic bearing to a feature on the ground e.g. road end, building hill top.

Step	Action
1	Hold the compass in the position shown with the direction of travel arrow pointing to the object or feature.
2	Rotate the compass housing until the orienting arrow is directly beneath the north (red end) of the compass needle.
3	Read the magnetic bearing on the graduated dial against the lubber line. If you need to plot the magnetic bearing on a map you will need to first convert the magnetic bearing to a grid bearing.

Back Bearings

Where a bearing gives the direction of a line from the observer to an object, a back bearing gives a direction from the object back to the observer.

The difference between the bearing and a back bearing is 180 degrees.

If the bearing is between 0 degrees and 180 degrees the back bearing can be determined by adding 180 degrees to the bearing.

If the bearing is between 180 degrees and 360 degrees the back bearing can be determined by subtracting 180 degrees from the bearing.

For example

Your bearing is 30° then the back bearing is 30+ 180 = 210°.

Your bearing is 260° then the back bearing is 260 – 180 = 80°.

The Compass

A compass is a navigational instrument for finding directions.

It contains a magnetised pointer free to align itself accurately with Earth's magnetic field.

A compass provides a known reference direction that greatly assists navigation. The cardinal points are north, south, east and west.

There are many types of compass available from homemade models to very accurate surveying instruments.

The two most common types of compasses in use are the *prismatic* compass and the *base plate* compass.

Figure –Prismatic Compass

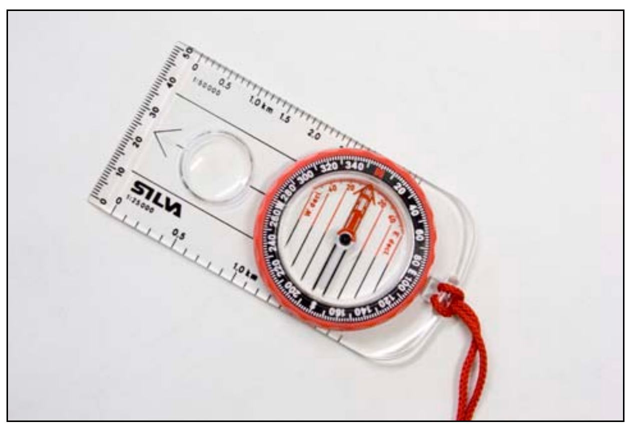


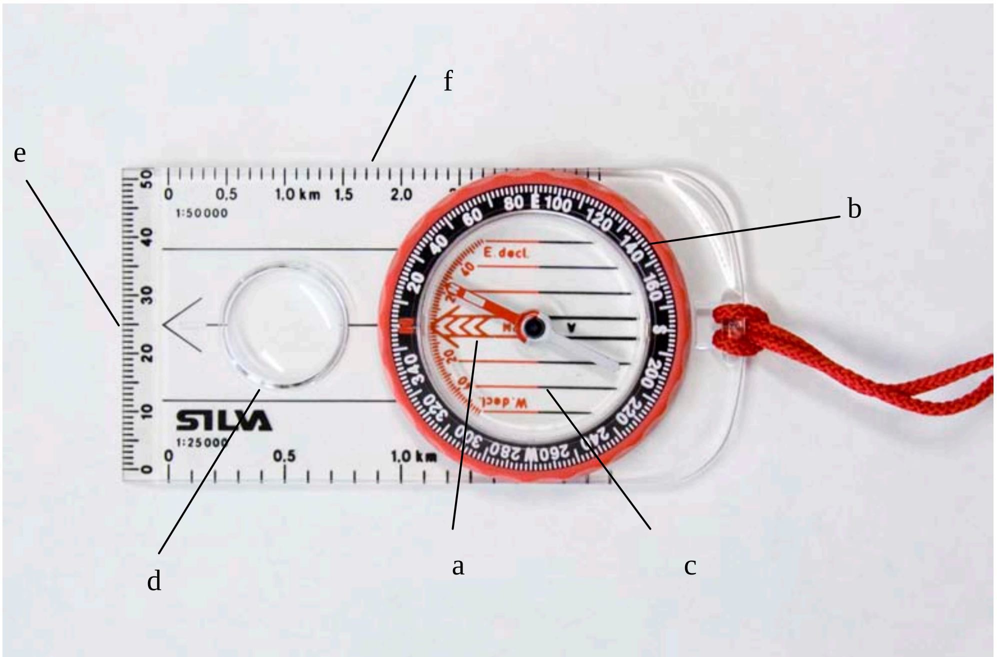
Figure Base Plate Compass

Note

Metal objects such as cars, fence posts and wires, steel power poles and transmission lines, can affect the accuracy of a compass reading. Stand clear of such items when using a compass – at least 1 m from metal fence posts and wires and up to 20 m from a car.

Base Plate compass

A base plate compass combines both the compass and the protractor on a common base plate. This enables the user to plot and calculate bearings rapidly and accurately on a map without the need of a separate protractor.



The typical base plate compass consists of a magnetised needle in a liquid filled acrylic housing. The north end of the compass is painted red and has a luminous strip (a). The dial of the housing is graduated in degrees and this freely rotates in the base plate (b). The base of the housing has parallel orienting lines and an orienting arrow for alignment with the compass needle (c).

The base plate is usually fitted with a small magnifying lens (d). Down the centre of the base plate is the lubber line (e). The lubber line is used to get the measurement from the graduated dial. The edge of the base plate are graduated in a variety of ways for use with various metric/imperial scales (f)

The dial of most base plate compasses has graduation marks at every 2º and accuracy cannot readily be achieved beyond this.

Compass errors

Compasses can have built in errors. A new compass should be checked against another compass or against references to check accuracy before use.

Metals and other magnets locally distort magnetic field.

Magnets and hence compasses attract to other magnetic substances.

Compasses will often be affected by iron or iron ore nearby - the compass is a delicate instrument and quite small quantities of iron have a surprisingly large affect on its behaviour. A wristwatch or steel framed glasses can have an effect on the compass reading.

Make sure that the compass is being used at a safe distance from magnetic substances such as iron and steel.

While small articles may be safe in a trouser pocket, larger items should be located at least 2 m away from your compass.

Keep well clear of power lines, wire fences, corrugated iron water tanks, railway lines, and vehicles when using a magnetic compass.

Section 7: Map Settings

Orienting a map

You can more readily identify an object on the ground by looking in the same general direction as it is depicted on the map – this is called orienting a map.

A map is said to be oriented when grid north on the map is pointing to grid north on the ground.

A map may be oriented by inspection or by a compass.

Setting by inspection

The quickest and simplest way to set a map is by inspection. This means comparing the features on the map to what's around on the ground.

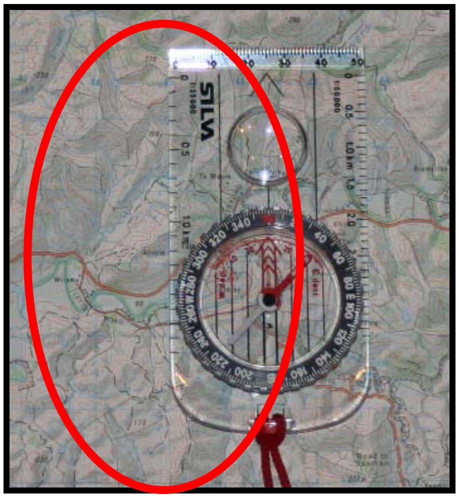
If there is a linear feature such as a straight road that can be easily identified on the map then all that is necessary is to turn the map until the road on the map is aligned with or parallel to the road on the ground. Other useful straight or linear features include railway tracks and fences.

If there is no convenient road or railway a map can be set by lining it up on distant objects provided you know your position on the map. To do this lay a ruler or any straight edge on the map so that it passes through your position and through that of one of the objects on the ground. Rotate the map without disturbing the ruler until the ruler is pointing directly at the object on the ground

Setting by compass

By far the most accurate method of setting a map is by using a compass.

Use this method if you're not aware of your exact location and it's difficult to identify sufficient detail on the map and on the ground.



Place the compass on the map so that its axis lies along any vertical grid line (any easting). This requires the rotatable protractor to be aligned so that N on the scale is set to the lubber line.

Turn the map and compass until the north point of the compass is east of the lubber line by the amount of the grid magnetic variation.

Note

The map should not be set using the north diagram. This diagram is only representational and not accurately drawn

The magnetic variation throughout New Zealand is between 21 and 24 degrees.

Position finding

Finding your position on a map can be achieved in one of two ways. You can estimate your position by using local objects; or by using a process known as resection.

Local objects

Once a map has been set it's relatively easy to locate your position by comparing the map details with the features on the ground.

You should be able to roughly fix (i.e. work out) your position in relation to the major features around you such as hills and towns. If the map was set by using a road, fix your approximate position by estimating your position along the road. The same applies to other ground features.

Find your exact position by using minor features such as creeks, tracks fences and houses. Remember that the shape of the ground is most helpful when locating your position and may be far more reliable than artificial features.

Resection

Carry out a resection to locate your position on a map if you're unable to do so by observing features on the ground.

1. Select three prominent widely spaced features around you that can be recognised on both the map and the ground. Two features can be used to obtain an approximate position.
2. On the ground, take grid bearings to these features with a compass.
3. Convert the grid bearing to back bearings.(directly across the compass circle)
4. Using the base plate of the compass or a protractor plot on the map the back bearing from the identified features.
5. These lines will intersect to locate your position exactly or form a small triangle from where your position can be determined. This triangle is known as the triangle of error.

Section 8: Cross Country Navigation

Navigation is the process that enables movement between two points and at the same time knowing the location at any given time.

Cross county navigation requires careful planning, a high degree of ability in map reading and skill in the use of navigation aids. Rugged terrain and dense vegetation along with low cloud mist and rain can impose additional difficulties for the navigator.

Plan

When putting your plan together consider the points below - by doing this you can save unnecessary hardship and greatly reduce the chances of error.

Study the map and note such things as main features, direction of river and creek flow, changes in vegetation and constructed objects that you may encounter.

Planning the best route

Planning the best route

When making an appreciation of what the best route will be consider the following points.

Slope of the terrain

Following contours around a hill is sometimes easier than going straight up or down. Following contours may be longer and slower but it may be safer. It also takes less energy and provides more navigation check points for example spurs, streams etc.

Ridges

This is the most sensible course to take for a number of reasons. They are in themselves a direction guide and can be easily observed both on the ground and on the map. Also vegetation is generally less dense and quite often animals make tracks along ridge tops.

Rivers/Streams

These can serve as useful direction guides to make sure you are going in the right direction. It is generally not a good idea to follow them in rugged country as they often wind around and are usually boarded in thick vegetation with wet slippery rocks that can create hazardous going.

Thick vegetation

Movement in thick vegetation is generally slow. This can cause an over estimation of the distance travelled, visibility is limited and a small undulation can be mistaken for a prominent spur line. In thick vegetation finding a viable route may have to take precedence over shortest path navigation.

Following the route

When moving through rough country and dense vegetation it's important to maintain your direction by compass.

The most proven method of maintaining a magnetic bearing is to select a prominent object along your bearing and move towards it. When the object is reached, select another object that lies along the bearing and move to that. Keep repeating the process until the destination is reached.

In open country direction can be maintained by referring to prominent landmarks that can be easily read from the map. Although you don't need to continually refer to your compass, check it regularly to ensure you haven't made any map reading errors or that you haven't strayed off course

Distance travelled

When planning a route the distance to be travelled should be estimated especially in thick vegetation that will prevent position finding by inspection.

When actually navigating distance can be estimated by pacing. It is one of the most reliable methods of measuring the distance travelled. As each individual takes a different length of stride everyone must determine the average number of paces they take over 100m over varying types of ground. With experience the counting of paces and their conversion to metres will give an accurate gauge to the distance travelled. Even so it's advisable to have a check pacer.

Pacing technique

There are various techniques for pacing. Some people prefer to count every time the right or left foot comes to the ground i.e. every second step. This is a good idea when travelling over long distances. Their total paces must be doubled before converting the distance to metres.

Keep Count

It's important to not lose count of your paces. Whatever method is used for recording it must be reliable so that they are not forgotten when the counter is distracted. Some reliable methods include tying a knot in a piece of string after every 100 paces or carrying a quantity of small pebbles and transferring one pebble to another pocket after each 100 paces.

When estimating distances on a map allowances must be made for the rise and fall of the ground. If the distance to be travelled is measured at 1000 m it will only be accurate if the ground is flat. If there's a hill between the start and finish points then the height of the hill must be taken into account and the pacing count adjusted for the climb up on one side and down on the other side.

Basic Rule

You will not have walked as far as you think you have.

Approximate times

The below is a table that can be used as a general rule of thumb only.

The following rates of movement are offered as a guide:	
By day over open country	5 km/hr
By day in close flat country	3 km/hr
By day in extremely rough country and deep sand	1.5 km/hr
By night over open country	1 km/hr
By night over flat country with vegetation and undergrowth	100 – 500 m/hr

Avoiding Obstacles

When unexpected bad going is encountered e.g. flooded area or dense undergrowth a decision must be made whether it is better to go around the obstacle or through it. If the decision is to bypass it, avoid the tendency to cling to the edge of the obstacle and feel a route around as a loss of direction and position will result.

Navigation in foggy/night conditions

Introduction

Ensure that you have plotted and note course taken as low cloud and/or darkness may inhibit your ability to navigate back to where you need to go.

Fog

Fog, rain and snow can creep up very fast, and the worst of these conditions is a 'white out', where the fog is grey and the snow is white. In conditions like this you have to put faith in your instruments and persevere. A good tip is to line up the party with the person with the compass at the rear. This way, when the group gets off course, they can tell when the group deviates because they will see the back of more than one person. If the group is aligned correctly, the person in the rear should only be able to see the back of the last person.

This method works better the further apart the groups is, but take care not to get too far apart or lose contact.

Night time

Before you start on any night activity the luminous strips on your compass need to be exposed to light to ensure their maximum brightness. If the skyline or prominent objects are visible you may be able to maintain your direction by methods similar to those used in the day.

Another method is to send someone forward with a torch until they are barely visible then instruct them to move left or right to line up with the compass bearing. The group then moves to the person with the torch and the process repeats.