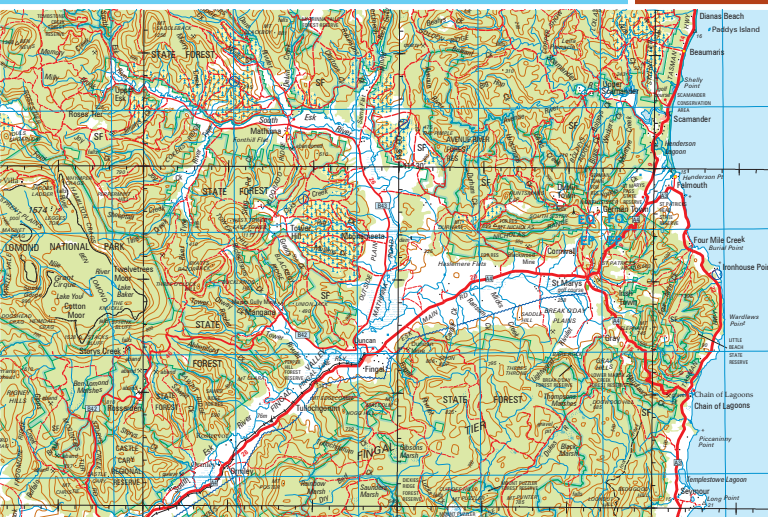




Australian Government  
Geoscience Australia

# Map Reading Guide

How to use  
Topographic Maps



GEOSCIENCE AUSTRALIA  
APPLYING GEOSCIENCE TO AUSTRALIA'S MOST IMPORTANT CHALLENGES



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## **Preface**

This booklet has been produced for the client who has the specific need to learn how to read a hard copy map. It explains the types of information on topographic maps, how to interpret that information and how to use these maps with satellite navigation systems and a compass.

It will help to read the booklet in sequence because the early chapters explain concepts that are mentioned in later chapters. The glossary also contains definitions of words and terms.

It does not cover the use of other types of maps, such as general reference, thematic, tourist and cadastral or interactive mapping.

For examples of online mapping, please refer to

<http://www.ga.gov.au/interactive-maps/>

or

<http://www.nationalmap.gov.au/>

## **Map cards**

Map cards are useful for map reading. These transparent cards have line scales (in kilometres) marked along each edge. Each card also includes a grid reference guide, a compass rose and a bearing guide. The map card available with this guide has line scales and text that are colour coded for different map scales:

Blue 1:250 000 scale

Black 1:100 000 scale

Red 1:50 000 scale

Green 1:25 000 scale

With thanks to Silva Sweden AB, a leading compass supplier, for permission to include text and images from their *Read this, or get lost* leaflet on pages 19 to 24. Members of the Intergovernmental Committee for Surveying and Mapping (ICSM) for feedback and comments during the development of this booklet.

# Map Reading Guide

## How to use Topographic Maps

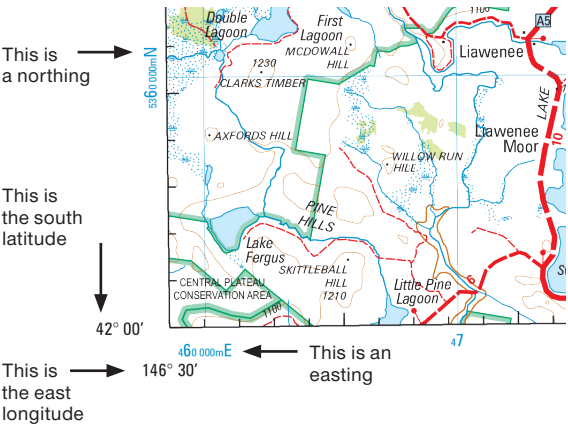
### What is a Topographic map?

Topographic maps are detailed, accurate graphic representations of features that appear on the Earth's surface. These features include:

- **Cultural:** roads, buildings, urban development, railways, airports, names of places and geographic features, administrative boundaries, state and international borders, reserves
- **Hydrography:** lakes, rivers, streams, swamps, coastal flats
- **Relief:** mountains, valleys, slopes, depressions
- **Vegetation:** wooded and cleared areas, vineyards and orchards.

A map's legend (or key) lists the features shown on that map, and their corresponding symbols.

Topographic maps usually show a geographic graticule (latitude and longitude, in degrees, minutes and seconds) and a coordinate grid (eastings and northings, in metres), so you can determine relative and absolute positions of mapped features.



Maps are produced from information available on a certain date. Over time, that information may change. Topographic maps include a reliability statement, which states the map's age and accuracy.

## Who makes topographic maps?

Topographic maps of Australia are published by Commonwealth, State and Territory government agencies and private industry.

Topographic maps at **1:10 000**, **1:25 000** and **1:50 000** scales show geographic features in detail. They are useful for a wide range of activities such as local navigation by vehicle or on foot, locality area planning, study of the environment, and so on.

As well as State agencies, the Department of Defence produces topographic maps at the **1:50 000** scale, primarily of northern Australia. Some are available to the public through Geoscience Australia and its retailers.

Geoscience Australia produces **1:100 000**, **1:250 000**, **1:1 million**, **1:2.5 million** and **1:5 million** scale maps. These maps are available through map retailers or direct. Geoscience Australia publishes the only complete national topographic map coverage and these maps are branded as NATMAP products.

The **1:100 000** and **1:250 000** scale maps are useful for planning travel over large distances, while the **1:1 million**, **1:2.5 million** and **1:5 million** scale maps are best for giving an overview.

## How to read a topographic map

The first step in reading a topographic map is to become familiar with the specific characteristics of the map or maps that you are using. Open up your map, check that it covers the places of interest, and then find the following characteristics:

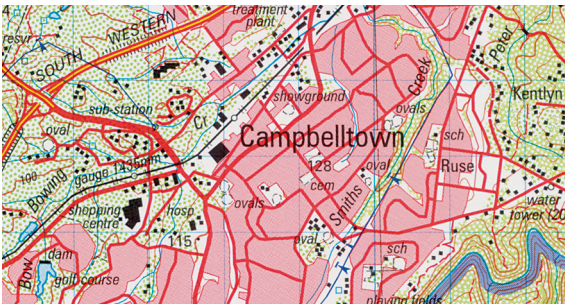
- **What is the map scale?** This is important because scale tells you about the comparative size of features and distances displayed on the map.
- **Which direction is north?** This is important because direction orients the map to the real world.
- **What map projection is used?** This is important because it tells you about the potential distortions to scaled distances and measured angles on the flat map as compared to the round Earth.



Common scales for Australian topographic maps are:

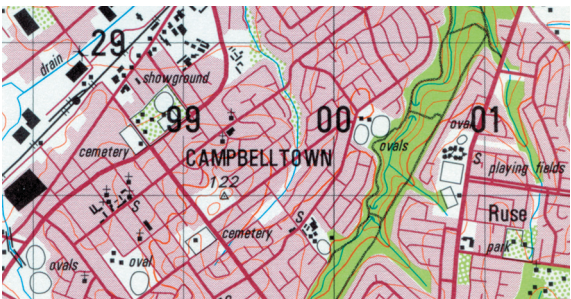
Scale		Ground Distance of 1 cm on the Map
Larger ↑	1:10 000	100 m
	1:25 000	250 m
	1:50 000	500 m
	1:100 000	1 km
	1:250 000	2.5 km
Smaller ↓	1:1 million	10 km
	1:5 million	50 km
	1:10 million	100 km

To explain scales graphically, let's look at a 1:100 000 scale map. The first number of the scale (1) represents a core unit of distance on the map, while the second (100 000) represents that same distance on the ground.



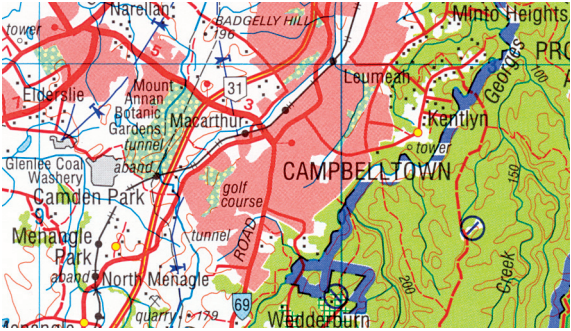
Segment of a 1:100 000 scale map of Campbelltown.

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



Segment of a 1:50 000 scale map of Campbelltown.





Segment of a 1:250 000 scale map of Campbelltown.

## Distance

Most topographic maps include a scale bar that you can use to determine the distance between two points on the map. Scales are usually shown in increments of one, five or 10 kilometres.

### HINT

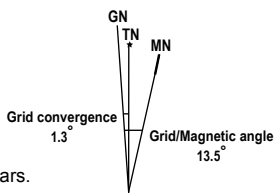
Use a piece of string, ruler or strip of paper to measure the distance between two points on the map. Then compare that measurement to the scale bar on the map to determine how many kilometres the measurement represents.

## Directions

Maps usually include a north point diagram in the map margin information which shows the direction of **true north**, **grid north** and **magnetic north** at the centre of the map.

True North (TN), Grid North (GN) and Magnetic North (MN) are shown diagrammatically for the centre of the map.

MN is correct for 2016 and moves easterly by less than  $0.1^\circ$  in 10 years.



Example of a North points diagram

This graphic also shows the actual grid-magnetic angle for the centre of the map face.

- **True north** (TN) is the direction to the Earth's geographic North Pole.
- **Grid north** (GN) is the direction of the vertical grid lines (eastings) on a topographic map. The angular difference between GN and TN is known as grid convergence. This varies across the country, its magnitude and direction east or west of TN being usually less than  $2^\circ$ .

- Magnetic north (MN)** is the direction from any point on the surface of the earth towards the earth's north magnetic pole. The angular difference between TN and MN is known as magnetic declination. As GN is used in preference to TN for map reading purposes, it is more useful to know the difference between GN and MN. This is known as the Grid/Magnetic angle. It ranges from about  $5^\circ$  west of true north in Western Australia to about  $15^\circ$  east of true north in eastern Australia. Because the position of the north magnetic pole moves slightly from year to year, the grid/magnetic angle and magnetic declination will vary by a small amount each year. In using a map for accurate navigation, magnetic variation can be important, particularly if the map is several years old.

### Bearings

Directions can also be expressed as bearings.

A bearing is the clockwise horizontal angle, measured from north to a chosen direction. Bearings are usually shown in degrees and range from  $0^\circ$  (north) to  $360^\circ$  (also north). South is  $180^\circ$ , east is  $90^\circ$ , west is  $270^\circ$ .

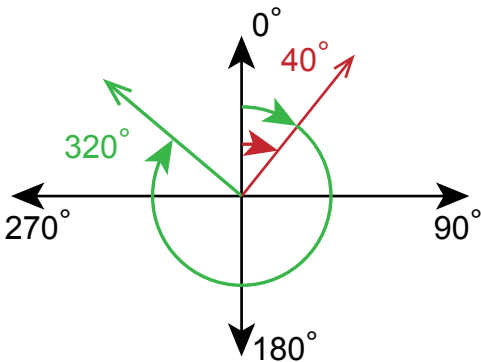
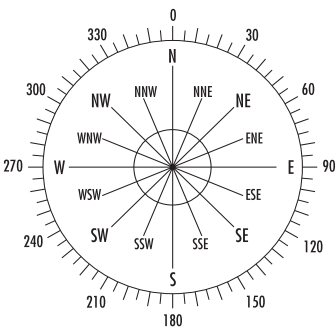


Illustration depicting bearings of  $40^\circ$  and  $320^\circ$



where:

W = west

N = north

S = south

E = east

and, for example

ESE = east  
south  
east

SSW = south  
south  
west

A compass rose and bearing guide

The map card (see inside back cover) includes a compass rose and bearing guide.

## Map projections

Map projections are attempts to portray the surface of the Earth or a portion of the Earth on a flat surface. Some distortions of conformality, distance, direction, scale, and area always result from this process.

Some projections minimise distortions in some of these properties at the expense of maximizing errors in others. Some projections are attempts to only moderately distort all of these properties.

A **conformal** projection is when the scale of a map at any point on the map is the same in any direction. Meridians (lines of longitude) and parallels (lines of latitude) intersect at right angles. Shape is preserved locally on conformal maps.

A map is considered **equidistant** when it portrays distances from the center of the projection to any other place on the map.

A map preserves **direction** when azimuths (angles from a point on a line to another point) are portrayed correctly in all directions.

**Scale** is the relationship between a distance portrayed on a map and the same distance on the Earth.

When a map portrays areas over the entire map so that all mapped areas have the same proportional relationship to the areas on the Earth that they represent, the map is an **equal-area** map.

There are many different map projections in use across the world. The most commonly used is the Universal Transverse Mercator (UTM) projection. It is a conformal projection, meaning that angles and small shapes on the globe project as the same angles or shapes on the map. However there is a great variation in scale away from the central portions of the map.

For more details on map projections, a great resource can be found at:

[http://www.icsm.gov.au/mapping/about\\_projections.html](http://www.icsm.gov.au/mapping/about_projections.html)
























## Map symbols (the legend)

Maps use symbols to represent features on the ground. These features include roads, tracks, rivers, lakes, vegetation, fences, buildings, powerlines, administrative boundaries and the like. Given the size of a map, it is not possible to show all features that occur on the ground. Large scale maps show more detail and a larger number of features.

Colour plays an important part in symbols, and some international conventions apply to the use of colour. For example, blue for water features, black for culture and green for vegetation.

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

### *Legend*

Dual carriageway; Distance in kilometres.....	
	sealed    unsealed
Principal road; Locality; Built-up area.....	
Secondary road; Bridge; Causeway.....	
Minor road (access & condition not assured).....	
Vehicle track (access & condition not assured).....	
Route marker: National, State.....	
Gate; Stock grid.....	
Embankment; Cutting.....	
Airport; Heliport.....	
Multiple track railway; Station or siding.....	
Single track railway; Bridge; Tunnel.....	
Powerline (110 kV and over).....	
Homestead; Building/s; Ruin.....	
Chimney; Silo; Tower.....	
Fence; Levee; Open cut mine.....	
Mine; Windpump; Yard.....	
Contour with value; Depression contour .....	
Horizontal control point; Spot elevation .....	
Sand; Sand dunes .....	
Sand ridges; Pinnacle; Cliff.....	
Orchard or vineyard; Windbreak .....	
Rainforest; Urban recreation parkland.....	
Plantation: Hardwood, Softwood .....	

### Sample legend

Symbols are grouped in themes on the Legend. Two or more symbols are often shown on the same line. The first feature named on the line corresponds to the first symbol on the same line, and so on.

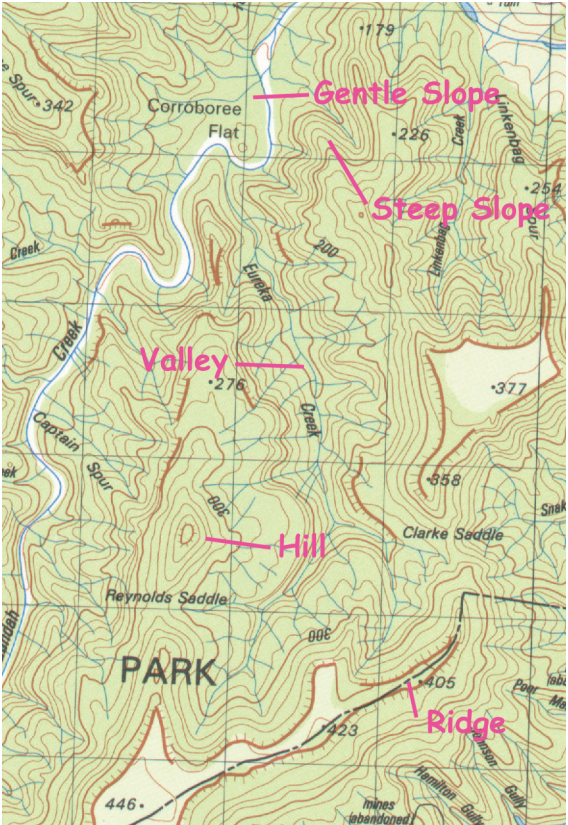


## Contour lines

Topographic maps also show contour lines. These lines, 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.

### HINT

Contour values read uphill, so as you read the contour numbers, you would be looking up hill.



Examples of contour shapes.

Source: Yarwal 1:50 000 scale.

## Datums

A datum is a reference system which allows for the determination of latitudes, longitudes and heights to define a unique location on the Earth's surface at a national or global scale.

Maps refer to a horizontal datum to define the size, shape, position and orientation of a reference ellipsoid. This is then used to define the geographic graticule (latitude and longitude, in degrees, minutes and seconds) and the coordinate grid

(eastings and northings, in metres). The position of all the map features are then placed on the map relative to these coordinate reference systems.

Heights are displayed on maps, more commonly by using contours and spot heights. These are all relative to a fixed vertical datum. In Australia this datum is known as the Australian Height Datum, where the zero height across the continent approximates mean sea level.

There have been a number of horizontal datums used in Australia over the last 50 years, so it's always important to check that the datum on the map is the same or compatible with any coordinates you are using, from say a GPS or a smartphone.

Datums are changed for two main reasons; improvements in the measurement of coordinates on the Earth that then realise the datum and changes in the position of features caused by the constant movement of tectonic plates. As Australia sits on the fastest moving continental tectonic plate, the need to change datum is required more often than other parts of the world.

Maps produced from the late 1960's to the turn of the century defined their coordinates relative to the Australian Geodetic Datum. This datum was defined by fixing the coordinates of a point in the middle of Australia and adopting the Australian National Spheroid.

The datum was first realised in 1966 with geographic coordinates (latitude and longitude) defined as AGD66 and was used nationally. New longer baseline measurements found deficiencies in AGD66 coordinates and was thus updated to AGD84 in 1984. The Commonwealth, Western Australia, South Australia and Queensland adopted AGD84 for their mapping purposes.

As AGD84 and AGD66 coordinates are based on the same datum for map reading and navigation purposes they can be regarded as being compatible.

From the year 2000, all Australian mapping authorities started using the Geocentric Datum of Australia (GDA). This datum was defined in 1994, and is based on a mathematical surface that best fits the shape of the Earth as a whole, with its origin at the Earth's centre of mass, hence the term 'geocentric'.

## HINT

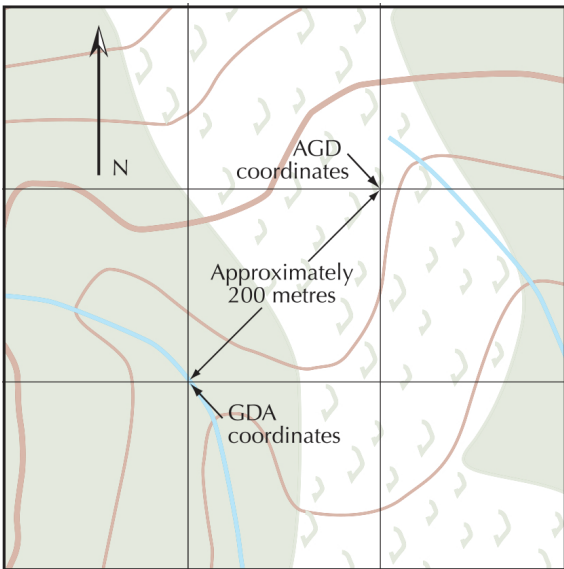
Look for the GDA logo on your topographic map. If it is not present, check the datum used. Remember, your GPS may show your location as 200 metre different if the map is not on the GDA.



The primary reason for this change was the emergence and widespread use of satellite-based navigation systems such as the Global Positioning System (GPS), which is based on a geocentric datum known as the World Geocentric System 1984 (WGS84). For most mapping and navigation purposes, WGS84 and GDA94 coordinates are the same.

A major implication of this change is that GDA94 coordinates, both latitudes and longitudes, and eastings and northings, differ from their AGD predecessors by approximately 200 metres.

The diagram below illustrates the difference between latitude and longitude coordinates generated from both the AGD and GDA datum. While features on the ground do not change, their coordinates will change by approximately 200 metre in a north-easterly direction.



This illustrates the difference between latitude and longitude coordinates generated from both AGD and GDA datum.

By the year 2020, an update to GDA94 will be widely in use. The new datum, GDA2020, mostly accounts for the tectonic shift of Australia and will only differ from GDA94 coordinates by about 2 metres. So for most mapping and navigation purposes, GDA94 and GDA2020 can be regarded as being the same.



For more details on map projections, a great resource can be found at:

<http://www.icsm.gov.au/mapping/datums1.html#difference>

## Map coordinates

Map coordinates are usually shown in one of two ways:

- geographical coordinates, given as latitude and longitude values in degrees, minutes and seconds; or
- grid coordinates, given as easting and northing values, in metres.

### **Geographical coordinates—latitude and longitude**

You can find or express a location using the geographic coordinates of latitude (north or south—horizontal lines) and longitude (east or west—vertical lines).

These are measured in degrees ( $^{\circ}$ ), minutes ( $'$ ) and seconds ( $''$ ). For example, the geographical coordinates for a position could be stated as:  $33^{\circ}40'30''\text{S}$ ,  $153^{\circ}10'40''\text{E}$ . Each degree is divided into 60 minutes; each minute is divided into 60 seconds.

#### **HINT**

Because of its location in the southern hemisphere, all Australian geographical co-ordinates are south and east.

Latitude is the angular expression of the distance north or south from the equator ( $0^{\circ}$  latitude). The South Pole is at  $90^{\circ}\text{S}$ ; the North Pole at  $90^{\circ}\text{N}$ .

Longitude is the angular expression of the distance east or west from the imaginary line known as the Prime Meridian— $0^{\circ}$  longitude on all maps.

Latitude and longitude coordinates are shown at each corner of a map's face. On some maps, short black lines along the edges of the map face indicate the minutes of latitude and longitude. When expressing coordinates, latitude is given first.

### **Grid coordinates—eastings and northings**

Grid lines can also be used to find or express a location. Grid lines are the equally spaced vertical and horizontal intersecting lines superimposed over the entire map face. Each line is numbered at the edge of the map face. On 1:100 000 scale maps, the distance between adjacent lines represents 1000 metres or 1 km.

The following terms are used to indicate the different types of coordinates and their datum (see explanation of datums on 10–13):

- AGD66 & AGD84—geographical coordinates based on the AGD
- AMG66 & AMG84—grid coordinates based on the AGD
- GDA94 & GDA2020—geographical coordinates based on the GDA
- MGA94 & MGA2020—grid coordinates based on the GDA

Maps are normally printed so grid north points to the top of the sheet (when the print is the normal way up). One set of grid lines runs north-south, while the other runs east-west. 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.

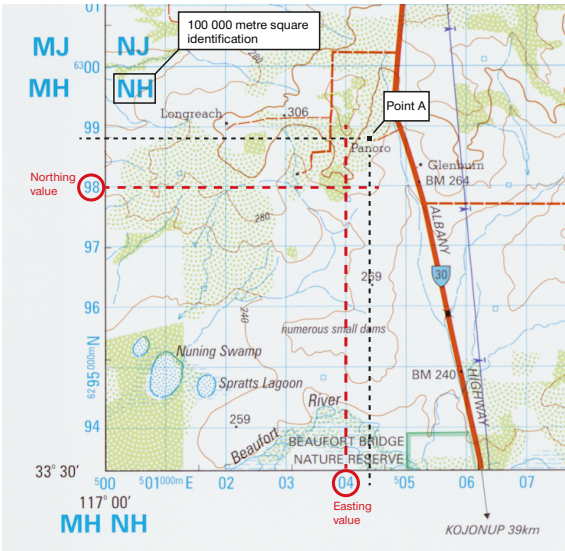
For this reason, grid lines are also called:

- 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 squares formed by intersecting eastings and northings are called grid squares. On 1:100 000 scale maps, each square represents an area of 100 hectares or one square kilometre.

### **How to quote a grid reference for a particular point**

A grid reference is used to describe a unique position on the face of the map. The degree of accuracy required will determine the method used to generate a grid reference. All methods follow a similar approach. A four figure grid reference is used to identify which grid square contains a map feature. A six figure grid reference will further specify the position to an accuracy of one tenth of the grid interval. In a map's margin, there is usually a section devoted to how to quote a grid reference. The information needed to complete a grid reference will be found in this section of the margin.



Example of determining a grid reference (not to scale)

### HINT

Use the corresponding scale grid referencing tool on a map card to help in estimating the number of tenths, from a position to a grid line.

To obtain a complete 1:100 000 scale grid reference for point A (Panoro), on the map above, you need to:

1. Note the map name. The grid zone number, a unique identifier, can be used as an alternative. It is found in the map margin. Point A is located on the Wagin map sheet. The grid zone number is 50H.
2. Read the letters identifying the relevant 100 000 metre square containing the point. In this case it is NH.
3. Locate the vertical grid line to the left of the point of interest and read the two figure easting value. Point A's easting value is 04.
4. Estimate the tenths from the vertical grid to the point. If using the Map Card supplied with this guide, place the matching scale grid referencing tool over the point to be measured as shown in the diagram above. Using the same vertical grid line as described earlier, count the tenths back from Point A to the grid line. In this case it is 4.5.
5. Locate the horizontal grid line below the point of interest and read the two figure northing value. Point A's northing value is 98.

6. Estimate the tenths from the horizontal grid line to the point. Using the same method as described in point 4, count the tenths down from Point A to the grid line. In this case it is 8.

Note the datum of the map from the map margin.

The Wagin map is on GDA94. Therefore, the complete grid reference for Point A is either: Wagin, NH044988 or: 50HNNH044988.

### **HINT**

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

## **Planning a trip**

Planning a successful route through rough country usually requires a topographic map, a compass, perhaps a Global Navigation Satellite System (GNSS) such as GPS receiver or a smart phone, and observation of various landforms. Streams and vegetation can help with navigation but may hinder your progress.

Make sure you have the right scale map for the trip you are planning. Obviously, journeys on foot should be supported by a larger scale map, or set of maps.

Often, route finding does not require great accuracy, but it does require planning. Before setting out, study the map. Find your start and finish points. The terrain depicted on the map will help you select a suitable route, and anticipate and make best use of the features you will encounter.

For example, you may discover a leading spur or main ridge that will help you avoid a river valley with cliffs or steep terrain. You will also be able to measure the route's distance and any heights to climb, allowing you to estimate how long each stage of the trip will take.

## **Using a GNSS receiver**

The Global Positioning System (GPS) is one of many Global Navigation Satellite Systems now operating worldwide. These multi-satellite systems are now used widely in smartphones and motor vehicles for civilian positioning, navigation and timing, surveying and scientific applications, and although an excellent tool, it is best used with a map.

GNSS 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 GNSS receiver can provide positions with an accuracy better than 10 metres and often at the 5 metre level.

## Global Navigation Satellite System

The first GNSS system widely used was GPS. There are now 6 systems operating worldwide. As of the middle of 2016, there were over 80 GNSS satellites orbiting the Earth. A GNSS receiver calculates position by measuring distances to four or more of these satellites. These systems are accessible 24 hours a day, anywhere in the world, in all weather. Modern smartphones also have in-built hardware that provides observations to these systems.

For more information about datums and GNSS, visit <http://www.ga.gov.au/scientific-topics/positioning-navigation>

## Using GNSS with a map

GPS is based on the WGS84 datum developed by the United States of America's Department of Defense (see explanation of datums on pages 10–13). However, not all maps use the WGS84 horizontal datum and not all GNSS systems use WGS84. It is then very important to check which datum your map is based upon.

### **HINT**

Set your GNSS receiver to the horizontal datum that matches your map's horizontal datum.

This horizontal datum information will be shown in the map margin. For the best match between coordinates of your map and GNSS receiver, configure the GPS receiver to display coordinates (geographical or grid) on the same datum as the map being used.

Most GNSS receivers have the ability to display either geographic or grid coordinates on a number of national and regional datums. It is important to know how to set the correct datum in your receiver. Please consult the GNSS receiver's user guide for details. If the datum you need is not offered in your receiver, consult your GNSS dealer for assistance.

It is recommended practice to check your GNSS receiver against well-defined map features every time you use it. Visit a feature such as a road intersection, determine its position by GNSS and compare this with coordinates calculated from a map. The larger the scale of this map, the better. The coordinates of

survey control marks or trig points, may be obtained from your local surveying and mapping authority and used for this purpose.

Care should be taken when using heights from a GNSS receiver. GNSS receivers can generally only measure heights to an accuracy no better than 10 to 20 metres. Matching the GNSS vertical datum selection to the map's vertical datum is also important.

## The magnetic compass

A magnetic compass is an important aid to route-finding and anyone who ventures into untracked country should carry one.

A compass works on the principle that the pivoting magnetised needle (or the north point of the swinging dial) always points to the north magnetic pole.

As a result, you can use a compass with graduations (degrees) marked on it to measure the bearing of a chosen direction from magnetic north.

### *HINT*

Metal objects such as cars, fence posts, 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 one metre from metal fence posts and up to 20 metres from a car.

## Compass errors

Geological features such as iron ore deposits and dolerite rock that has been struck by lightning can affect a compass. It is even possible for the needle to become reverse-polarised if it is stored for a long time near a strongly magnetised object.

It is therefore advisable to treat magnetic bearings with caution and to check the accuracy of your compass. Determine magnetic bearings between objects at least one kilometre apart, using information available from a map and compare them with your compass bearing. This should be repeated in different directions. Check for local anomalies by reading bearings between objects about 100 metres apart in both directions—the bearings should differ by 180 degrees.

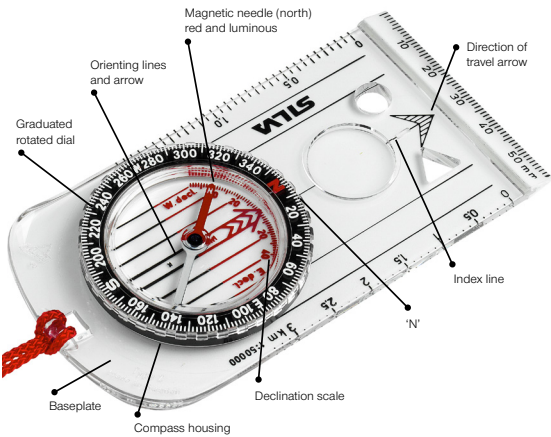
## Features of a compass

There are numerous types of compasses. The pivoted needle, adjustable dial compass is the most useful type. See example—Silva compass below.

As well as a north-pointing needle, it often will have a transparent base with a Direction of Travel Arrow and Orientating Lines marked on the Rotating Dial housing, so it can be used as a protractor for measuring grid bearings on a map.

## Features of the Silva\* compass

*\*registered name of Silva Sweden AB.*



## Using your compass to reach a destination

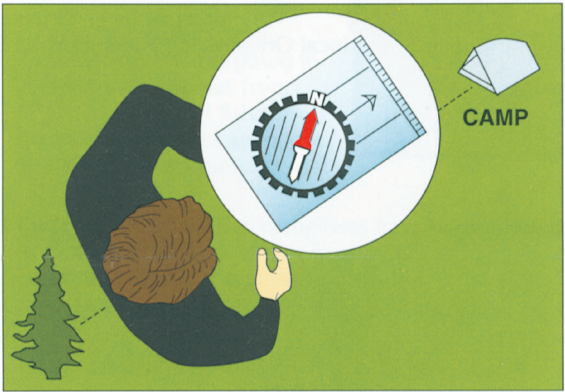
To follow compass bearings to your chosen destination, you will either need to determine magnetic bearings from visible features along the route, or will already have these bearings.

### To determine magnetic bearings:

1. Select a visible feature along the route you want to travel. Holding the compass level, point the Direction of Travel Arrow at the visible feature.
2. Find your bearing to the visible feature by turning the Compass Dial until the 'N' aligns with the red end of the needle. Read your bearing in degrees at the Index Line.



3. Keeping the needle aligned with the 'N', proceed in the direction indicated by the bearing at the Index Line. The bearing will help you keep on track when the feature is not visible. Repeat this procedure until you reach your destination.



#### *When magnetic bearings are known:*

1. If you've been given a bearing in degrees to travel, turn the dial so that the bearing is set at the Index Line. Hold the compass level in front of you, with the Direction of Travel Arrow pointing straight ahead.
2. Turn your body until the red end of the needle is aligned with the 'N' on the dial. You are now facing your direction of travel.
3. Pick out a visible feature in line with your bearing and walk to it. Repeat the procedure until you reach your destination.





## Conversion of bearings

Magnetic bearings measured with a compass must be converted to grid bearings for plotting on a map. Similarly, grid bearings measured on a map must be converted to magnetic bearings for compass navigation on the ground.

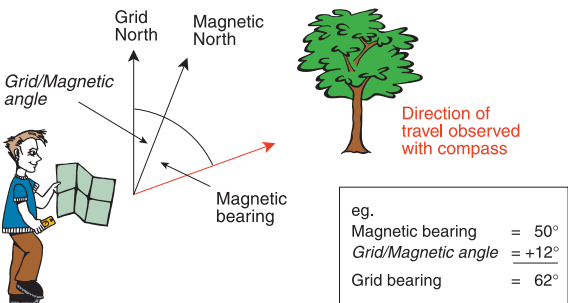
The Grid/Magnetic angle is the difference between grid north and magnetic north. If magnetic north is east of grid north, it is a positive value. If magnetic north is west of true north, it is a negative value.

To convert from a Magnetic bearing to a Grid bearing, add the Grid/Magnetic angle to the magnetic bearing.

To convert a grid bearing to a magnetic bearing, subtract the Grid/Magnetic angle (see page 5).

### HINT

The M A G rule is: Magnetic Add Grid



## Simple uses of a map

### Orientating a map

It is a good habit to orientate your map before reading it. To do this, hold your map horizontally and rotate it until its direction and features correspond to what you see before you on the ground.

If you are unable to identify the surrounding features, you can use the compass to orient the map. To do this:

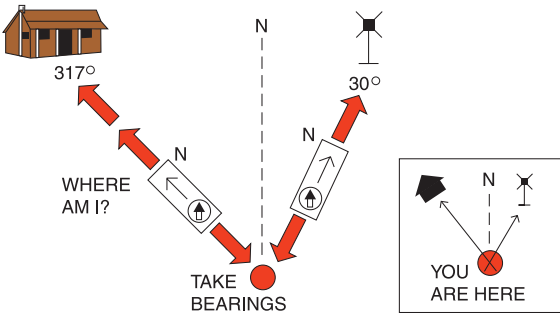
- lay the map flat and place your compass so the baseplate side edge lies along any grid north line, and the Direction of Travel arrow is also pointing to grid north;
- rotate the map and compass until the north point of the compass needle is east or west of the Index Line by the amount of the Grid/Magnetic angle shown in the map's margin.

Once the map is orientated, you should be able to identify prominent features in the landscape.

## Finding your present position

If you have a GPS receiver, you can use it to determine your coordinates, remembering to set it to a datum corresponding to the datum on your map. Or, once you can identify surrounding features on the ground and on the map, you can use the following procedure to find your current position:

1. Choose two visible features and find these on your map. Now point the Direction of Travel Arrow towards one feature and rotate the Compass Dial until the red end of the Needle points to the "N" on the dial.
2. Add the Grid/Magnetic angle to the bearing shown at the Index Line and turn the dial to the new bearing.



3. Place the compass on your map with the side edge of the Baseplate touching the feature and pivot it until the Orientating Arrow or lines align with the grid north lines. Draw a line from the feature along the side of the Baseplate across the map.
4. Repeat this process with the second feature. Your location is where the two lines intersect.

### HINT

Pack your map and compass in an easy-to-reach place. In wet weather, put the map, with the appropriate area displayed, in a clear plastic bag.

## Setting a course

Once you have oriented your map and identified your position, you can set a course. Do this by sighting or by laying a straight line (using the edge of the map card or a piece of string) across the map. It is also good practice to identify a distant visible feature that is on the line, such as a rocky outcrop, and proceed. Then identify another feature on the line, and so on, until you reach your destination.

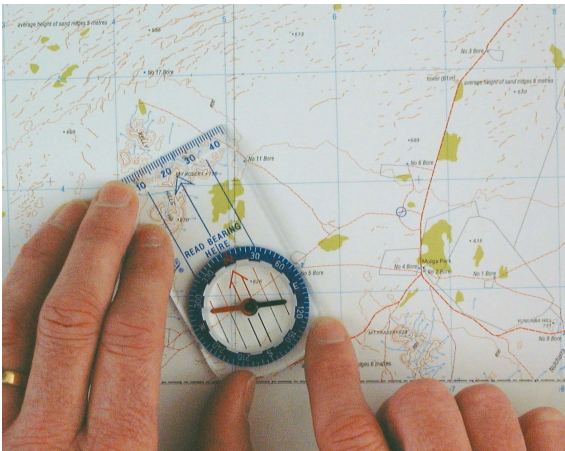
When features are sparse, you could use a GPS receiver. First, determine the coordinates of the destination point from the map and enter them into the receiver, then walk in the approximate direction of your destination, letting the receiver point you in the right direction as you go.

### *HINT*

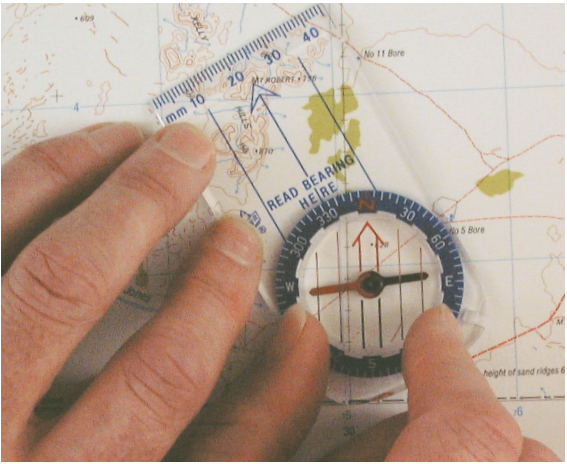
Check your map to determine if there are land features that may prevent you from following your GPS bearing.

Or you can use your map and compass in this way:

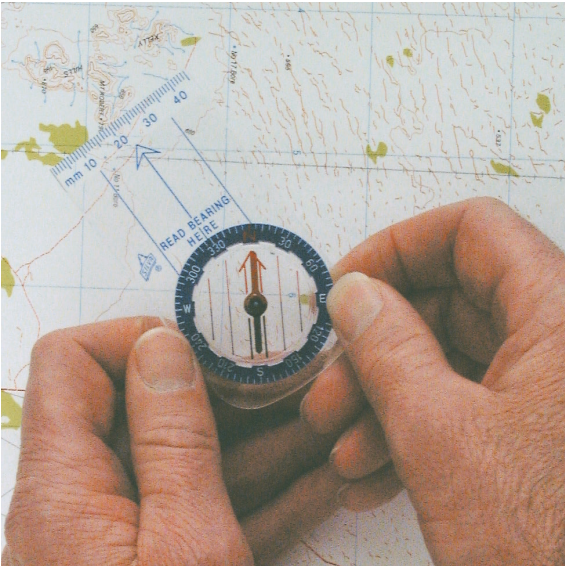
1. Before you start on your way, place the compass on the map so that the side edge of the Baseplate connects your present position (No 5 Bore) to your destination (No 11 Bore), and the Direction of Travel Arrow is also pointing that way.



2. Turn the compass dial until the Orienting Lines are parallel with the grid north lines on the map and the Orienting Arrow is also pointing to grid north.



3. The dial's reading at the Index Line shows the grid bearing. Subtract the Grid/Magnetic angle from this bearing and turn the dial to show the new magnetic bearing at the Index Line.



4. Put the map aside. Hold the compass steady and level in front of you with the Direction of Travel Arrow pointing straight ahead. Turn your body until the red end of the Needle is directly over the Orienting Arrow, pointing to the "N" on the dial. The Direction of Travel Arrow now points to your destination (No 11 Bore). Look up, align the Direction of Travel Arrow with a feature and walk to it. Repeat this procedure until you reach your destination.

## Glossary

**AGD**—Australian Geodetic Datum—the framework used for coordinates in Australia from 1966 to 2000. It has now been superseded by the Geocentric Datum of Australia (GDA). AGD had two geographic coordinate sets that were realised as AGD66 and AGD84.

**AHD**—Australian Height Datum—the datum used for the determination of elevations in Australia since 1971. The determination used a national network of bench marks and tide measurements from 1966–1968, and set mean sea level as zero elevation. Tasmania has an equivalent vertical datum derived from tide measurements for mean sea level in 1972.

**AMG**—Australian Map Grid—a Cartesian coordinate system based on the Universal Transverse Mercator projection and the Australian Geodetic Datum. The unit of measure is the metre.

**Bearing**—geographic orientation of a line given as an angle measurement in degrees clockwise from north.

**Cadastral map**—a map showing land boundaries and parcels.

**Cartography**—the art and science of producing maps, charts and other representations of spatial relationships.

**Contour**—a line drawn on a map joining all the points on the Earth that are the same height above sea level.

**Coordinates**—linear or angular values which designate the position of a point in a given reference or grid system.

**Coordinate, geographic**—a system of spherical coordinates commonly known as latitude and longitude.

**Coordinates, grid**—a plane-rectangular coordinate system expressed as eastings and northings.

**Datum**—a mathematical surface with a defined size, shape, position and orientation on which a mapping and coordinate system is based.

**Elevation**—the height above mean sea level.

**Ellipsoid**—An ellipsoid is a three dimensional figure symmetrical about each of three perpendicular axes, whose plane sections normal to one axis are circles and all the other plane sections are ellipses. An ellipsoid is used to approximate the size and shape of the Earth and used in coordinate computations and map projections.

**GDA** Geocentric Datum of Australia—a coordinate framework for Australia which is compatible with the Global Navigation Satellite System (GNSS) position. The GDA was realised in 1994 producing GDA94 geographic coordinates and implemented from the year 2000. By the year 2020, an update to GDA94 will be widely in use. The new datum, GDA2020, will only differ from GDA94 coordinates by about 2 metres.

**Geocentric Datum**—a datum which has its origin at the Earth's centre of mass. The advantage of the geocentric datum is that it is directly compatible with satellite-based navigation systems.

**Geographical coordinates**—a position given in terms of latitude and longitude.

**Geographical grid**—grid derived from geographical coordinates (commonly referred to as longitude and latitude or graticule).

**Global Navigation Satellite System (GNSS)**— GNSS is based on several jurisdictional satellite positioning systems including the United States' GPS, Russia's GLONASS, the European Union's Galileo, Japan's Quasi Zenith Satellite System (QZSS), China's Beidou and the Indian Regional Navigation Satellite System (IRNSS).

**Global Positioning System (GPS)**—is a satellite based navigation system developed by the United States Department of Defense and widely used for civilian navigation and positioning.

**Graticule**—a network of lines on a map or chart representing the parallels of latitude and meridians of longitude of the Earth.

**Grid**—two sets of parallel lines intersecting at right angles to form squares.

**Grid convergence**—the angular difference in direction between Grid North and True North.

**Hypsometric tint**—a shade or tint of colour between two contours showing high and low land at a glance.

**Latitude**—the latitude of a feature is its angular distance on a meridian, measured northwards or southwards from the Equator.

**Longitude**—an angular distance measured east or west from a reference meridian (Greenwich).

**Map**—a representation of the Earth's surface. A cadastral map is one showing the land subdivided into units of ownership; a topographic map is one

showing the physical and superficial features as they appear on the ground; a thematic map displays a particular theme, such as vegetation or population density.

**Map Grid of Australia 1994 (MGA94)**—a cartesian coordinate system based on the Universal Transverse Mercator projection and the Geocentric Datum of Australia 1994. The unit of measure is the metre. By the year 2020, an update to GDA94 will be widely in use. The new datum, GDA2020, will also have an associated UTM projection with grid coordinates designated MGA2020.

**Map projection**—any systematic way of representing the meridians and parallels of the Earth upon a plane surface.

**Mercator projection**—the conformal cylindrical projection tangential to the Equator, possessing the additional valuable property that all rhumb lines are represented by straight lines. Used extensively for hydrographic and aeronautical charts.

**Meridian**—an imaginary line from the North Pole to the South Pole connecting points of equal longitude.

**Relief**—the deviation of an area of the Earth's surface from a plane. It refers to the physical shape of the surface of the Earth.

**Rhumb line**—a curve on the surface of a sphere which cuts all meridians at the same angle; the path which maintains a constant true bearing.

**Topography**—description or representation on a map of the physical and cultural surface features.

**Transverse Mercator (TM) projection**—a conformal cylindrical map projection, originally devised by Gauss, also known as the Gauss-Kruger projection. As its name implies, its construction is on the same principle as the Mercator projection, the only difference being that the great circle of tangency is now any nominated meridian. Meridians and parallels are curved lines, except for the central meridian for a specified zone (meridian of tangency), which remains a straight line. Projection zones are established about the central meridian and vary in width from two degrees to six degrees of longitude, with some overlap between zones. The amount of scale distortion may become unacceptable at distances greater than about 1.5 degrees in longitude from the central meridian. In a modified form the projection is in general use for topographic mapping at scales of 1:250 000 and larger. See Universal Transverse Mercator projection.

**Universal Transverse Mercator (UTM)**—a world wide systematic application of the Transverse Mercator Projection applying to the region between 80°S and 84°N latitude. The UTM is a modified TM projection whereby the natural scale of the central meridian is scaled by a factor of 0.9996 to enable a wider area to be mapped with acceptable distortion. Each Zone is six degrees of longitude in width with a half degree of overlap within the adjoining zone and having a true origin at the intersection of the central meridian of that zone and the Equator.

**WGS84 World Geodetic System 1984**—a geocentric geodetic datum developed by the United States Department of Defense for use with GPS. For most practical purposes, GDA94 and GDA2020 are compatible with WGS84.



## Notes

## Notes