BASIC MAP READING and NAVIGATION

This is an update of a few map reading and navigation basics I have learnt over the years.
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Why? The ability to read a map (interpret the information it provides) is an essential skill for safe and enjoyable bush travel. No one wants to get lost, and maps can provide information on things to see and places to visit on your trip. A map will also give an indication of the type of terrain you are likely to encounter. How steep are the hills? Are there creeks to cross? What are the distances involved. With this, important skills to develop are your of sense of direction, being able to visualize terrain by looking at a map, and relating what you see in the bush to the features on a map. A GPS (even one with a moving map) is not really a substitute for a good paper map. You need both and cross check one with the other. Besides, what happens if your GPS stops working?

Types of maps: There are many different maps e.g. tourist maps with limited detail; 4WD touring maps (eg HEMA, Rooftop, WestPrint) with good track detail; and topographic maps from NatMap. Maritime mas are called charts. Different maps serve different purposes.

Care of maps: Never write on paper maps with pen – only use pencil. Always fold correctly along original fold lines.

Map identification: The map will always have a name for the area covered. The map may also name adjoining maps. Always check the **date** of publication and the age of the information used to create the map because over time things change e.g. roads may be different or man-made features may change. Remember that the map may show tracks which no longer exist, or there may be tracks in the bush that are not shown on the map. Digital maps loaded on computers or GPS may not have a date so you will need to check when they were made.

North: The top of the map is always north but be aware there are 3 “norths”: *True north* (the north pole), *magnetic north* (where a compass points) and *grid north* (where the artificial lines drawn on a map point. Topographic maps show the variation between these but usually for touring the difference does not matter. If using a compass and map together to navigate, be aware that magnetic north is constantly moving in relation to north pole – there is an annual variation which is shown on topographic maps. If using a compass and map to navigate you need to calculate the change to be able to accurately plot a bearing on a map. This is essential if using a compass for cross country bushwalking or aviation. Also be aware that local magnetic forces or influence of the metal in a vehicle can mean that the north arrow may not point to the correct magnetic north.

***Cardinal points**:* There are 360 degrees in a circle. A compass points to magnetic north so this is zero/360 degrees (0/360º), east is 90º, south is 180º, and west is 270º. These 4 directions are the cardinal points. You can use a compass to show a direction of travel in degrees (a bearing) and your GPS will probably also show the bearing (direction) you are travelling e.g. a bearing of 136º means you are travelling southeast.

Map Scale: Maps will always show the scale e.g. large scale (1:50,000), small scale (1:250,000) etc. They will have a ruler drawn in the margin showing the distances. On a map of scale 1:1,000,000, 1 cm = 10 km. On a 1:100,000 map 1 cm = 1 km.

Legend: In the margin there will be a legend showing what all the symbols mean e.g. quality of road, houses, bridges, water holes, sand dunes etc.

Colours and shading: Different colours and shading may indicate different land uses (e.g conservation areas), different vegetation (forest, light timber, plantations), or maybe the relief (hills, valleys etc).

Contour lines: Topographic maps show contour lines (usually in brown). Each contour line is drawn at exactly the same height above sea level at a set height difference apart (like taking horizontal slices). These lines will indicate hills, valleys, the steepness of slopes (steep when contour lines are close together), the height of hills and so on. This can be useful when planning trips because you know what sort of terrain you will be traversing as you travel along a road.

Waypoints and Coordinates

A coordinate is a numerical way to indicate a location on a map. This is important because when planning trips we often want to mark *waypoints*. Also, if you are informing others (mates, emergency services etc) of your location you need an accurate way to do this. If using a GPS, it will tell you the coordinates of where

you are but you have to find this location on a map. Unfortunately, a number of systems are used.

Emergency Plus APP – what3words

If you are giving your location to emergency services it recommended that you use the *what3words* system. The excellent smart phone Emergency Plus APP indicates your location very accurately using 3 words e.g. my desk is located at "*pretender.kitten.barge".* The APP also gives latitude and longitude plus address and shows your location on a Google map. A GPS will not give a w*hat3words* location.

Map location references

Touring maps may have a grid of vertical and horizontal lines superimposed on it. These are usually labelled with letters and numbers. For example, HEMA touring maps have the vertical grid squares marked A. B. C. etc and the horizontal ones numbered 1. 2. 3. etc. so a general location can be indicated in square D14 for example. There is no consistency in how this is done and it is of no use with a GPS. Touring maps may also show *latitude* and *longitude* as explained below.

Topographic maps use two different systems: *latitude/longitude* and *UTM* (Universal Transverse Mercator) *grid references*. A GPS may be set to either or both. Check your map to see if it is showing grid lines, or latitude/longitude lines or markers on the edge.

Latitude/Longitude (degree, minutes and seconds)

Latitude is the distance from the equator in *degrees*. Each line of latitude is a concentric ring around the world increasing in value from the equator to the pole. The equator is zero degrees, and the south pole is 90º south and the north pole is 90º north. Wagga sits roughly 35º south (also shown as -35º to indicate it is south of the equator). I call latitude "*ladder*-tude" so I can remember that they are the horizontal lines like rungs on a ladder.

Longitude is the distance from Greenwich Mean Time if you travel in an easterly direction. There are 360 degrees in a circle, so there are 360º of longitude round the world represented by lines drawn top to bottom from pole to pole – each 1º apart. Greenwich Mean Time (the international date line) is zero and longitude increases in value as you travel east. Wagga is roughly 147º E.

To more accurately indicate location, each *degree* is divided up into *minutes* and *seconds*. There are 60 minutes to a degree, and 60 seconds to a minute. For example, my location in Wagga is 35^0 08' 58" S, 147^0 22' 46" E. Finding this on a paper map may not be easy unless the map has lat/long lines drawn. Most 4WD touring maps are pretty good at this but in the bush you still have to estimate your position on the map using the coordinates plus other features like hills, creeks or track intersections. A GPS with electronic maps can be set to show lat/long. Most 4WD maps and trip notes etc will give lat/long coordinates for points of interest so that you can load them into your GPS as waypoints. For example, Big Red is located at 25^0 53' 45" S, 138^0 03' 11" E.

To confuse things, lat/long may be shown using one of 3 different systems!

1. DMS – degrees, minutes and seconds e.g 39^0 25' 30"
2. DD – decimal degrees. The minutes and seconds are converted to a decimal of a degree e.g. DMS of 39^0 25' 30" = DD of 39.425º. To convert DMS to DD you need to:
    - divide the minutes by 60 because there are 60 minutes to a degree i.e. 25'/60 = 0.4167º
    - divide the seconds by 3600 because there are 60 seconds to a minute or 3600 seconds to 1º i.e. 30"/3600 = 0.0083º.
    - then add these values together i.e. 39º + 0.4167º + 0.0083º = 39.425º.
3. DDM – degrees with decimal minutes. i.e 39º 25' 30" = 39º 42.5'. This is not so common.

The coordinates for gate to the QTA can be shown as:

- DMS: 35º 09' 28.3"S 147º 30' 32.1"E
- DD: -35.15632ºS 147.51004ºE
- DDM: 35º 09.471'S 147º 30.535'E

Note:

- Lat/Long is usually the default setting for a GPS.
- Check which system is used for written waypoints, your map and GPS. You can change the setting on the GPS to match.
- Google Maps use DD.

- The Emergency Plus APP and a GPS will give Decimal Degrees to an accuracy of 5 decimal places e.g -35.1459 Lat and 147.37954 Long.
- List Latitude coordinates before Longitude and use a full stop not a comma.

UTM Grid References

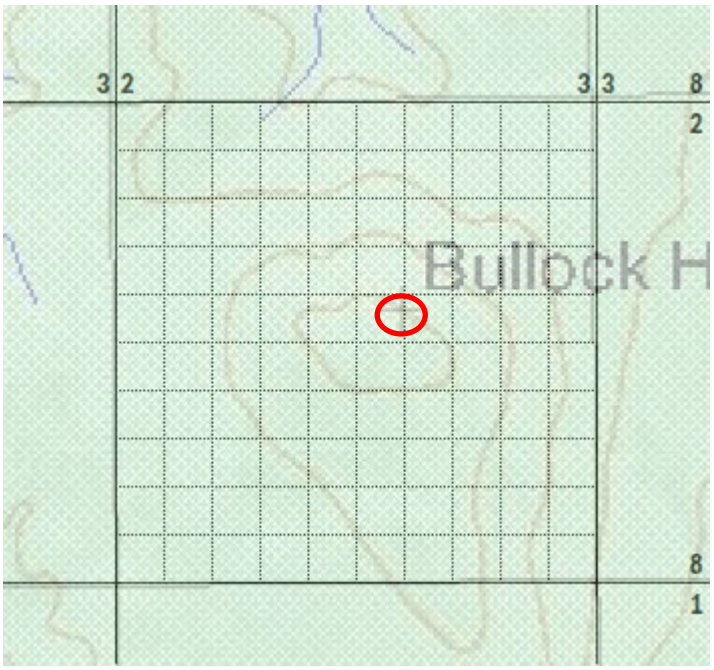
A more accurate (and easier?) way of locating your position on a large scale map is to use grid lines & ***grid references*** called **UTM** (Universal Transverse Mercator). The world is divided into Zones each of 6° of longitude. They are numbered 0 – 60 (6° x 60 zones = 360°) going around the world east from the International Dateline. WA is in Zone 50 and we are in Zone 55. Each Zone is then split horizontally into 22 bands each of 8° of latitude with letters A to X. Australia is in bands "L" to "G" (e.g. Cape York is in "L" and TAS is in "G". Our band is "H". Putting these together therefore we are in the Grid Zone 55H. This is shown on maps and on your GPS if it is set to UTM. For practical navigation we can ignore this because a single Grid Zone is around 20,000km tall and 700km wide – not very useful.

Each Grid Zone is further divided into a grid pattern which is VERY useful for navigation and finding waypoints. This grid pattern is shown on topographic and some other maps using numbered parallel vertical and horizontal lines (grid lines) drawn on them (not to be confused with tourist maps which have squares with numbers and letters). Also, these grid lines are NOT the same as latitude and longitude lines!

These grid lines then create *grid squares* which are 1km x 1km on large scale maps and 10km x 10km on small scale maps. (Check the scale ruler on the map). The tops of the vertical lines point to *grid north.*

Vertical lines are called *eastings* and increase in value going east. Horizontal lines are *northings* and increase in value going north. The numbering of eastings relate to distance in metres from the centre (the meridian) of each Grid Zone, and the numbering of the northings relate to distance to the equator.

Each grid square can be further divided into 100 smaller squares by visualizing 10 vertical lines between eastings, and 10 horizontal lines between northings (lines are 100m apart on large scale maps). These grid lines are used to determine grid references on maps using a six digit number to an accuracy of 100x100m. The first 3 numbers are eastings and the second three numbers are northings (I was taught to remember this by: "*Go across the creek before climbing the tree*").



In the example here, eastings 32 and 33 are 1km apart and northings 81 and 82 are 1km apart. The small internal grid lines are 100m apart. The UTM Grid Reference of Bullock Hill would be 326, 816 i.e. 6 small lines past easting 32, and (almost) 6 small lines above northing 81.

Note that a GPS will give the full UTM location to an accuracy of 1m so you will need to round off the coordinate for practical vehicle navigation unless you are geocaching where you have to find a hidden object. For example: My GPS says the gate to our QTA is at UTM Grid Reference: 55H 546382 6109288. 55H is our Zone. The numbers 546382 refer to the number of metres east of the meridian of Zone 55H, and numbers 6109288 refer to distance relative to the equator. For practical map location just use 463 and 092 i.e. the grid lines as marked on the map. This location happens to be at latitude -35.158134 and longitude 147.509266.

If reporting your location to emergency services you should give the *grid zone designation* for the map you are using or the *map sheet reference number* because the same grid coordinates will appear in other Zones. The Grid Zone and Map Reference Number will be written on topographic maps. We are in zone 55H.

You can set your GPS to give you UTM grid reference coordinates but when using a GPS make sure it is set to the same **DATUM** as the map. The Datum (or convention) determines the position of the grid lines on the map. The world standard datum is **WGS84** which is the same as GDA94 (the Geodetic Datum Australia). This becomes important because new and old maps of the same area may have grid lines in different places e.g. old maps may follow Australia's old Datum AGD66 which places grid references 200m

southwest of WGS84.

Note:

- You can use your GPS to navigate to a waypoint.
- You may be able to set your GPS to give both Lat and Long (as DMS, DD or DDM) plus UTM.
- There are on-line web sites, or you can download a phone APP to enable you to convert DMS. DD and UTM.

Map reading can be as simple or as complex as you like to make it. There is a lot more than this basic guide and there are some excellent reference books available (the RFS have a good manual). I don't know about you but I love poring over maps and dreaming about places I would like to visit and so on, and then getting on Google Earth to look at satellite photos of the places, and then dreaming some more. All I have to do now is go visit them… and learn how to get the best out of my GPS to assist.

Fun extra fact (from Ian Davidson),

Why do we use 360 degrees and not something like 100? There are a couple of reasons:

1) The ancient Babylonians loved triangles and symmetry. It just so happens that you can fit exactly six equilateral triangles into a circle, with sides equal to the radius of the circle, so six, and multiples thereof, were a natural in measuring circular angles.
2) 360 is what's known as a "superior highly composite number", because it's evenly divisible by no less than 24 divisors: 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30, 36, 40, 45, 60, 72, 90, 120, 180 and 360. That makes working with angles much easier! (This also relates to why there are 60 seconds in a minute and 60 minutes in an hour. Blame the ancients for breaking a day into 24 hours; they divided day and night into 2 x 12 (which is guess what: 6x2) parts, making 24 hours total.)

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