Chapter 20 - “Map Reading”

In this chapter we'll learn a few basics about Map Reading. We'll also talk about how to understand map directions, coordinate systems, topography, contour lines, scales, and geo-referenced digital maps.

All planters should have a basic understanding of maps and cartography. One of the benefits of becoming a tree planter is that you'll learn a lot about the world around you, including things like being able to tell directions without a compass.

Figure 20.01
Don’t Be Intimidated By Maps.

At first, maps can look very confusing. However, once you’ve learned a few basic rules, they’re usually quite easy to understand.

Let's start with the very basics. On most maps, all the writing is oriented the same way, so you can determine a "top" and a "bottom" to the map. If the map doesn't indicate otherwise, the top of the map is always north. This is the case in probably 99% of maps. Occasionally, for some odd reason, north will face a different direction, but if it does, there should be a little compass rose symbol or arrow on the map that points to north.

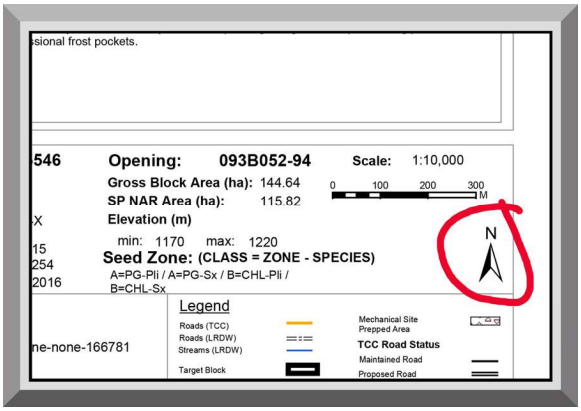

Figure 20.02
Compass Rose.

The compass rose shows you which direction is north on a map. Most of the time, north is at the top of the map. If you don’t see a compass rose, it’s probably safe to assume that north is at the top.

GPS System

Most maps that tree planters use in British Columbia will also have coordinates on them. There are literally thousands of different coordinate systems in place throughout the world. Some of them were created centuries ago by early explorers and surveyors, and it's safe to say that most are extremely confusing. Within BC, you'll normally just encounter one of the most well-known systems used today, a traditional Latitude and Longitude system. The Latitude and Longitude coordinates will be in "northings" and "westings" when you refer to coordinates within British Columbia.

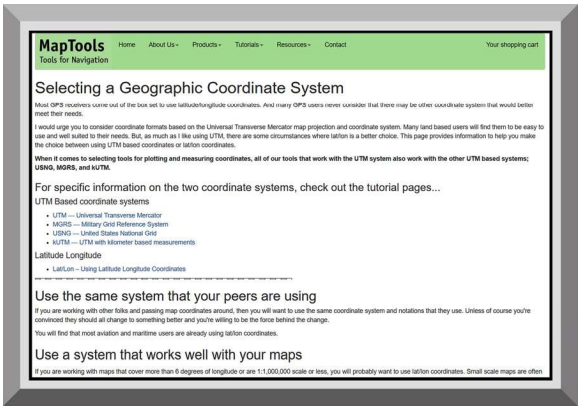

Figure 20.03
Coordinate Systems.

There are thousands of different coordinate systems used around the world.
Source: MapTools.com

Northings, or the distance north of the equator, range from about 49 degrees at the bottom of BC to about 60 degrees at the top of the province. These are also known as the latitude. Westings range from approximately 114 to 140 degrees, with the lower numbers on the east side bordering Alberta. These are known as the longitude. If you have problems with respect to latitude and longitude in terms of remembering which is which, think of the word "flatitude" instead of latitude. Latitude lines are flat lines, rather than vertical, when you look at a map. Lines of latitude run parallel to the equator (in fact, the equator itself is a line of latitude). If you're ever using software or a GIS system that doesn't allow you to type in the letters N or W to represent northing and westing, use positive numbers for the northings (southings would be negative), and use a negative sign for the westings (eastings would be positive). The number representing the latitude always comes first, before the number for the longitude.

If you get a block map, sometimes it will display the coordinates on the sides of the map, in a scale. As mentioned, the latitude is the distance above or below the equator, hence the reason why latitudes are always "north" in British Columbia. That's why the latitudes run up and down the sides of a map, even though a line of latitude is flat, running from left to right on a normal map. The longitude is the distance to the east or west of the Prime Meridian that runs north/south down through England, hence why longitudes are always "west" in British Columbia. That's why lines of longitude are vertical, and the longitude numbers always run along the bottom or top of a map.

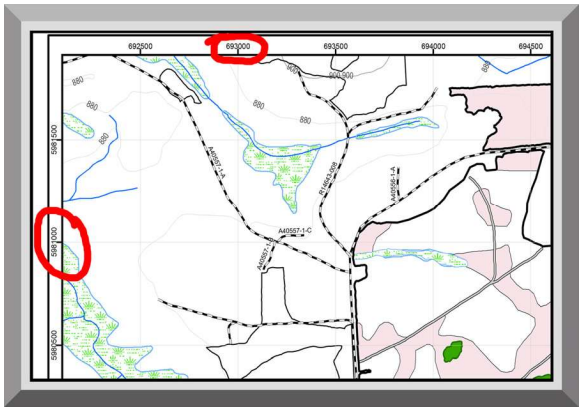

Figure 20.04
Latitude & Longitude Coordinates.

The Latitude coordinates run up and down the side of a map, because they refer to flat lines across the map. The Longitude coordinates run across the top or bottom of a map, because they refer to vertical lines throughout the map.

Here's an example of a northing/westing coordinate, or latitude/longitude: **53.89709, -122.76861**

That coordinate (which is in "degrees decimal" notation) can be cut & pasted into Google Earth or Google Maps. If you do, the coordinates refer to the physical location of "Mister PG" in Prince George, at the intersection of highway 97 and the Yellowhead.

In addition to the possibility of seeing latitudes and longitudes listed on the sides of your map, there may be a single point coordinate (latitude and longitude) listed somewhere in the map's key. That is probably for a point in the very center of the map, although occasionally, it will refer to a random point somewhere on the map where a surveyor decided to pick what's known as a "tie point" to start plots or something similar.

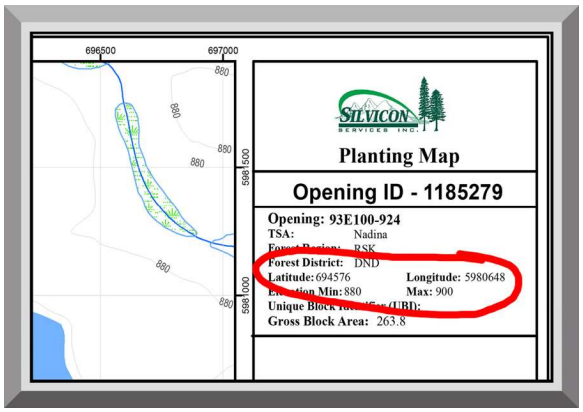

Figure 20.05
Tie Point Coordinates.

If there is a single pair of coordinates on a map, it might refer to the center of the map, but it could also refer to a specific point called a "tie point" or a point of commencement (POC).

The Global Positioning Satellite system, also known as GPS, is a network of approximately thirty satellites that are operated by the US government. If you're at any point on Earth with a GPS device that can "see" three satellites, you'll be able to determine your exact position in terms of latitude and longitude. Add a fourth satellite, and you should also be able to get your elevation above sea level. That's a simplification, but good enough for our purposes.

Figure 20.06
Handheld GPS Device.

This device can show your location, anywhere on the surface of the earth. All it needs is a direct line-of-sight to a few of the many GPS satellites that constantly circle the earth.

The GPS system (also known as NAVSTAR) is the American variety of a GNSS, or a Global Navigation Satellite System. Russia has a GNSS called GLONASS. China has a system called BeiDou. The EU has a system called Galileo. Japan and India are currently in the midst of launching their own networks.

GPS coordinates are typically listed in degrees, minutes, and seconds. These refer to units of arc, or distance on the surface of the Earth. An arc-degree covers a very large amount of distance. The exact distance depends on where you're located on Earth, but an arc-degree can sometimes be as large as 65 kilometers or more. An arc-minute is smaller, maybe around a kilometer wide depending on your location. An arc-second is a narrow range, only maybe around twenty to thirty meters wide, although again, this distance depends on your exact location. There are sixty arc-seconds contained in an arc-minute, and sixty arc-minutes contained in an arc-degree, just like in time-keeping. There are 360 arc-degrees to cover the entire surface of the Earth, just like there are 360 degrees in a circle. A lot of the time, people drop the "arc" prefix when they're talking about GPS coordinates, and just use the terms degrees, minutes, and seconds.

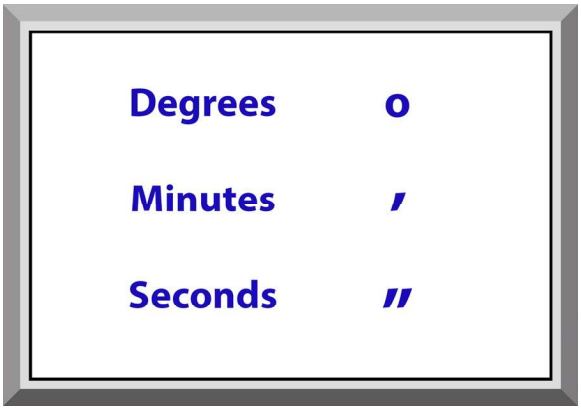

Figure 20.07
Symbols For Latitude & Longitude.

These symbols are used to designate degrees, minutes, and seconds of distance.

Sometimes, the written format of a GPS coordinate is written using specific symbols for degrees, minutes, and seconds. Degrees are symbolized by a small superscripted circle. Minutes are symbolized by an apostrophe. Seconds are symbolized by a quotation mark symbol. So for example, 54 degrees, 36 minutes, and 30 seconds would be listed as 54° 36' 30". At other times, decimal points will be used for either just the seconds, or sometimes for the minutes and seconds. In this example, if just the seconds were converted to minutes-decimal, the reading would be 54° 36.5'. That's because

thirty seconds is 0.5 (or 30/60) of a minute. If the minutes were also converted to decimal, the reading would be 54.60833°. That's because 36.5 minutes is 0.60833 (or 36.5/60) of a degree. If you have a GPS device, you can go into the settings and pick the display format that you want to use.

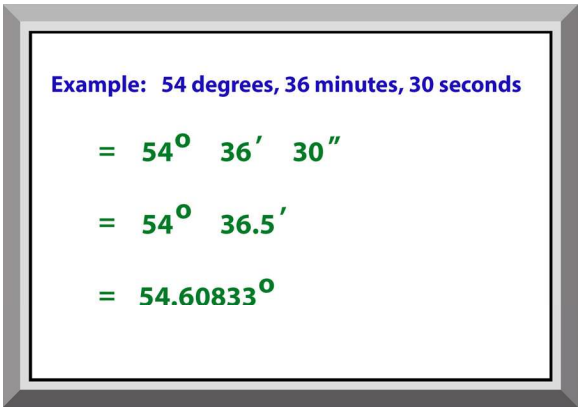

Figure 20.08
Degrees/Minutes/Seconds vs. Degrees Decimal.

Rather than using a degrees/minutes/seconds notation, sometimes the minutes and seconds are converted into degrees decimal. Convert minutes by dividing by 60, and convert seconds by dividing by 3600.

There are other coordinate systems in common use in some parts of the country. For example, you may encounter coordinates given in Canada's National Topographic System (NTS), which uses UTM zones and coordinates. In Alberta, there is a very unique system called the Alberta Township Survey (ATS) system. This system uses Sections, Ranges, Townships, and Meridians to come up with unique four-part identifiers which cover the entire province. If you know a specific identifier, it describes a parcel of land that is only approximately 400 meters across (a quarter mile). If you go to any oil lease in the province and see a sign at the front with a company name and the four-part identifier, you can call an emergency services responder and tell them that identifier code, and they will know exactly where to find you. An example of one of these codes might look like "1-87-18-W4" (which is the same place as latitude 56.50984 N, longitude 111.76315 W, about 30km southwest of Fort Mac).

Other Map Features

Your map may have a lot of curvy lines drawn all over it. These are called contour lines. This means that the map is a topographic map, or one that identifies the topography of the area being mapped. The best part about a contour map or topo map is that it lets you understand the hills and valleys on a block, because the contour lines indicate the elevations throughout the block. Each contour line represents a specific elevation, say perhaps 1380m. Contour lines are usually spaced 10m or 20m apart on a block map, or perhaps 20m to 100m apart on a larger regional map. The closer the lines are together, the steeper the slope.

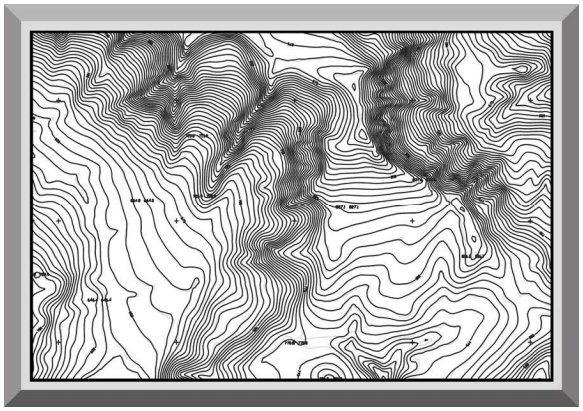

Figure 20.09
Contour Lines.

These lines indicate the "shape" of the land, in terms of elevation. In the areas where contour lines are close together, the elevation rise or drop is quite steep. This photo obviously has some steep hills.

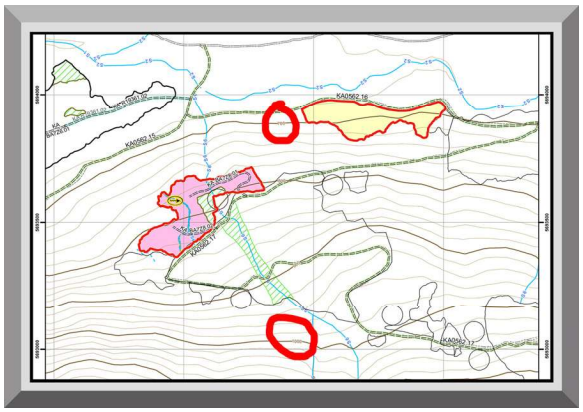

Figure 20.10
Elevation Markings on Contour Lines.

This map has elevation markings on the contour lines. The upper red circle shows a 700m elevation marking, and the lower red circle shows a 1000m elevation marking. Dark grey contour lines show even hundred meter intervals.

If your map doesn't have contour lines, but it has streams or creeks identified, there's a good chance that you can figure out a rough idea of the hills and valleys on your own. Streams and creeks are usually identified in blue. Look for a blue line, and follow that line to where it ends. If the line just stops suddenly, that's the highest part of the stream. Water flows downhill, so follow the creek away from the starting point where the stream officially begins, and you'll see where the block gets lower and lower in elevation. Perhaps the stream or creek will end in a blue pond, or join another larger stream.

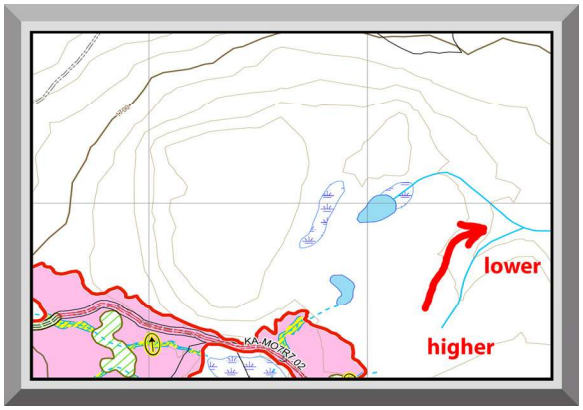

Figure 20.11
Determing Direction of Water Flow.

Because there is no pond at the end of the lower branch, my guess is that the water is flowing north then east as it flows downhill. The pond closest to the center of the map is probably a marshy source for water flow, rather than a collector.

Sometimes you can also guess approximate elevations on a map just by looking at the roads. The reason for this is because in hilly country, the odds are slightly higher that the roads on the block will generally be going uphill rather than downhill. Of course, it's certainly possible that roads can go

downhill upon entering a block, but that probably happens less than one third of the time, whereas more than two thirds of the time the roads are either flat or go uphill. The reason for this is simple. Logging companies like to harvest the easiest wood first, closest to the towns and mills. The easier wood near the valley bottoms was probably harvested years ago, and the logging companies are now making their way further and further up into the steeper ground. Also, it's easiest to build main roads along the valley bottoms and have then branches going up into the blocks in the hills. This method certainly isn't foolproof, but if you have to guess, you can sometimes increase your odds of guessing correctly to be slightly better than just 50/50. That's better odds than in Vegas.

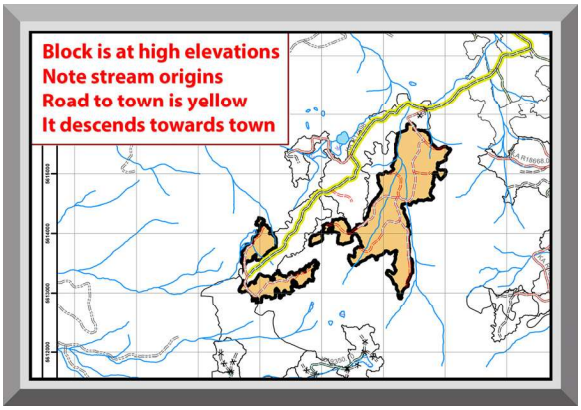

Figure 20.12
Determining Road Direction.

Various clues on the map can help you make a better than 50/50 guess at which part of a road is at the highest elevations, and which is lowest. Of course, many forestry roads are fairly flat too.

Understanding Map Scales

Most maps have a small "scale" on them. This will be a number expressed as a ratio. On a map showing a small area such as a single block, the ratio is often 1:5,000 or 1:10,000 or, for a very large block, maybe 1:20,000. On a larger "area map" which shows a larger region of many blocks, the scale might be 1:30,000 or even 1:100,000 or larger.

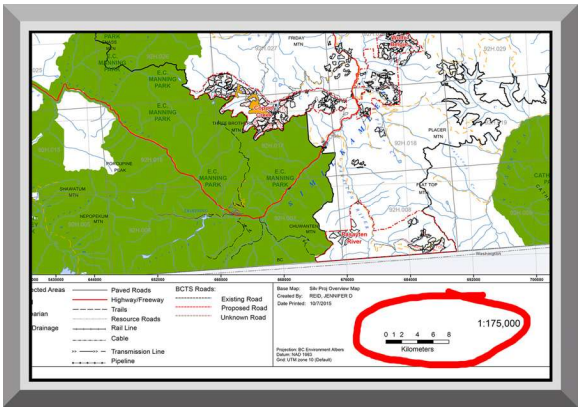

Figure 20.13
Overview Map with a Small Scale.

The scale on this overview map is 1:175,000. This is a "small" scale. It means that every centimeter on the map represents 175,000 centimeters in the real world, or 1750 meters. "Smaller" scales are more "zoomed out," with less detail, but showing a lot of area.

The scale is a multiplier to indicate how much real distance is covered by each part of the map. You multiply the distance on the map by the large number in the ratio, to find the real-world distance. Usually, we think in terms of centimeters on the map. Therefore, if you were to have a map with a ratio of 1:5,000 then one centimeter on the map represents 5,000 centimeters in the real world. Ten

centimeters on the map would be ten times that amount, or 50,000 centimeters in the bush. Now obviously, trying to measure real-world distances in centimeters is an exercise in futility. So you can convert those numbers to meters simply by dividing by 100, since there are 100cm in a meter. In other words, in the example where 1cm gave us 5,000 centimeters, that's equivalent to 50 meters. In the second example of 10 centimeters on the map, that becomes 50,000 centimeters or 500 meters in the bush.

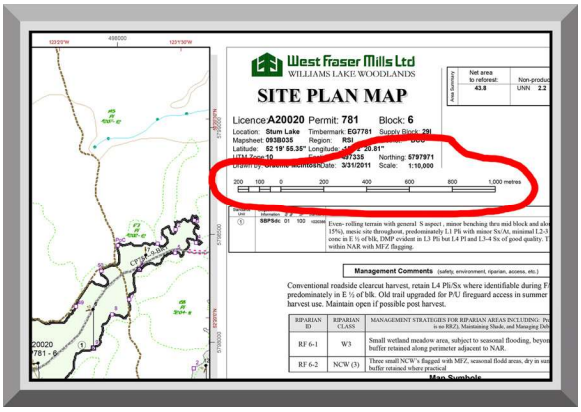

Figure 20.14
Scale of 1:10,000 on a Block Map.

When the scale is "large," the scale is more "zoomed in" and shows more detail, but covers less area. The "large vs. small" scale references seem backwards. On this map, 1 centimter of map distance is equivalent to 100 meters in the real world.

These scales are really useful because they can help a planter or a crew leader plan for how many trees need to go into an area. Let's say that you're looking at a map with your crew leader, and you've identified exactly where your cache is located on the road on the map. Let's also say that you're looking at filling a big pocket. You can get a ruler out and measure from your cache to the back of the pocket. Let's assume in this case that it is 4 centimeters on the map from your cache to the back of your pocket, and let's assume that the scale on the map is 1:10,000. This means that the 4 centimeters on the map represents 400m in real-world distance. Let's also assume that your average spacing on this block needs to be 2.5m between trees. To go 400m to the back of your pocket, you'll need to bag up with 160 trees. You get this number by taking the distance (400m) and dividing your average spacing between trees (2.5m). But you'll also want to be able to plant back to your cache, instead of dead-walking, so you should take a minimum of about 320 trees in order to plant into the back, and then work back to your cache. If you can carry even more than 320 trees in your bags, that's even better, because you can plant the extras at the back before you turn around and plant back to your cache.

Geo-Referenced Digital Maps

One of the biggest revolutions in the planting industry since the introduction of LFH planting in the mid-1990's has been the introduction of digital maps, and in particular, geo-referencing.

When a digital map is geo-referenced, this means that it has actual GPS location metadata embedded within the file. Certain apps can load these maps into your mobile device and correlate the map with the actual current location of your mobile device, based on the GPS receiver in the device. If the app determines that you're actually "on" the map, it will display your exact location on the map with a

little marker indicating where you're located, perhaps a blue dot or something similar. As you move around the block with your mobile device, your location indicator moves around on the map. It's just like using Google Maps or other similar services, except that these geo-referenced PDF's are generated by your silviculture forester and can show your planting blocks in great detail. Naturally, Google Maps focuses on towns and cities and government-maintained roads, so it usually isn't any good on remote planting blocks.

TIF/TIFF files can also be geo-referenced. Most other image types (JPEG's, GIF's, etc.) cannot be georeferenced.

At the moment, an app called Avenza Maps seems to be the most popular way to work with geo-referenced maps. There is a free version of this app which is fully functional, although it only allows you to work with three maps at a time. To use a fourth map, you have to delete one of your first three maps. In order to unlock the functionality of working with more maps loaded simultaneously, you can purchase the Plus version for an annual fee of roughly $46 CAD per year. The Plus subscription lets you work with twenty maps at a time. There is also an Avenza Maps Pro version for slightly over $200 CAD per year, which allows for the use of unlimited maps, although the other additional features when moving up from the Plus to the Pro version wouldn't be of interest to most people in the planting industry.

Another bonus of apps that use geo-referenced maps is that you can do the same sort of distance calculations as what I explained in the example with the ruler a few minutes ago. You just tap two spots on the map (presumably your cache and the back of your piece) and the app tells you the exact distance between the two points. You can also outline an area, such as your entire piece, and the app will do an area calculation for you. Let's say that your area calculation shows that your piece is approximately 1.2Ha in size. If you're aiming for 2000 stems/Ha and you do a good job with your density, you can assume that your 1.2Ha piece should hold approximately 2400 trees. Being able to make calculations like this really helps with planning.

Figure 20.15
Using Avenza to Determine Your Location.

Avenza Maps uses a blue dot on the screen to show your location, very similar to Google Maps. If there is no blue dot on the map, your mobile device is either located off the edge of the map, or not receiving a satellite fix.

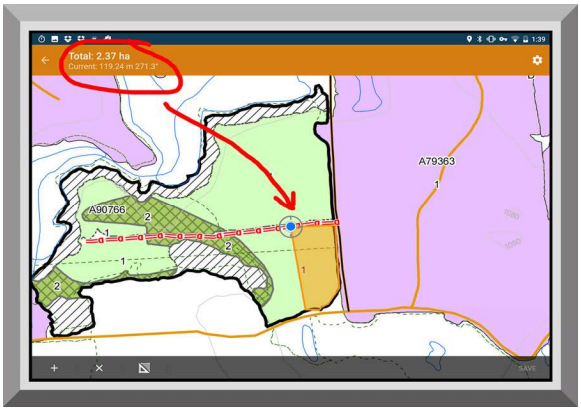

Figure 20.16
Using Avenza Maps to Calculate the Area of a Piece.

Avenza has calculated the area of the orange shaded piece to be 2.37 Ha. By calculating piece sizes, Avenza helps immensely with planning for tree delivery and related logistics.

In the modern era, it's very common for crew leaders to plan out the following day's block by cutting it up into measured pieces on Avenza, then saving that data "layer" as a separate KML file, and emailing both the underlying map and the KML layer to their planters. The planters don't have to load this data into Avenza if they don't want to, but some do, because it lets them have a more detailed understanding of how the crew leader has broken the block into pieces, etc.

Measuring Slopes

A slope can be smooth, or it can be rolling. A smooth slope has a constant gradient. A rolling slope, due to the presence of many small hills on the slope, will have a number of varying gradients, some steep and some shallow. There will even be small flat areas at the crest of each hill on the slope.

When we are describing how steep a hillside is with respect to planting, we don't pay attention to the variable slope gradients across that hillside the same way that a reclamation specialist would. As planters, for the most part, we are mostly concerned with the average slope of the piece as a whole (although highly variable slopes within a piece are certainly quite annoying).

Slope gradient can be expressed in different ways. Most of the time, the gradient is expressed either in degrees or as a percentage. It can also be expressed as a ratio. If the slope is measured in degrees, it is similar to the degrees of a circle. A flat slope would be zero degrees, and a vertical cliff would be the same as a right angle, ie. ninety degrees.

When the steepness of a slope is expressed in degrees, you'll need a bit of calculus to figure out the number properly. For example, if your piece is 200m to the back, and rises 50m over that distance, the slope equals ArcTan(50/200) = ArcTan(0.25) = 14 degrees. You can use a scientific calculator to figure this out.

The slope percentage is a ratio of the vertical distance divided by the horizontal distance, but expressed in percentage terms. For example, if your piece is 200m to the back, and rises 50m over that distance, the slope percentage is (50/200) = 0.25 x 100% = 25%. It is possible to have a slope

percentage that is greater than 100%. This is always the case when the slope angle is greater than 45 degrees.

The slope ratio is a ratio of the horizontal distance divided by the vertical distance. For example, if your piece is 200m to the back, and rises 50m over that distance, the slope ratio is 200:50 or 4:1. The slope ratio is the inverse of the slope percentage, if the slope percentage was expressed as a pure decimal number rather than as a percentage. Planters rarely talk about slope ratios.

If you're on a slope of twenty degrees or greater, you're probably going to be out of breath. It is not uncommon for some of the worst blocks on the coast or in the Southern Interior of BC to exceed slope gradients of sixty degrees or more.

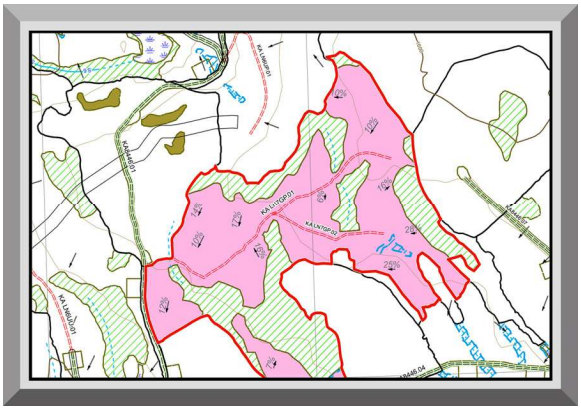

Figure 20.17
Slope Indicators On Map.

This map is great, because it indicates the approximate slope changes in a number of areas across the block.

Always Know Where You Are

Understanding maps and coordinate systems can be far more confusing than what I've explained here, because the topic can be incredibly complex. However, if you master the basics that I've explained here, you'll understand all that you need to know to be comfortable with looking at a map and trying to figure out where you are. It's important that your crew leader should always leave a map on the dashboard of the truck, so if there's an emergency and the crew leader is incapacitated, the crew will be able to figure out exactly where they are, and be able to relay that information to outside help. If there isn't such a map on the dash, ask your crew leader to leave one there for emergencies, with appropriate contact information to reach outside help. If the crew leader is the person who's seriously hurt, he or she will be really glad that they left this information for the planters. Most companies require that each crew have a written Emergency Response Plan with all of this information, and with instructions on what to do in an emergency. It can be as simple as a list on the dash of the truck with emergency phone numbers and radio channels.

Figure 20.18
Block Map on the Dashboard.

If the crew leader leaves a block map on the dash, it can help the planters figure out how to find help if there is an emergency that incapacitates the crew leader.

Figure 20.19
Emergency Response Plan (ERP) and Tailgate Safety Meeting Sheet on Dash.

The ERP sheet should also be left on the dash of the truck, so the planters can refer to it for emergency instructions in the event that their crew leader is hurt or becomes incapacitated.

As a planter, you should always know the number of the block that you're working on. A great idea is for the crew leader to use a dry-erase marker to write the block number on the rear-view mirror of each truck every morning. You should also be able to find the block number on the map on the dashboard.

Figure 20.20
Block Number Marked on Mirror.

It's easy for a planter to forget what block they're working on. If the crew leader writes this down on the rear-view with a dry erase marker, the planters always know where to find the block number in case they have to radio for outside assistance.

Never rely on just your mobile device to prevent yourself from getting lost. What happens if you're deep in the bush and your battery dies, or you trip and smash your screen on a rock? Can you make it to safety without the use of your phone for navigation or communication? Many of us have become to reliant on our phones, and forget that they can easily fail us at critical times. Make sure you always know how to get back to safety if your phone dies or breaks.

For more photo and video resources associated with this chapter of the book, including a tutorial about using the very popular Avenza app, visit:
www.replant.ca/training/maps