

Surveying Theory & Practice

What Is Surveying?

Surveying is the location of natural or man made objects relative to a known datum

It is the science by which lines, distances, angles and elevations are established and measured on the earth's surface.

It is used to prepare plans, maps, define legal boundaries, calculate lengths, areas and volumes. Surveys can range in precision from the use of a tape & compass to highly accurate cadastral or geodetic survey.

Surveys can involve locating objects in the horizontal plane, using instruments such as a GPS or theodolite, to locating objects in the vertical field with the use of instruments such as a dumpy level. By combining both techniques we can form three dimensional model of the object or surface being surveyed.

The science of surveying has a long history, triangulation across the English Channel being completed in 1787 using a theodolite with a three foot horizontal circle. This instrument is reputed to have an accuracy of 1 second.

Soil Conservation Surveys

Surveying provides a vital tool in for soil conservation activities. Common uses of surveying in soil conservation include:

- Assisting with the planning, selection and setting out of a variety of works
- Pegging out construction works such as diversion banks, trickle flow pipes and gully plug dams
- Preparing basic site plans for landholders & contractors
- Preparing detailed plans including long sections and cross sections used in the design of larger structures
- Preparing contour plans to assist with the design of flood retention dams, grassed waterways, and larger soil conservation or stream rehabilitation projects.

Equipment

There is an endless array of equipment that can be used for surveying

Sextant, Tape/compass & clinometer, measuring wheel, barometer, plane table, dumpy level, laser level, theodolite, total station and a range of GPS equipment.

For soil conservation purposes the dumpy level is by far the most versatile and useful instrument because of its durability, range of functions and speed of use.

The type of survey and level of accuracy will determine the type of equipment and method you employ.

Reliability/Accuracy

A good surveyor provides a reliable result at a known level of precision. A fundamental principle of surveying is that all surveys are “closed” to avoid mistakes.

With a well-planned survey, systematic errors are usually eliminated.

Levelling staves (staff) commonly used in soil conservation work are marked in metres with minor graduations down to centimetres.

Records

No matter what type of survey you are conducting, the results are usually only as good as the records you have kept.

Use waterproof survey books, indexed, with each page marked with the location, landholder name, date, type of survey, and surveyor/staff person names. Records should be neat and clear and written in pencil. Never rub out raw data. Normally a clear sketch should accompany all your

work. Your records should always be clear enough for some else to work out what you have done.

Use Of The Dumpy Level

Levelling is about determining the relative difference in elevation between two or more points by measuring (with a staff) from the ground level to the line of collimation.

Once the staff is above or below the visible line, too far away for an accurate sighting or obscured by another object, the instrument is moved to a new location. In this way the survey proceeds in a series of steps, each step being linked by a repeat reading to the “change point”. In a way, this is like a series of small complete surveys, linked to each other by a common point.

Reading The level And Staff

Once the centre cross hairs of the level are focussed on the staff, a reading is taken rounding off to the nearest 0.01 of a metre. On a standard metric “E” staff, the change in colour indicates a single centimetre. Five centimetres are linked together to form the letter “E”. The zero point at each numeral is usually marked with a fine horizontal line.

Booking

There are two main methods of booking level data. One method is called the Rise and fall method, the other the collimation method. The rise and fall method is recommended for soil conservation surveys.

While the rise and fall method is more tedious, it allows for all the calculations to be cross checked and a higher level of accuracy to be achieved.

The following technique is used for booking rise and fall data. The raw measurements are entered into one of three columns named back sight, intermediate and fore sight.

The first reading of the survey or “section” of the survey is always recorded in the back column.

The last reading of the survey or “section” of the survey is always recorded in the fore column.

All other readings are placed in the intermediate column.

Where a reading is repeated at the finish of one section and the start of the next, a change point, you place both readings on the same line.

Assuming the survey is “closed”, the total of the back column should equal the total of the fore column. This is known as a “field check”. The field check should be completed prior to leaving the site.

A few hints to success include:

- Pick the location of your change point carefully. It needs to be a fixed solid object or point.
- Always double check temporary bench mark and change point readings; these are critical to successful results
- Remember, at a change point, both the backsight and foresight readings are entered on the same line
- Always leave at least two lines at the bottom of your page for calculations
- When changing pages, always carry forward (repeat) the last reading from the previous page
- Never change pages on a change point reading

Reduction (Rise And Fall Method)

Once the survey is closed, and the field check completed, the process of reduction can proceed. In the rise and fall system, levels are determined by calculating the rise or fall between sequential readings. If the second reading is higher than the first the level has fallen, lower and the level has risen. The difference between each pair of readings is noted in the rise & fall column. Once completed the rise & fall columns should be totalled up with the result being the same as between the totals calculated in the field check for that page.

The “reduced” levels can then be calculated by adding the rise or subtracting the fall from the previous reading. Unless a known datum is used to start the survey, a large positive figure is

entered in as an arbitrary starting point for the reduced levels, eg 100.00. As each page is completed, the difference between the first and last reduced levels should match the field check and diff in rise and fall columns.

Field Notes

Field notes should record chainage along a centre line with offsets recorded in metres, north or south of the chainage point. Even where stadia and bearing is used to locate your survey points, your notes should still indicate the approximate location of the reading.

All relevant features that help locate/verify the survey point should be recorded. The location and description of the temporary bench mark needs to be carefully noted. Record all poor readings, errors, and change points. Complete a detailed sketch of the site including all relevant features including the temporary bench mark and north point. You can never have too much detail in your survey book.

Benchmarks

Apart from the simplest surveys, a temporary bench mark (TBM) should be established at an appropriate location, usually a clearly defined point well away from any proposed construction works. It can consist of an existing object such as the top of a concrete post or peg/nail established for the purpose.

Care And Maintenance Of Dumpy Levels

Dumpy levels, particularly automatic levels are particularly vulnerable to vibration and shock. Never put them away damp as the lens will quickly deteriorate. Check the accuracy the instrument at least once a year.

Setting Up Dumpy Level

Set up tripod at correct height in firm level ground. Ensure legs are spread well apart and are pushed firmly into the ground. Check that thumbscrews holding legs in place are firmly tightened. Roughly level the top of the tripod using the horizon as a guide. Mount the instrument, taking care not to over-tighten the locking screw. On a tripod with a domed top, the instrument can be roughly level by sliding it over the dome until the level bubble is centred. Final levelling should be completed using the thumbscrews under the instrument.

Next, focus the cross hairs against a featureless white background using the focusing ring closest to your eye. Line up instrument using the gun-sight, focus using the main focus screw and make fine horizontal adjustments using tangent screw. With an automatic level you can test the compensator operation by applying gently pressure to the tripod while viewing the staff.

Planning Your Survey

Careful planning of your survey will ensure you gather all the data you require in a fast efficient manner. You need to consider how far you can read, the elevation of instrument and location of any obstacles. An air photo can be a useful aid in planning a larger survey.

Signals

While radios are becoming more common in surveying, good clear hand signals are still the most effective and efficient method of communication.