Basingstoke Archaeological & Historical Society (BAHS)

How To Set Up And Use A Level

Basingstoke Archaeological and Historical Society

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Introduction

A level is used to measure the height of different features on an archaeological site relative to a datum point. The datum point may be arbitrary or it may be established from an Ordnance Survey benchmark if there is one available. Either way it gives us a quick way to determine the vertical distance between features on a site.

Setting up a level.

We normally set up a level at the start of the working day, and leave it in the same position unless there is a good reason to move it, this is to save time.

In order to make level measurements on a site, you will need a tripod, a level (sometimes referred to as “Dumpy” level), a measuring staff and level record sheet.

The first thing that you need to do is to set up the instrument so that it is truly level in the horizontal plane. Select a convenient place where you can see the site datum and, ideally, all of the site and set up the tripod. The tripod has legs which can be adjusted in length by releasing a clamp, extend the legs to a height that is going to be comfortable for you to look through the level, and try to get the central plate level by eye, then tighten the leg clamps.

Erected tripod – note clamps approx. half way down each leg.

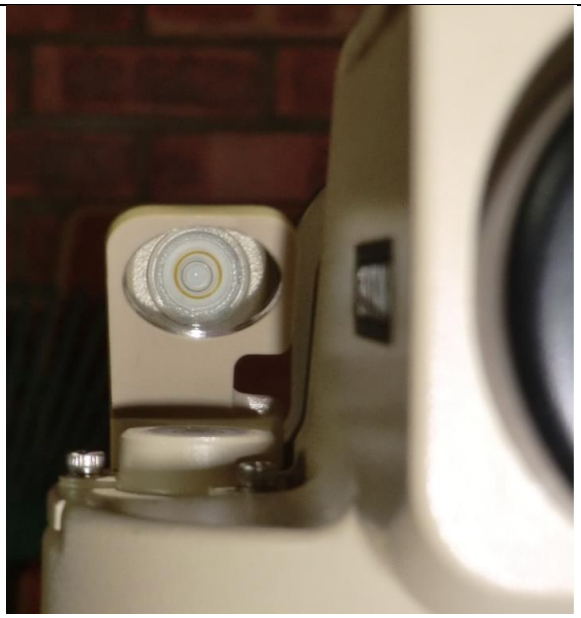
Top view of the tripod top face showing the captive screw which is used to clamp the level instrument into place.

The next step is to take the level out of its case and clamp it to the tripod by threading the captive screw in the tripod into the base of the instrument, you will need to turn the tripod screw anti-clockwise to do this. Align the instrument so that it is central to the tripod plate.

From the manufacturers manual, the various parts of the level.

The optical level is itself mounted on a small tripod with adjustment screws, this is referred to as the Tri-Bach. In the base of the instrument, there is a circular bubble level, and you need to adjust the Tri-Bach until the bubble is in the centre, and remains there as you turn the level telescope full circle. Turn the telescope so that it is parallel to two of the adjustment screws and then turn the screws in opposite directions until the bubble starts to move. It should move towards your left hand. Adjust the bubble so that it is on the centre line of the circle which means that it is level on the axis between the two adjustment screws you have been turning. Adjust the third screw to move the bubble into the centre of the circle. As a final check, rotate the level and make sure that the bubble remains in the centre, you should only need to make minor adjustments if not.

Positioning the level so that the telescope is parallel to two of the three level adjustment screws.



A centralised bubble level viewed through the mirror, this is the best way to view the bubble on this instrument.

At this point you are ready to take a reading.

Taking a reading

You will need two people to take a reading, one to hold the measuring staff in position over the feature of interest, and the other to take the reading. The first measurement of the day should be of the site datum.

The measuring staff is marked with centimetre squares and it has several sections so that it can be extended. The job of the person with the measuring staff is to hold it with the bottom of the staff resting on the feature, to hold the staff vertical and to hold it steady. Depending on the site they may need to extend the staff for a specific reading.

The person making the measurement needs to turn the level so that it is facing the staff, this can be done using the rifle sight on top of the level. Then they need to look through the eye piece and use the horizontal adjustment knob to line up the centre of the central cross wires with the staff. There is an optical focus knob that will also need to be adjusted to bring the view into focus. Once everything is aligned take the reading from the staff to the nearest centimetre, and estimate the sub-centimetre reading. Write the reading down as a foresight on the recording sheet.

One common problem is that there are three sets of cross wires visible through the eye-sight, only use the central set for level readings.

Unless the person with the staff and person with the level are within hailing distance they will need to work out a system of hand signals to indicate whether the staff needs straightening or whether a reading has been taken. If more than one measurement is to be taken, then it is worth agreeing beforehand the order in which the measurements are taken, or the person with the staff should keep note of which measurement goes with which feature.

Calculating Levels

Once set up, the level is used to take measurements relative to the datum. The first measurement of the day will be used to calibrate the height of the level to the datum.

The datum reading is taken from the staff and this should be noted as the reference for the day. This is added to the datum height (if known) to get the levels height above sea level.

All further readings are taken by subtracting the staff reading from the datum.

We use a level record sheet to keep track of the readings taken each day.

Using the level form

In order to keep a record of levels taken on-site, and also to make it easier to work out the spot heights we use a daily levels register:

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Daily Levels Register

Site Code:	SCC19	**Site:**	Stanchester
Date:	20 Aug 19	**Sheet:**	1
TBM	1.75		
Backsight Reading	1.23		
Instrument Height (TBM+Backsight)	2.98		
Level Number	**Foresight Reading**	**Reduced Level (IH-Foresight)**	**Comments/Context/Feature/Plan/Section reference**
1	2.23	0.75	Plan SSC19-1, feature 03, SW corner
2	2.34	0.64	Section SCC19-4, top of trench
3	2.75	0.23	Section SCC19-4, bottom of ditch

The datum is filled in at the beginning of each day that the level is set up. A new sheet is started if the level has to be moved.

All readings are recorded as foresight readings in the second column and then the reduced level is calculated and written in the third column. The fourth column describes the reference for the level.

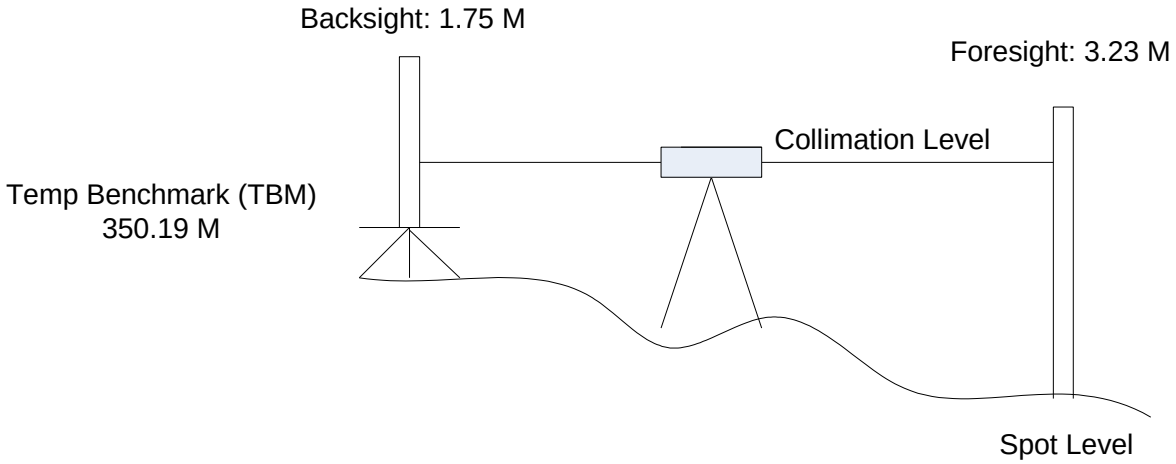
Some Technical Terms

In the literature, you will see the following technical terms:

Collimation level – This is the actual height above sea level of the level's cross wires (Collimation because we are using a monocular column based optical system, otherwise known as a telescope).

Back-sight – This is a reading made from a reference height point to attain the collimation level. A back-sight reading is **added** to the reference height to obtain the collimation height.

Fore-sight – This is a reading made to get a specific spot level based on the collimation height of the instrument. A foresight reading is **subtracted** from the collimation level in order to get the actual height of the spot above sea level.



Technical Terms used with the level

Initial Setup

The first measurement you should make is the height of the instrument relative to the datum. To do this take a level placing the staff on the datum point and make a note of the reading. Adding the staff reading to the datum point's height will give the height of the level above sea level. The technical term for this measurement is the **collimation** level. The level is now calibrated and any further spot height readings made from this position can be referenced to the site datum. If the level is moved, or set-up again, then this process must be repeated.

For instance:

If the site datum is 250 M above sea level and the level measured with the staff at the datum point is 1.53 M, then the cross wire of the level sight is at 250 + 1.53 M = 251.53 M above sea level. The 251.53 M level should be noted, since all other readings made will be relative to this level when the instrument is in this position.

When other spot height readings are made around the site, the reading made from the staff should be subtracted from the collimation level to get the actual level of the spot height.

For instance:

Assuming that the collimation level is 251.53 M, and that the reading on the staff at the spot height is 2.68 M, then the level of the spot is 251.53 – 2.68 M = 248.85 M.

Setting up a site datum from a OS benchmark (Project manual)

Depending on the site location, there may be an OS benchmark nearby and this can be used to establish an accurate height for the site datum, relative to sea level. OS benchmarks are to be found in solid structures such as churches or bridges. You should be able to find the height of the benchmark marked on larger scale OS maps. Alternatively, there is a database of benchmarks that can be downloaded from the OS website.

An OS benchmark – The top line denotes the benchmarked level

If you can find a benchmark, then you will need to make a traverse from the benchmark to the site. Depending on the terrain, any obstacles and the distance involved you will need to make a judgement call on whether a traverse is feasible.

A traverse requires that you set up the level, take a back-sight reading on the datum, and then move the staff to a point closer to the site and take a foresight reading. You then set up the level again, in a position closer to the site, leaving the staff in place since it is now the modified datum. You now take a back-sight reading on the staff to recalibrate the level and then move the staff closer to the site. You repeat the process until you arrive at a convenient place to set up the site datum.

If there is no OS benchmark available, then having a fixed datum point for all level measurements is fine. The important thing is to be able to have systematic way of comparing relative levels of features across a site.

The site datum should ideally be a fixed structure, such as a point on a wall or a building, or a fence post. If the excavation is for one season only, a square peg could be used, but take care about the location, since pegs can be knocked over by machinery or other agents.