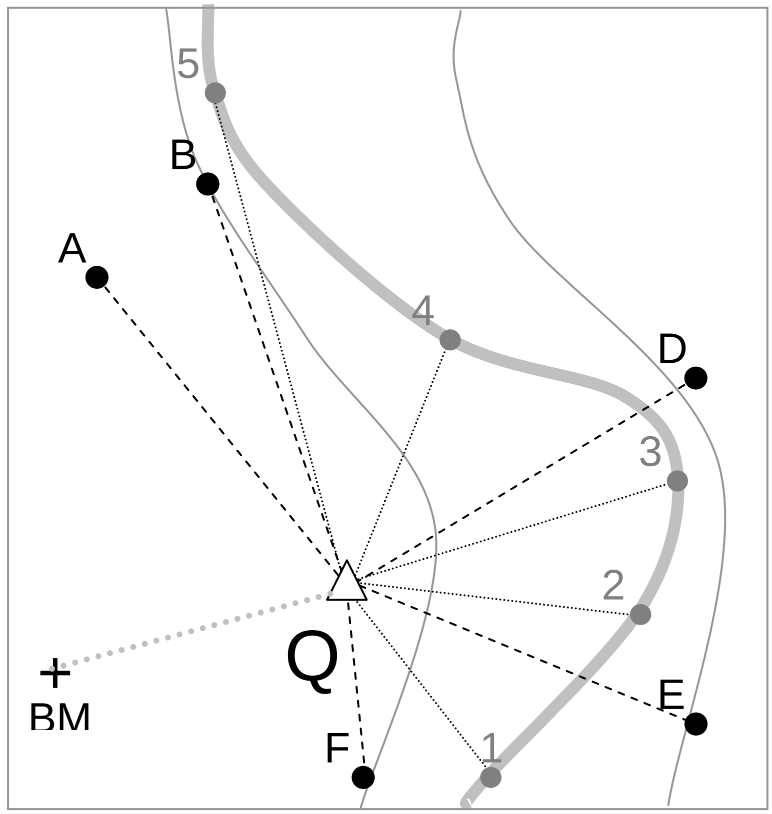


Using the Leica Sprinter Digital Level for Longitudinal Profiles

The Sprinter's good vertical accuracy and reasonable horizontal accuracy make it a decent tool for doing a longitudinal profile and a plan map. For this purpose we'll add a bit to the Cross Section survey method: (1) setting up the instrument at a known point; and (2) setting the horizontal circle to read azimuth. Then we'll record data as before, adding the HC readings to our notebook as before.

1. Setting up the instrument at a location (Q) to backsight to a benchmark (BM).

2. Set HC to azimuths: Use the telescope to sight to an easily seen but distant feature that you can clearly see also with the unaided eye. Then stand back from the instrument, then use a compass to sight through the instrument position to the feature. Record this as either a magnetic or true azimuth in your data notes column as either "mag az = ___°" or "true az=___°". Move the HC to the azimuth setting, and make a note that HC is set to this.

3. Backsight to benchmark BM (at a known XYZ) by reversing the HC reading from Q to BM. *If* true azimuths are used (or after later conversion in Excel), the equations would look like:

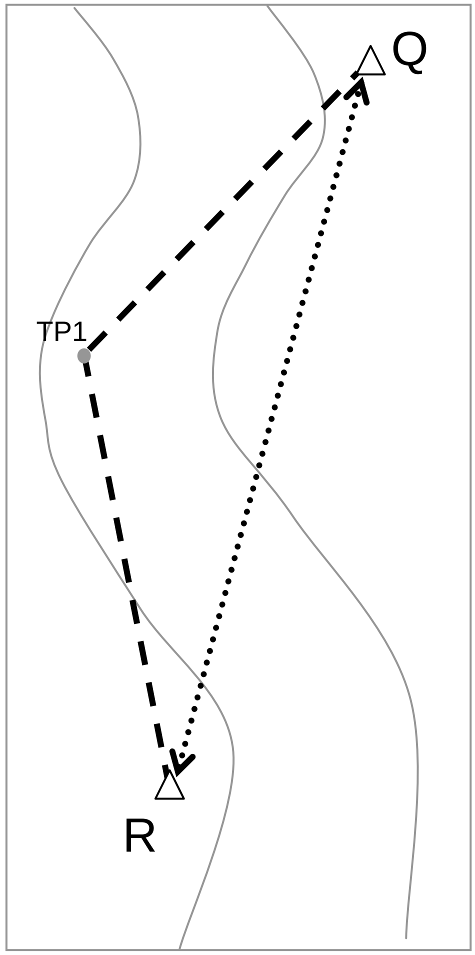
$X_Q = X_{BM} + D_{QtoBM} * \sin(\text{radians}(AZ_{QtoBM}+180))$ ...(AZ=HC + mag declination)
$Y_Q = Y_{BM} + D_{QtoBM} * \cos(\text{radians}(AZ_{QtoBM}+180))$
$Z_Q = Z_{BM} + V$

All readings will be offsets from the instrument position, which you should have at this point. After you download your data and enter the HC readings, and convert these to true azimuths AZ, the computations in the spreadsheet for a given position should be as follows, with AZ, D (distance), V (height) as inputs, and X_Q, Y_Q and Z_Q being the position of the instrument at Q:

$X = X_Q + D * \sin(\text{radians}(AZ))$
$Y = Y_Q + D * \cos(\text{radians}(AZ))$
$Z = Z_Q – V$

Thalweg readings: Make sure to measure all thalweg points in sequence. Longitudinal distance will be derived by the difference from one point to the next, and it can be confusing to rearrange things later to make this work. Before moving the instrument (see next section), make sure you have captured all the thalweg points before the first one of the next series. Ideally the turning point

Moving the Level using a Turning Point



In many surveys, including most longitudinal profiles, you won't be able to get all measurements from one instrument position. You'll need to move the instrument, but we must maintain vertical and horizontal control.

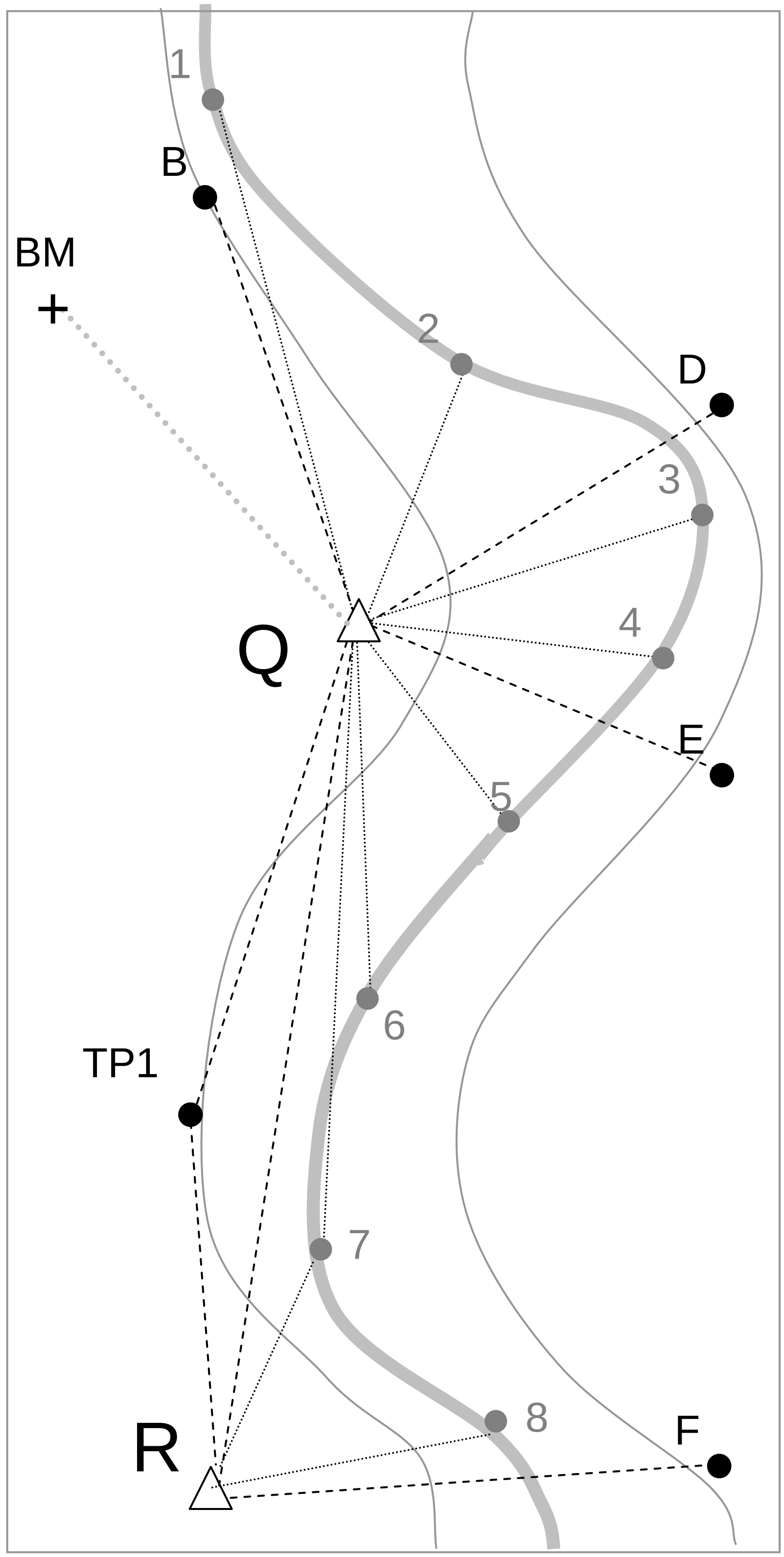
To maintain **vertical control**, which is critical in any leveling survey, we'll use a *turning point*, which we'll establish on a stable surface: boulders work well, or the best available surface – it must not move while you move the instrument, and preferably it's an easily identifiable feature so if you accidentally move the rod, it can be put it back reliably. Vertical control is passed from the instrument (for which we know its elevation as HI) at Q to the rod at TP1. Think of TP1 as a new benchmark. Then when we backsight from the new instrument location at Q to TP1, we can derive a new HI for measurements from R.

For **horizontal control**, which we need for longitudinal distances, or for making a plan map, we need to determine (1) where R is, and (2) have horizontal circle readings that work like true azimuths, at R as we did at Q. Ideally we can establish this by adding a foresight from Q to R (to get an XY for R and an azimuth from Q to R we'll call HC_{QR}), then a backsight from R to Q to set the horizontal circle to a reversed azimuth (HC_{QR}+180). If QR visibility is blocked, we'll need to (1) establish the horizontal circle at R with a compass, and (2) establish XY at R by reversing a reading from R to TP1.

So the process to get both vertical and horizontal control goes like this:

1. First, we survey to the turning point (from Q to TP1 in the diagram), just like any other reading, as a foresight. *Note that the rod holder needs to stay in place while the instrument is moved.* Think of TP1 as a new benchmark. We'll derive XYZ for TP1, just like for other foresight readings.
2. Before moving the instrument, check the azimuth backsight (distant feature) to make sure you haven't adjusted the HC. If it differs from your notes, make a note of the difference.
3. If possible, and it doesn't compromise your surveying efficiency, also survey Q to R to get XY for R, and HC_{QR} from the HC.
4. Leaving the rod holder at TP1, reposition the instrument at R.
5. If backsighting to Q, do that first to establish the HC as HC_{QR}+180 (or minus 180). Otherwise use a compass as before to set the HC to azimuths.
6. Backsight to TP1 to establish the HI at R. If you didn't backsight to Q, you can establish XY at R by reversing the HC reading from R to TP1.
   $X = X_{TP1} + D_{RtoTP1} * \sin(\text{radians}(AZ_{RtoTP1}+180))$ …as before, AZ=HC + mag decl.
   $Y = Y_{TP1} + D_{RtoTP1} * \cos(\text{radians}(AZ_{RtoTP1}+180))$

Turning Points and the Thalweg



The longitudinal distance is an important measure, which can either be measured directly or derived from successive xy positions. If we know the xy position of thalweg point 1 and 2 in the figure, we can derive the distance. From a known position for Q we can assign xy coordinates of #1 and #2 using their distance and direction; if we have used a compass to get true direction, the coordinates can be true coordinates (but even with a rotated direction we can still derive coordinates and thus distances in that rotated coordinate system; we just can't make a plan map with it.)

Note in the figure that the last thalweg point was #7. To determine the distance from #7 to #8, this requires that we either take a reading from R to #7 again or we make sure we're in the same coordinate system by reorienting the level at R to true directions, as described above.

If we could use the #7 thalweg point as a turning point, this would simplify things, but using a thalweg point as a turning point is often unreliable. Often a thalweg point is unstable, and difficult to re-establish if the rod moves, so it's often safer to use stable turning points not in the thalweg.

Therefore, the most reliable and accurate method when about to move the instrument from Q to R is to: (1) flag #7 with a long stake inserted in the streambed; (2) Make the turning point foresight reading to TP1; (3) set up the instrument at R; (4) backsight to TP1; (5) repeat the thalweg #7 reading using the flagged stake to get to the location reliably; and (6) continue the thalweg survey to #8, etc.

Checklist for moving the instrument

1. Before moving the instrument:
    - ☐ Make last thalweg reading and flag with long stake in bed
    - ☐ *Optional: sight to next instrument location and flag both instrument points*
    - ☐ Foresight to the turning point, and record all data, including HC.
    - ☐ Repeat the azimuth backsight to the same distant feature used previously, and record any change in the HC reading. If it differs by more than a degree, estimate when the change may have occurred.
2. After moving the instrument:
    - ☐ Measure compass azimuth and set the HC to true azimuths (Add magnetic declination ______°)
    - ☐ Backsight to the turning point, recording all data
    - ☐ *Optional: backsight to last instrument location and unflag*
    - ☐ Set the HC using an azimuth backsight to a distant feature, or the last instrument location. Make this clear in the notes.
    - ☐ Repeat last thalweg reading at staked location; remove stake

Notebook columns for longitudinal profile:

ID	Height	Distance	Sta	Depth	HC	Type	Substrate	Notes

Column Definitions:

1. **ID**: Id number assigned by the instrument. Redundant: Data recorded by the instrument should include this, but should be recorded in the field to avoid errors.
2. **Height**: The height reading on the rod from the instrument. Also redundant.
3. **Distance**: The distance from the instrument to the rod. Also redundant.
4. **Sta**: station distance measured from a survey tape.
5. **Depth**: Water depth measured on the rod – should be read before the instrument reading and not moved, to ensure that the depth is read at exactly the same point on the bed.
6. **HC**: Horizontal Circle. Read manually from the horizontal circle on the instrument. When setting up the instrument and back-sighting to a benchmark or turning point, the HC should be initially set to a known magnetic azimuth using a compass, and this should be noted clearly in the notes column as "HC set to Mag azimuth of ___°".
7. **Type**: Type of reading. Use abbreviations:
   BS = backsight to benchmark or turning point. **TP =** foresight to turning point.
   T = Thalweg **P** = Pool **R** = Riffle (P and R assumed also to be thalweg unless noted.)
   LBkf = Left Bankfull **RBkf**=Right Bankfull
   LTerr RTerr = Left and right terraces (maybe with a subscript for a numbered terrace)
8. **Substrate**: type of sediment or vegetation in substrate: mud, sand, gravel, cobble, etc.
9. **Notes**: Provide any information needed to interpret the readings for future users, such as backsight information, HC settings, more info on type of reading, etc.