Survey of Chatterley Whitfield Hill

13 December 2016

The Team:

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1) Introduction

Chatterley Whitfield Hill (Hill 19245, Section 36, OS 1:50000 Map 118, OS 1:25000 Map 258, Grid Ref SJ883529) is listed as a TuMP with a drop of 35m. (A TuMP is any hill in England, Scotland and Wales with a minimum drop of 30m). The hill is a landscaped spoil heap derived from coal mining that took place in the area up until a few decades ago. The old colliery lies over the col and until recently housed a museum that recorded the industrial heritage of the area. The OS 1:50000 map shows a summit 220m contour ring, while higher scale maps currently show no detail for the area. However, a LiDAR (Light Detection and Ranging) survey conducted by Ordnance Survey reveals four possible summit positions. These are given below, together with their heights, from a study by Chris Crocker and George Gradwell:

Summit 1: 209.08m at SJ 88313 52930

Summit 2: 208.84m at SJ 88266 52908

Summit 3: 208.75m at SJ 88287 52828

Summit 4: 208.78m at SJ 88305 52839

Two of these positions were also located by Nigel Thackrah from an earlier site visit. The col was also located using the LiDAR data and found to be next to one of the colliery buildings at SJ 88489 532787 and with a height of 174.4m, thus giving a drop of 34.4m.

The purpose of this survey was to locate and measure accurately the height of the hill and, if time permitted, explore the col area from outside the security fence that surrounds the old deserted colliery buildings.

2) Equipment used and Conditions for Survey

Optical work and line surveys were carried out using a Leica NA730 Professional Automatic level (X30 telescopic system)/tripod system and a "1m" **E**-staff extendable to 5m.

Absolute heights were measured using a Leica Geosystems Viva GS15 Professional receiver. This instrument is dual-frequency and multi-channel, which means it can lock on to a maximum of 12 GPS and 8 GLONASS satellites as availability dictates, and receive two signals (at different frequencies) from each of these satellites. The latter feature reduces inaccuracies that result from atmospheric degradation of the satellite signals. As a stand-alone instrument it is capable of giving position and height to an accuracy of about two metres and five metres respectively.

Note that small hand-held GPS receivers used for general navigation can only receive up to 12 GPS satellites and each at a single frequency and therefore these instruments have a poorer positional accuracy of +/-5metres and a height accuracy of no better than +/-10 metres. Some recently produced hand held GPS Garmin receivers can also receive signals from GLONASS satellites which greatly improve the speed at which these units can achieve a satellite "fix".

Despite the on-board features of the Leica Viva GS15 receiver, there are still sources that create residual errors. To obtain accurate positions and heights, corrections were made to the GNSS (Global Navigation Satellite System) data via imported RINEX data from Ordnance Survey which were post-processed using Leica Geo Office 8.3 software.

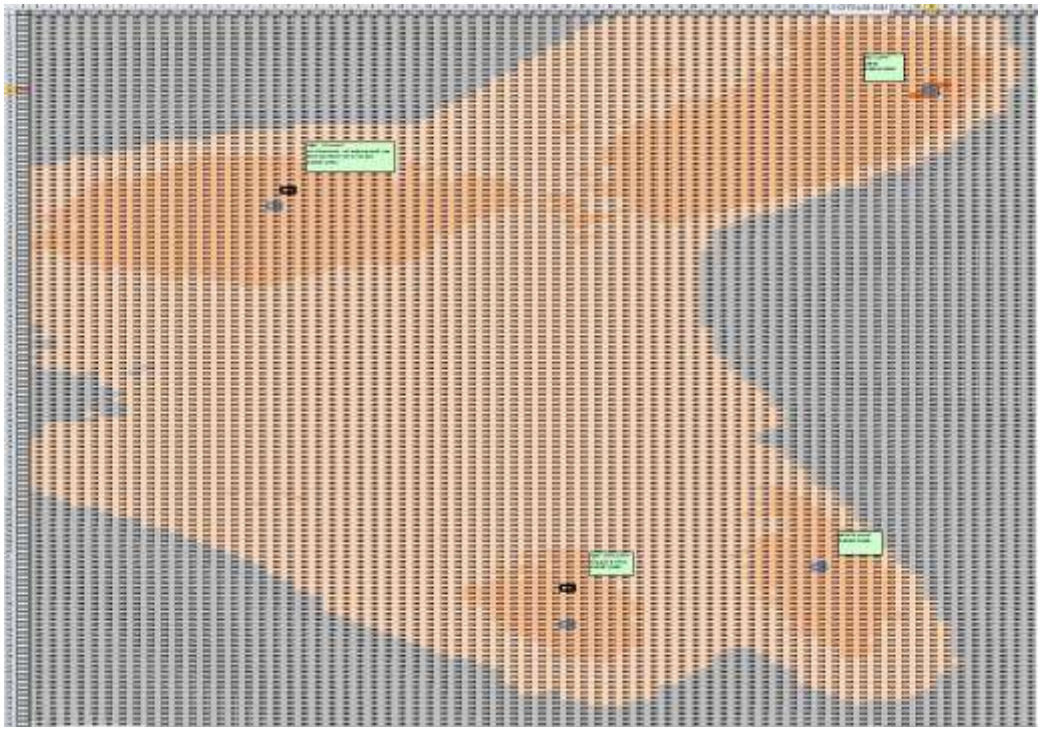
Conditions for the survey, which took place between 10.00hr and 15.00hr GMT, were poor. Despite a forecast for a dry day with cloud and occasional sunny intervals, we experienced frequent heavy showers with fog enveloping the hill later in the day. The temperature was about 8 degrees Celsius and the wind was light.

3) The Survey

3.1) Character of Hill

Chatterley Whitfield Hill lies about 5km south east of Mow Cop and is situated on the outskirts of Stoke on Trent. It is best approached from the A527 where, at Fegg Hayes, a minor, but busy, road through a housing estate leads after 400m to a small car park that serves an allotment. Just 50m from here a metalled track gives access to the hill and the surrounding country park.

Chatterley Whitfield Hill is now part of a nature reserve that is surrounded by the suburbs of Stoke. The information board on the summit describes some of the wildlife to be found there including common spotted orchids and a colony of Dingy Skipper butterflies. The flanks of the hill are clothed with young trees, mainly birch, and while we were collecting GNSS data, a woodcock emerged from the undergrowth and flew across the summit. Streams lie to the North and South of the hill providing the park with a variety of habitats. Despite its proximity to the urban environment, the area shows considerable potential for wildlife.



The summit area is adorned with a circular stone wall about 10m in diameter encompassing a flat area of short grass interspersed with paving, as seen in a photograph in the Appendix. The rest of the summit is clothed in rough grasses and nettles. The latter appear to grow to about 1.5m in height in extensive, dense clumps, but fortunately on our visit these had largely died back leaving bare stems. Nevertheless, the amount of thick vegetation on the summit presents a challenge to the surveyor. The sketch above is taken from the LiDAR data and the brown area represents the summit plateau; the blue dots show the four possible summit positions identified by the LiDAR study; the black dots show two positions (2 and 4) identified by Nigel Thackrah. The spreadsheet representation means that the scale is compressed in the vertical (north-south) direction and is 70m (E-W) and 150m (N-S).

3.2) Survey of the Summit

The Leica NA730 automatic level was setup on a tripod on a stone platform that formed part of the circular wall. This provided a vantage point for the whole of the summit area.

Next, the four candidate summit locations that were found from analysis of the LiDAR data and from a previous visit by Nigel Thackrah were visited and marked with flags. Despite the height of the vegetation and the general flatness of the summit area, a further reconnoitre was conducted, but this failed to find any other candidate summit locations. Once the reconnoitre was completed staff readings were taken at each candidate high point.

The hill's summit was found to be close to a small oak tree and consequently it was decided to set up the Leica GS15 away from this area to where there was a clear view of the sky and a position within the circular stone feature was chosen. A staff reading for this point was also taken and this and the readings for the four potential summits are given below.

Summit 1: ground by oak tree: (SJ88313 52930): staff reading = 1.165m

Summit 2: ground within circular stone wall: (SJ 88266 52908): staff reading = 1.753m

Summit 3: no feature: (SJ 88287 52828): staff reading = 1.839m

Summit 4: no feature: (SJ 88305 52839): staff reading = 1.919m

The Staff reading for the Leica GS 15 setup position = 1.788m

Next, the Leica GS15 was setup on a 2.000m pole and supported by a Quickset tripod at this position. GNSS data were collected for 2 hours with an epoch time of 15 seconds. (See photographs in Appendix).

Ten-figure grid references measured for the summit were:-

Garmin Oregon 450	SJ 88312 52935	Height = 215m
Garmin Fenix 3	SJ 88311 52936	Height = 212m
Satmap 10	SJ 88313 52936	Height = 214m
Garmin Fenix 3	SJ 88313 52933	Height = 211m

The height data for the summit that were recorded by the Leica Viva GS15 were post-processed with Leica GeoOffice 8.3 using imported OS RINEX data for the twelve nearest base stations and the Computed model for tropospheric correction. Note that the offset for the

2m pole plus the height difference between the set-up position and the summit (1.165 - 1.788 = -0.623m) have been incorporated into the offset used in GeoOffice). The results are given in the table below:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	388267.439	0.002	352901.195	0.005	209.390	0.006

The height of Chatterley Whitfield Hill is 209.39m

The heights of the other contenders for summit position are:

Summit 2 (ground within circulate stone wall) = 209.390 – 1.753 +1.165 = 208.80m

Summit 3 (no feature) = 209.390 – 1.839 + 1.165 = 208.72m

Summit 4 (no feature) = 209.390 – 1.919 + 1.165 = 208.64m

These height values are in good agreement with the LiDAR data. The biggest discrepancy is with the summit where the GNSS height is 0.3m higher than the LiDAR height. This is not surprising since the summit was covered by the oak tree.

3.3) The Col Area

As described in the Introduction the col lies within the site of the disused colliery and many of the buildings there are still present and until recently formed part of a heritage museum. The whole complex is surrounded by a high security fence and entry to the site without permission is not allowed. We may seek permission to survey there, although the area will present a unique challenge; the high buildings both inhibit line-of-sight (difficult for line surveys) and mask large areas of the sky (difficult for GNSS work). Nevertheless, we explored the security fence for several hundred metres and came within 70m of the probable col position as identified by the LiDAR study. The area to the West from the foot of the hill to an entrance road gradually falls to the North and to the West. To the East from the foot of the hill there is a metalled path that rises gradually to a high point and then descends. This path is in a cutting about 2m deep. On the North side of the path the ground is flat and about 20m beyond is the security fence. We followed this to the NE, approaching the col, and this ground fell very gradually. After a while the security fence turned sharply into a small steep-sided valley in the bottom of which there was a wide track which would originally have given access to the site. This was the nearest we could approach the col from outside the fence. Having completed this reconnoitre we returned to the high point in the metalled path which we deemed to lie on the hill to hill traverse. It was decided to set up the Leica GS15 here to determine the height by the side of the path. We recognised that this position was probably a few metres higher than the col position and was about 250m distant from it. However, we reasoned that, if the result yielded a drop of greater than 30m then the status of the hill as a Tump would not be in doubt.

The Leica NA730 level was setup on a tripod on the North edge of the path and staff readings were taken along the path thus enabling us to locate accurately the highest point. Next, the Leica Viva GS15 was setup on a 2.000m pole and supported by a Quickset tripod at this position. GNSS data were then collected for 53 minutes with an epoch time of 15 seconds.

The position and height data that were recorded by the Leica Viva GS15 were post-processed with Leica GeoOffice 8.3 using imported OS RINEX data for the twelve nearest base stations

and the Computed model for tropospheric correction. Note that the offset for the 2m pole has been entered into GeoOffice). The results are given in the table below:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	388357.292	0.002	353067.638	0.002	178.338	0.005

The height of the position on the path is 178.37m

The drop from the summit to the point on the path is 31.03m

4) Summary of Operating and Process Conditions

	GS15
Data Collection summit (min)	124
Data collection path (min)	53
Number of Base Stations used in Processing for all points	13
Epoch Time (sec)	15
Tropospheric Model	Computed
Cut off Angle (degs)	15
Geoid Model	OSGM36(15)

5) Coordinate Recovery Analysis

In order to verify the accuracy and consistency of a GNSS dataset, Ordnance Survey recommends a procedure called Coordinate Recovery Analysis. Instead of processing the data with reference to all the nearest OS Base Stations under approximately 100km distance, as used in this report, the data is first processed with reference to only the nearest Base Station. The data is then reprocessed with the survey point taken as a Reference Point and all the remaining Base stations taken as survey points. These measured values for the OS Base Stations can then be compared directly with the actual OS values for Position and Height. (This has been carried out via an Excel Spreadsheet supplied to us by OS).

Although the spreadsheet calculates a number of different parameters, two important ones are presented in the tables below. "Height Difference **U** metres**"** is the vertical height difference between the heights of the Base Station as measured in this survey compared with the actual OS value. "Separation $\mathbf{D_{ij}}$ metres" is the distance in 3-d space between the measured and actual OS values for each Base Station.

The results for the summit of Chatterley Whitfield Hill show a consistent dataset, as all measured OS Base stations are within 0.07m in distance and height of the OS actual values. Note that the Height Difference values are all negative indicating that there is a small bias in the dataset.

Base Station	Code	Distance to Survey Point km.	Height Difference **U** metres	Separation $\mathbf{D_{ij}}$ metres
Leek	LEEK	15.10		
Buxton	BUXT	25.26	-0.0180	0.0189
Daresbury	DARE	43.61	-0.0132	0.0148
Lichfield	LICF	46.70	-0.0480	0.0482
Manchester	MANR	49.72	-0.0633	0.0644
Shrewsbury	SHRE	52.83	-0.0250	0.0250
Hoober	HOOB	70.82	-0.0206	0.0220
Keyworth	KEYW	76.99	-0.0082	0.0113
Arisaig	LEED	88.66	-0.0072	0.0149
St Asaph	ASAP	89.22	-0.0363	0.0369
Droitwich	DROW	90.55	-0.0401	0.0423
Church Lawford	CLAW	97.40	-0.0104	0.0159
Blackpool	BLAP	97.33	-0.0073	0.0124

6) Discussion of Results

The uncertainties in the height measurement taken by the GS15 for the summit are +/-0.05m associated with its location and +/-0.05m for the GNSS 2 hour data set. This gives an overall uncertainty in the summit height of +/-0.07m.

For the path the uncertainties in the height measurements are estimated to be +/-0.02m for the location of the high point and +/-0.06m for the data set which gives and overall uncertainty of +/-0.06m.

The height of Chatterley Whitfield Hill is 209.4+/-0.07mm and the drop to the path is 31.0m+/-0.06m.

Since the set-up position on the path is higher than the true col position, it may be confirmed that Chatterley Whitfield Hill is a TuMP.

7) Ordnance Survey Verification

The result of this survey was submitted for validation to Mark Greaves at Ordnance Survey. The height for Chatterley Whitfield Hill was accepted and a spot height for the summit will be included on future OS maps.

8) Summary and Conclusions

The **summit** of **Chatterley Whitfield Hill** is at grid reference * SJ 88312 52936 and is unfeatured ground by a small oak tree. Its height is **209.4+/-0.07m**.

The **re-ascent** from the **position on the path to the summit is 31.0m** and therefore **Chatterley Whitfield Hill is confirmed as a TuMP. The true drop is a few metres greater than 31m.**

* NB average hand-held Garmin/Magellan GPS grids are quoted in the summary.

John Barnard, Graham Jackson 15 December 2016.

Appendix

The stone wall with prominent pole behind (point 2)

The summit position (point 1) by oak tree about 50m NE of stone circle

Point 4 about 70m SE of stone circle

Point 3 about 80m SSE of stone circle: Point 4 is 20m behind in the thick vegetation

The Survey Team

Position on path about 250m from true col