

# Survey of Moel y Waun

11 January 2013

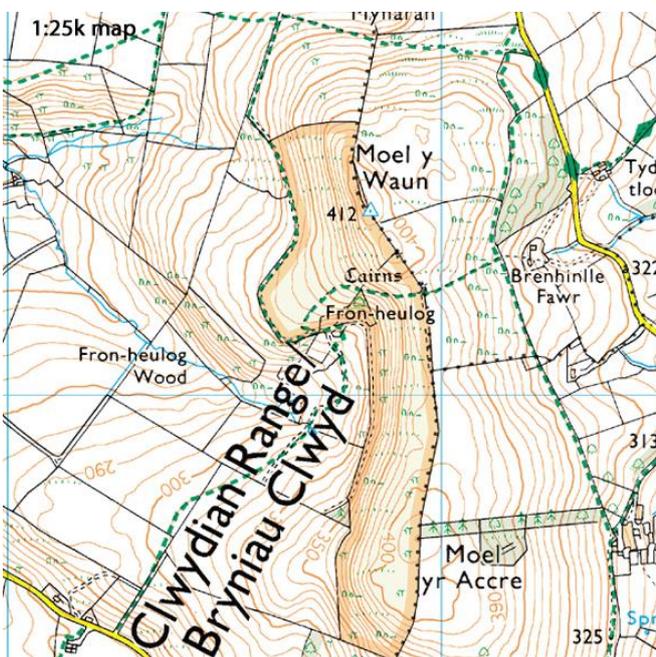
The Team:

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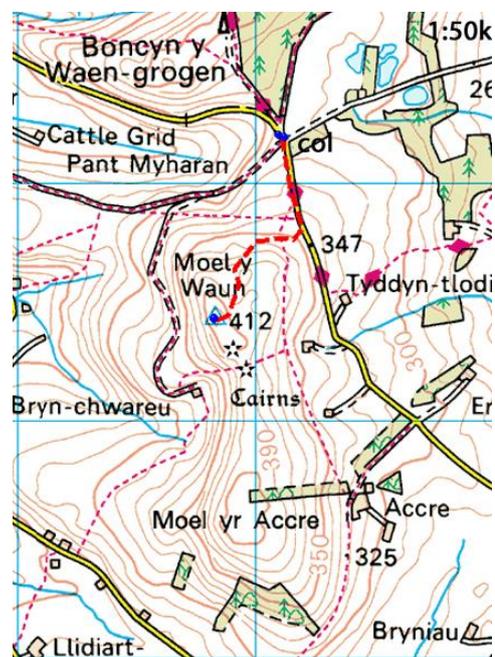
## 1) Introduction

Moel y Waun (Hill 7518, Section 30C, OS 1:50000 Map 116, OS 1:25000 Map 256, Grid Ref. SJ168534) is situated in the southern Clwydians about 12km South West of Mold. With a summit height of 412m and a spot height of 313m in the area of the col, it is listed as having 99m of drop. Therefore it fails by just one metre to be on the list of one hundred metre prominence (HuMP) hills. Moel y Waun has a trig point on its summit with a flush bracket height of 412.07m as recorded in the OS database of trig points. About one kilometre to the South is a secondary summit, Moel yr Accre, which has a small 410m ring contour on the 1:25k map and so, in principle, could be as high as its neighbour.

*1:25k map of summit area*



*1:50k map of summit and Bwlch*



The purpose of this survey was to find the positions of summit and bwlch and measure their heights accurately and thereby determine if Moel y Waun, or its neighbour Moel yr Accre, should be considered for HuMP status.

## 2) Equipment used and Conditions for Survey

Ground surveys to determine the positions of the bwlch and summit 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 both a Leica Geosystems 530 GPS receiver and a Leica Viva GS15 receiver. These are dual-frequency, 24-channel instruments, which means they can lock on to a maximum of 12 satellites 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 signal. As stand-alone instruments they are capable of giving position and height to an accuracy of about two metres and five metres respectively. Note that a hand-held GPS receiver can only receive up to 12 satellites and each at a single frequency and therefore it has a poorer positional accuracy of +/-5m and a height accuracy of no better than 10 metres. Despite the on-board features of the 530 and Viva GS15 receivers, there are still sources that create residual errors. To obtain accurate positions and heights, corrections were made to the GPS data via imported RINEX data from the Ordnance Survey which was post-processed using Leica Geo Office v7.01 software.

Conditions for the survey, which took place between 10.00hr and 15.00hr, were good with long periods of sunshine. It was cool, 5 degrees Celsius, and the wind was very light.

### 3) **The Survey**

#### 3.1) **Character of Hill**

Moel y Waun is very accessible from the minor road which runs North-West from the B5431 about 4km South of Llanarmon-yn-Iâl. The minor road rises gently beneath the hill arriving after 2km to the bwlch which separates Moel y Waun from its next higher neighbour Moel y Plas which lies just to the North. There is parking at the bwlch for about four cars. A footpath 350m back along the road winds its way through short grass to just beneath the summit making access very easy.

The summit ridge lies in a North-South direction and is gentle on its East side but has steep slopes on the side facing West. The summit ridge is a mixture of coarse grass and well-cropped sheep pasture. A line of trees stretch up the East slopes of Moel yr Accre but terminate just before the obvious summit area.

The bwlch very clearly lies in the vicinity of the junction of the minor road and a vehicle track which strikes due East to the waterfowl centre Pen y ffrith although several features in this area vie for that distinction.

#### 3.2) **Summary of Survey Method**

The strategy for the survey was to use both the Leica 530 and the GS15 to collect data on the bwlch and summit simultaneously. This would then allow one instrument to be used as a base station and the height of the second to be measured relative to it. This is the most accurate method of determining height differences and with one hour's simultaneous data collection should give an instrumental measurement uncertainty of +/-0.05m. Of course, measurement uncertainty due to the terrain would have to be added to this value.

First the exact position of the bwlch was determined with the level and staff. There appeared to be a rise of a metre or so in the track to the waterfowl centre, while just across the road in a field a minor ridge of ground also appeared to be a contender. A third possibility was the junction itself. Ground in the adjacent conifer plantation was easily dismissed from consideration.

By taking staff readings through the level it was very quickly established that the junction itself was the bwlch. The track to the waterfowl centre fell significantly and the position identified by the unaided eye was in fact two metres lower. The ground in the field was about 0.1m lower. Several staff placements on the track showed a general unevenness of the ground of about +/-0.03m.

The summit of Moel y Waun required only cursory measurement with level and staff in order to identify the highest point which was ground by a fence post about 1m SW of the trig point and on the same side of the fence as the trig point. The general unevenness of the ground here was determined to be +/-0.05m.

The summit of Moel yr Accre was also readily identified as ground at the base of the highest fence post and again the general unevenness of the ground was of the order of +/-0.05m.

The absolute heights of Moel y Waun and the bwlch were measured with the Leica 530GPS and the absolute heights of Moel y Waun and Moel yr Accre were measured with the Leica GS15. Thus we were able to obtain simultaneous measurements for both summits and for Moel y Waun and the bwlch. The AT502 antenna of the Leica 530 was set up on a 2.000m pole with tripod support to hold it firmly over the point to be measured. The Leica GS15 was set up on a tripod using a Leica proprietary tribrach and optical plummet system and its height above the ground measured. Data at each point were collected with an epoch time of 30 seconds. The collection time on the col was 135min and on the summits 60min (Leica GS15) and 100min (Leica 530). These times gave an hour's overlap for summit-col and for summit-summit.

### 3.3) **The Bwlch**

As described above the position was identified as ground on the track to the waterfowl centre near the road. It was not possible to set up the Leica 530 at this position because the track was overshadowed by the mature conifer trees of the plantation. Consequently, it was set up in the field across the road, where the trees subtended an angle of less than 15 degrees to the horizon and therefore did not interfere with satellite reception. The height difference between the set-up position of the GPS and the actual position of the bwlch was measured with the Leica NA730 level and staff.

Height reading at bwlch = 0.89m

Height reading at GPS position = 0.985m

Difference = 0.095m

The ten-figure Grid References for the bwlch were:-

Montana 600	SJ 17136 54198	Accuracy 3m Height = 310m
Garmin Map60CSx	SJ 17136 54195	Accuracy 2m Height = 303m
Garmin Venture	SJ 17134 54196	Accuracy 4m Height = 317m
Magellan Explorist 100	SJ 17136 54194	Accuracy 7m Height = 316m
Etrex	SJ 17135 54195	Accuracy 6m Height = 314m
Garmin Oregon 450	SJ 17135 54195	Accuracy 4m Height = 313m

The ten-figure Grid References for the GPS set-up position were:-

Etrex	SJ 17107 54203	Accuracy 6m Height = 318m
Garmin Oregon 450	SJ 17109 54205	Accuracy 3m Height = 319m

The position and height data for the bwlch that were recorded by the Leica 530 and post-processed with Leica GeoOffice 7 using imported OS RINEX data from the eight nearest OS base stations were:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
SR 530	317105.126	0.003	354199.347	0.002	312.696	0.009

The height of the bwlch is therefore  $312.696 + 0.095 = 312.79\text{m}$

### 3.4) Summit of Moel v Waun

While the Leica 530 was collecting data at the col and attended by one member of the team, the other members climbed the hill and set about locating the summit. The exact position was established using the level and staff and is ground by a fence post one metre from the trig point. A suitable point for setting up the Leica 530 and Leica GS15 was identified as ground one metre SE of the summit position and one metre from the trig point because the fence post prevented set-up of the instruments on the summit position itself. The height difference between these two positions was then determined along with the flush bracket of the trig point so that a comparison could be made with the flush bracket height in the OS trig point database.

Staff reading at GPS set-up position = 0.751m

Staff reading at summit = 0.662m

Staff reading at flush bracket of trig point = 0.394m

Staff reading at trig point base = 0.726m

The ten-figure Grid References for the summit are:-

Montana 600	SJ 16842 53432	Accuracy 3m	Height = 412m
Garmin Map60CSx	SJ 16840 53433	Accuracy 3m	Height = 406m
Garmin Venture	SJ 16839 53427	Accuracy 5m	Height = 419m
Magellan Explorist 100	SJ 16838 53431	Accuracy 3m	Height = 412m
Etrex	SJ 16842 53433	Accuracy 5m	Height = 409m
Garmin Oregon 450	SJ 16842 53433	Accuracy 3m	Height = 411m

The Leica GS15 was set up on the tripod with its base 0.619m above the ground and position and height data for the summit recorded over a period of 1hr. The data were subsequently post-processed with Leica GeoOffice 7 using imported OS RINEX data from the eight nearest OS base stations:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	316838.720	0.001	353427.836	0.001	411.755	0.007

Having completed this task the team moved to Moel yr Accre, while the team member at the bwlch completed the survey there and then moved to the summit of Moel y Waun. Here the Leica 530 was set up in the exact position as that occupied by the GS15 previously. This position had been marked with flags by the advance party before it left for Mole yr Accre.

The position and height data for the summit recorded by the Leica 530 over a period of 1hr 40min and post-processed with Leica GeoOffice 7 using imported OS RINEX data from the eight nearest OS base stations were:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
SR 530	316838.716	0.002	353427.854	0.001	411.779	0.009

The two measurements are within excellent agreement of one another with a difference of just 0.024m. Therefore the height of Moel y Waun (taking the average of the two readings) is:  $411.767 + 0.089 = 411.86m$ .

The height of the flush bracket is  $411.767 + 0.751 - 0.394 = 412.12m$

The Ordnance Survey lists the height of the trig point flush bracket as 412.07m. The two values are in good agreement. The flush bracket is located 0.33m above the base of the trig point.

#### 4) **Summit of Moel yr Accre**

While the Leica 530 was being set up on the summit of Moel y Waun the advance party had moved to Moel yr Accre and determined its summit position using the level and staff. This was found to be ground at the base of the highest fence post. Once again it was not possible to set up the Leica GS15 at this point so a more convenient site was chosen a few metres away. The height difference between the GPS set-up position and the summit was determined.

Height reading for summit = 0.753m

Height reading for GPS set-up position = 0.937m

The ten-figure Grid References for the summit are:-

Montana 600	SJ 16955 52671	Accuracy 2m	Height = 410m
Garmin Map60CSx	SJ 16955 52669	Accuracy 3m	Height = 405m
Garmin Venture	SJ 16955 52665	Accuracy 6m	Height = 410m
Magellan Explorist 100	SJ 16953 52667	Accuracy 8m	Height = 412m

The Leica GS15 was set up on the tripod with its base 0.613m above the ground and position and height data for the set-up position recorded over a period of 1hr. The data were subsequently post-processed with Leica GeoOffice 7 using imported OS RINEX data from the eight nearest OS base stations:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	316953.848	0.002	352660.812	0.001	411.065	0.008

Therefore the height of Moel yr Accre is:  $411.065 + 0.937 - 0.753 = 411.25\text{m}$

## 5) Discussion of Results

The errors in this survey were all small being +/-0.03m for the location of the col, +/-0.05m for the location of the summits and +/-0.05m for the height difference determinations. This gives an overall measurement uncertainty of +/-0.08m for both summit – col height difference and summit – summit height difference. The height difference between the two tops as measured from the difference of the two processed heights is  $411.86 - 411.25 = 0.61\text{m}$ .

If we use Moel y Waun as the base station and Moel yr Accre as the rover, which as described in Section 3.2 is the method that gives the most accurate determination of height difference, then the height difference between the two tops is calculated to be 0.60m. While this is the more accurate measurement, it is in this case only 0.01m different from the value measured by taking the difference in absolute heights and this is much smaller than the other measurement uncertainties in the determination.

During the survey the level was used to give an approximate visual height difference based on the trig point height of 1.25m. The result was between 0.6m and 0.8m in reasonable agreement with the accurately determined value.

The drop measurement is  $411.86 - 312.79 = 99.07 \pm 0.08\text{m}$ . If we take the GPS on the bwlch as the base station and Moel y Waun as the rover, then the measured difference in height between them is calculated to be 99.06m. Once again this is only 0.01m different from the value measured by taking the measured height difference and this is much smaller than the other measurement uncertainties in the determination.

We conclude that Moel y Waun does not achieve the 100m required to give it HuMP status.

## 6) Summary and Conclusions

The **summit** of **Moel y Waun** is at grid reference \* SJ 16840 53432 and is ground at the base of a fence post about 1m SW of the trig point. Its height is **411.9m**. Its neighbour Moel yr Accre is 0.6m lower at 411.3m

The bwlch separating Moel y Waun from its next higher neighbour to the North is at grid reference \*SJ 17135 54196. Its height is **312.8m**.

The **re-ascent** from the **col to the summit is 99.1m** and therefore Moel y Waun **is not a candidate for promotion to HuMP status**.

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

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## Appendix

**Leica 530 set up near the position of the bwlch**



**Leica 530 set up at the summit of Moel y Waun**



**Leica GS15 set up at the summit Moel y Waun**



**Detail showing tape measurement from ground level (61.9cm)**



**Leica GS15 set up at the summit Moel yr Accre**

