Survey of Tomaneena

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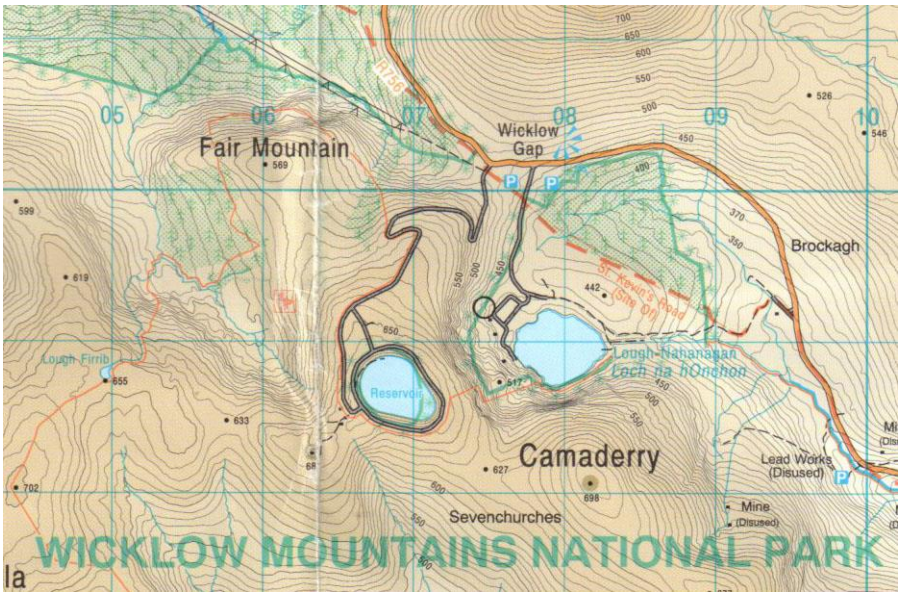
1) Introduction

Tomaneena otherwise known as Turlough Hill or Tuaim an Aonaigh (Hill Number 20117, Section 55A, OSi 1:50000 Map 56, Grid Ref. T062982) is listed as a Vandeleur-Lynam (a hill of height 600m or greater with 15m or more of drop) in the Database of British and Irish Hills (DoBIH). The topography of the area is complicated by the fact that there are two summits one of which is crowned with a large reservoir.



This forms part of a pumped water storage scheme that provides power to the National Grid of Ireland during periods of high demand. The second summit just to the South of the first appears to be natural, but closer inspection reveals that some, at least, of the large boulders present have been dumped there from a nearby now-disused quarry. It is this summit that is currently listed by Mountainviews and DoBIH.

The purpose of this survey was to identify the highest natural ground on both summits, accurately determine their heights and measure the drop between them. If the drop were to exceed 15m then both would be classed as Vandeleur-Lynams and if the drop is found to be less than 15m then only the higher of the two summits would retain this status.

2) Equipment used and Conditions for Survey

A Leica NA730 Professional Automatic level (X30 telescopic system)/tripod system and a "1m" **E**-staff extendable to 5m were used to determine the positions of the col and summit and to measure drop.

Absolute heights were measured using a Leica Viva GS15, a Trimble GeoXH 6000 and a Trimble 2008 GNSS (Global Navigation Satellite System) receivers. These receivers are dual-frequency, multi-channel instruments, which means they are capable of locking on to a maximum of 12 GPS and 8 GLONASS satellites as availability dictates, and receiving 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 stand-alone instruments they are 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 GS15, GeoXH 6000 and 2008 receivers, there are still sources that create residual errors. To obtain accurate positions and heights, corrections were made to the GNSS data via imported RINEX data from Ordnance Survey Ireland which were post-processed using Leica GeoOffice 8.3 and Trimble GPS Pathfinder Office respectively. Repeated measurements with a GeoXH 6000 instrument made on the same point gives a height precision of +/-0.2-0.3m; height precision for the GS15 using the same method is +/-0.05m.

Conditions for the survey, which took place between 11.00hr and 17.00hr BST, were favourable. The weather was overcast and the cloud base was generally at or above 700m thus enabling a line survey to be carried out. The wind was light.

3) The Survey

3.1) Character of Hill

Tomaneena lies within the Wicklow Mountains National Park just South of the R756 which links the villages of Laragh to the East and Hollywood to the West. Lugnaquillia, which at 925m is the highest mountain in the group lies about 8km to the South-West. The presence of a large pumped water-storage scheme with a large reservoir in the summit area and one at the foot of the mountain will give the reader the impression of an industrial landscape. This is not so. The area is wild and rugged save for a car park at Wicklow Gap which is the summit of the road, and a small service road that leads to the upper reservoir. Tonelagee just to the North of the road is the highest point locally and a thin track from the car park leads through thick heather to its top. Our route to Tomaneena began at the car park and followed the service road. The huge size of the reservoir only becomes apparent when the road deposits the walker at its base. It is approximately 1km in circumference and the man-made embankment containing it is roughly 10m – 15m high. There are vertical lines of concrete structures at frequent intervals (access for inspection?) along and within the embankment and a building on at least one section of its summit. We concluded that the whole structure had a concrete core with a cosmetic earthen covering on its outer side. At its base is a service road and all of this is surrounded by a high security fence.

The second natural summit lies about half a kilometre to the South-East. On its northern slope is the remains of a quarry and its summit comprises tussock grass and heather with, in places, scattered boulders. A path leads from the col between the two tops to the summit area. As mentioned in the introduction some of the boulders were probably dumped there from the quarry; in a pond we found one among several there with a chiselled mark on it. The summit itself is not obvious as a couple of boulders (these probably natural), outcrops and a small cairn adorn the area and vie for being the highest point.

3.2) Summary of Survey Method

Upon arrival at the terminus of the service road, we first of all carried out a reconnoitre of the perimeter of the reservoir in order to identify the highest natural ground. Two candidates were found and these were about 700m apart, one being near the terminus of the road. There was no line of sight between them and it was decided that collecting GNSS data on both would be quicker than carrying out a line survey in order to determine which was the higher. To measure the drop from the ground near the road terminus to the col between it and the SW top would be straightforward since the two points were only about 300m apart and it was clear that the drop was little or no more than 15m. To measure the drop from the SW top to the col involved a longer distance and so it was decided that collecting GNSS data on the second summit and the col was the best option. This approach would also give us an absolute height for the col. So the final plan was that both the Leica Viva GS15 and the Trimble receivers would be used to collect data at the col and the three potential summit positions with the line survey providing confirmatory data.

3.3) The Reservoir Summits

The survey started at the summit furthest from the terminus of the road (position 1), where the Leica NA730 level and staff were used to find the highest point there. We could not be sure this was natural ground and in fact it may have been formed in part by spoil from the construction of the service road just over the fence. However, if this were the case it was impossible to determine the demarcation between spoil and natural ground. The highest point was a rock.

Next the tripod was set-up over this position and the Leica Viva GS15 was then fixed to it with a clamp and tribrach (the "short tripod" configuration). The height of the receiver above the ground was then measured with the integral tape. The vertical offset from measuring point to the ground was 0.503m (see photograph in Appendix) plus 0.255m for the tribrach/hook system. GNSS data were collected for 30mins with an epoch time of 15 seconds.

Later in the day the Trimble 2008 was placed on this rock and data were then collected for 5 minutes once the receiver accuracy measurement had reached 0.1m.

The data for the Leica Viva GS15 were processed in Leica GeoOffice 8.3 using the seven nearest base stations and the data from the Trimble receivers were processed in Trimble GPS Pathfinder Office using the five nearest base stations. The results are given in the table below:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	307086.703	0.002	198783.281	0.002	681.24	0.005
Trimble 2008	Not given	Not given	Not given	Not given	681.17	Not given

The height of position 1 is 681.2m.

Next, the survey moved to the high point near the road terminus (position 2). Once again the level and staff were used to find the highest point on the rounded summit. There was no feature marking this summit.

Next the tripod was set-up over this position and the Leica Viva GS15 was then fixed to it with a clamp and tribrach (the "short tripod" configuration). The height of the receiver above the ground was then measured with the integral tape. The vertical offset from measuring point to the ground was 0.530m (see photograph in Appendix) plus 0.255m for the tribrach/hook system. GNSS data were collected for 60min with an epoch time of 15 seconds.

Later in the day the Trimble 2008 was placed on this rock and data were then collected for 5 minutes once the receiver accuracy measurement had reached 0.1m.

The data for the Leica Viva GS15 were processed in Leica GeoOffice 8.3 using the seven nearest base stations and the data from the Trimble receivers were processed in Trimble GPS Pathfinder Office using the five nearest base stations. The results are given in the table below:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	306667.272	0.002	198531.477	0.002	676.36	0.006
Trimble 2008	Not given	Not given	Not given	Not given	676.26	Not given

The height of position 2 is 676.3m.

Thus position 1 is 681.2 – 676.3 = 4.9m higher than position 2.

3.4) The SW Top

The area of the SW Top is quite complex. To the naked eye, there are several boulders and outcrops that are candidates for summit position. In addition there is an area of ground crowned with a small cairn that is also a candidate and clearly others have thought so too. Consequently, the Leica NA730 level was set up on ground near to the cairn so that it was approximately level with the ground by it. A 360 degree sweep was then carried out to look for other candidate positions. Only one was found and this was a large boulder about 75m to the South. Next a staff reading was taken at the cairn and also on the top of the boulder.

Staff reading on ground by cairn = 0.142m

Staff reading on top of boulder = 0.075m

The boulder is 0.142 – 0.075 = 0.067m higher than ground by the cairn.

The Leica Viva GS15 could not be set up on the boulder and so a convenient position close by was chosen and the height difference between the top of the boulder and the set-up position was measured.

Staff reading on top of boulder = 0.075m

Staff reading at set-up position = 1.174m

Set-up position is 1.174 – 0.075 = 1.099m lower than top of boulder.

Next the Leica Viva GS15 was fixed to the tripod with a clamp and tribrach (the "short tripod" configuration). The height of the receiver above the ground was then measured with the integral tape. The vertical offset from measuring point to the ground was 0.622m (see

photograph in Appendix) plus 0.255m for the tribrach/hook system. GNSS data were collected for 30min with an epoch time of 15 seconds.

The data for the Leica Viva GS15 were processed in Leica GeoOffice 8.3 using the nine nearest base stations. The Trimbles were not used to determine the height at this position. The result is given in the table below:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	306263.889	0.002	198268.237	0.003	681.295	0.008

The height of Tomaneena (SW Top) = 681.295 + 1.099 = 682.394m = 682.4m

The height of ground by the cairn is 682.394 – 0.067 = 682.327m = 682.3m

The height of ground by the cairn was also determined using the Trimble GeoXH 2008 and this gave a value of 682.15m = 682.2m.

4) <u>The col</u>

While the col was quite well defined a line of peat hags made its exact location less easy to locate. In the hill to hill direction there were several possibilities defining the exact line of the col. Each one of these was marked out with a line of flags about 2m apart and staff readings taken at each flag position. The lowest overall set of staff readings (highest points) therefore represents the line of the col. Further interpolated staff readings on this line were taken so that the exact col position could be correctly identified.

Next the tripod was set-up over this the flag and the Leica Viva GS15 was then fixed to it with a clamp and tribrach (the "short tripod" configuration). The height of the receiver above the ground was then measured with the integral tape. The vertical offset from measuring point to the ground was 0.582m (see photograph in Appendix) plus 0.255m for the tribrach/hook system. GNSS data were collected for 30mins with an epoch time of 15 seconds.

Later in the day the Trimble 2008 was placed on this position and data were then collected for 5 minutes once the receiver accuracy measurement had reached 0.1m.

The data for the Leica Viva GS15 were processed in Leica GeoOffice 8.3 using the seven nearest base stations and the data from the Trimble receiver were processed in Trimble GPS Pathfinder Office using the five nearest base stations. The results are given in the table below:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	306536.013	0.003	198430.981	0.002	667.97	0.007
Trimble 2008	Not given	Not given	Not given	Not given	667.94	Not given

The height of the col is 668.0m.

The drop from Reservoir Summit (position 1) to the col = 681.24 – 667.97 = 13.27m (Leica GS 15)

or = 681.17 – 667.94 = 13.23m (Trimble 2008)

5) Line Survey

While the Leica Viva GS15 was collecting data at the Reservoir Summit (position 2), a line survey was conducted from the col to this summit and then back to the col. The Leica NA730 level was set up on the tripod at a convenient position near to the col and staff readings were taken with the staff set up on the col position. Once this set of readings had been taken (Backsights BS) the staff was then moved to an uphill position, but the level not moved apart from a rotation through 180 degrees, to take another set of readings (Foresights FS). The line survey route then continued towards the summit. This process of alternately moving the staff and level was repeated until the final reading was taken with the staff on the summit position. Readings were taken from the horizontal and also the lower and upper stadia lines of the level to provide a check on any staff misreadings and to improve accuracy. If in any set of three readings the average was greater than 1mm different from the horizontal reading, then that set was re-measured. Once completed the line survey was then repeated, this time going from the summit to the col and using exactly the same method as just described. The line survey readings are given in Appendix 2.

The drop between the Reservoir Summit (position 2) and the col measured by the line survey is 8.40m with a closing error of 0.002m.

Therefore the drop between the Reservoir Summit (position 1) and the col from a combination of line survey and GNSS data = 681.24 – 676.31 +8.40 = 13.33m

6) Summary of Operating Conditions

	GS15	GeoXH 6000
Data Collection col (min)	30	5
Data collection at all summit (min)	30 or 60	5
Number of Base Stations used in Processing for all points	7	5
Epoch Time (sec)	15	1
Tropospheric Model	Computed	Unknown
Cut off Angle (degs)	15	5

7) Discussion of Results

For the GNSS results from the Leica Viva GS15, a 30 minute data collection time gives results with a measurement uncertainty of +/-0.07m. This measurement uncertainty applies to both the col and summit measurements. In addition the measurement uncertainty in height

associated with the location of the col is +/-0.05m as determined by the staff measurements. The summit positions were also all found to within +/-0.05m of height.

Therefore the overall measurement uncertainty associated with measurement of both col and summits is 0.09m [Square root ($0.07^2 + 0.05^2$)]

Similarly, the overall measurement uncertainty for the GNSS determination of drop from the Leica Viva GS15 measurements is +/-0.12m [square root ($0.07^2 + 0.07^2 + 0.05^2 + 0.05^2$)].

The drop determination using the line survey data (reservoir summit position 1) will also be to +/-0.1m since these include GNSS data.

The average value of the drop, as determined by GNSS data only and by a combination of GNSS and line survey data, is 13.3+/-0.1m. Since this is less than 15m and since the SW top is the highest natural point, this summit retains its status as the Vandeleur-Lynam.

8) Summary and Conclusions

The **summit** of **Tomaneena** is at grid reference * **T 06265 98273** and is a boulder c 50m S of a small cairn. Its height is **682.4+/-0.1m**.

The two highest positions on the reservoir summit are 681.2+/-0.1m at T 07088 98788 and 676.3+/-0.1m at T 06669 98536.

The **col** of **Tomaneena** is at * T 06538 98435 and is unfeatured ground in an area of peat hags. Its height is **668.0m+/-0.08m.**

The **drop** from the reservoir summit position 1 and the col is **13.3+/-0.1m** and consequently the reservoir summit has insufficient drop to be considered as a **Vandeleur-Lynam**.

Tomaneena (natural summit) remains the **Vandeleur-Lynam.**

- NB: Grid references adjusted for Garmin receivers are quoted in the summary.

24 November 2015

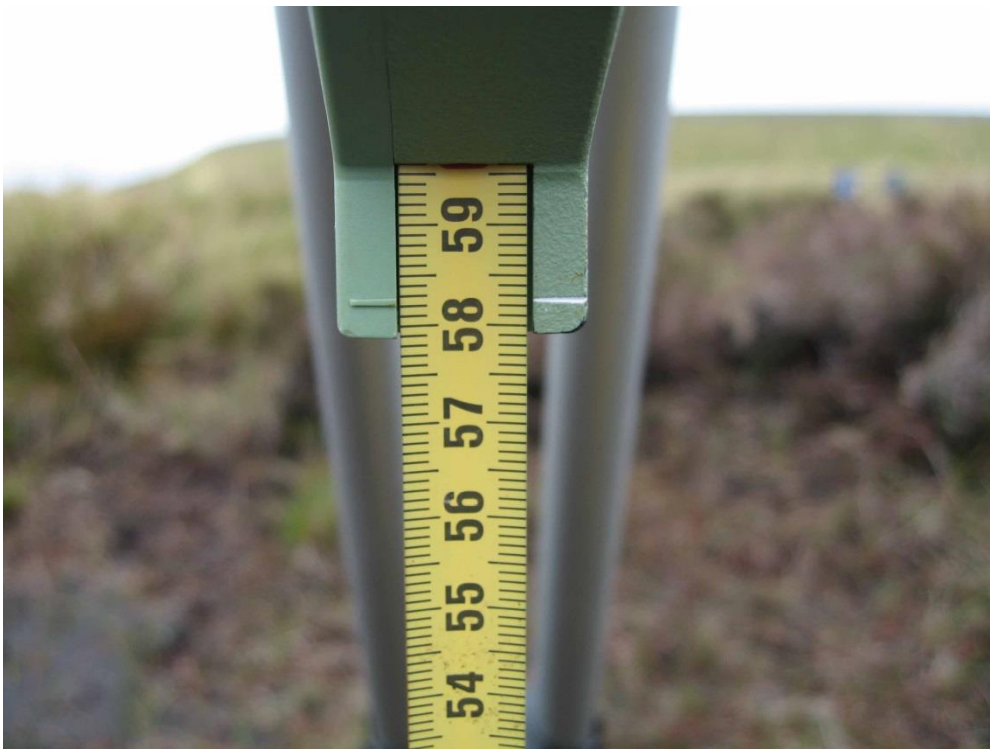
Appendix

Figure 1: Offset reading for Leica Viva GS15 set up at reservoir summit position 1

Figure 1: Offset reading for Leica Viva GS15 set up at reservoir summit position 2

Figure 3: Offset reading for Leica Viva GS15 set up by summit of SW Top

Figure 4: Offset reading for Leica Viva GS15 set up at col of SW Top



Appendix 2

Title:- Tomaneena - Ireland

Instrument:- Leica NA730 **Date:-** 06-Sep-15

	Horizontal Line			Lower Stadia Line			Upper Stadia Line							
Point Number	**Backsight R**	**Foresight F**	**Height H**	**Backsight R**	**Foresight F**	**Height H**	**Backsight R**	**Foresight F**	**Height H**	**Mean BS**	**Mean FS**	**Height Difference**	**BS Distance**	**FS Distance**
	metres	**metres**	**metres**	**metres**	**metres**	**metres**	**metres**	**metres**	**metres**	**metres**	**metres**	**metres**	**metres**	**metres**
Col to Summit : JB Level and Data recording, CC Staff.														
1	3.380	0.537		2.902	0.414		3.860	0.661		**3.381**	**0.537**		95.800	24.700
2	4.187	0.762		4.054	0.660		4.321	0.865		**4.187**	**0.762**		26.700	20.500
3	3.184	1.054		3.074	0.992		3.294	1.116		**3.184**	**1.054**		22.000	12.400
									Sum =	**10.752**	**2.354**	**8.398**	**144.500**	**57.600**
Summit to Col : JB Level, CC Data recording, GVJ Staff.														
1	1.054	2.956		0.992	2.855		1.116	3.056		**1.054**	**2.956**		12.400	20.100
2	0.285	3.982		0.216	3.820		0.353	4.144		**0.285**	**3.982**		13.700	32.400
3	1.145	3.503		1.039	3.262		1.251	3.745		**1.145**	**3.503**		21.200	48.300
4	1.715	2.155		1.568	1.993		1.862	2.312		**1.715**	**2.153**		29.400	31.900
									Sum =	**4.199**	**12.594**	**-8.396**	**76.700**	**132.700**