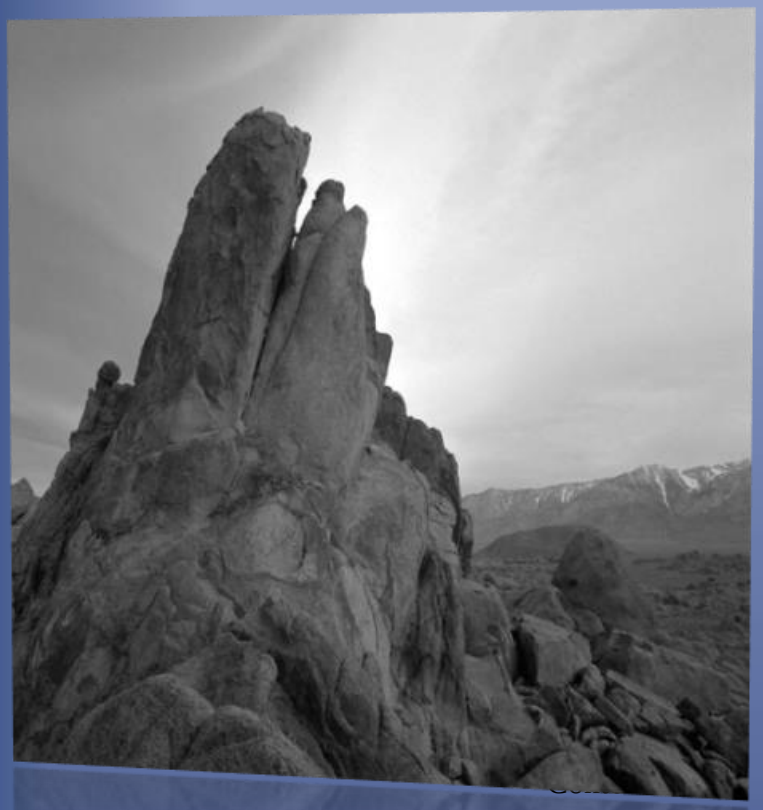

Defining the Summits and Cols of Hills

Version 7

Contents

Revisions

Version 7: 16 April 2022

General overhaul with expansion of some sections and additional examples

Hedgerows and golf courses covered in Summits section 3

Barry Island covered in Cols section 6

Appendix 2 expanded to encompass other complex situations arising from human activity

Version 6: 14 February 2018

New section in Human Activity clarifying treatment of changes brought about by quarrying, with detailed example in Appendix 2

Minor addition to Cols sections 4 and 5 to clarify treatment of embankments and dams

Version 5: 14 February 2017

Section 2 Defining Summits: added examples of artificial hills in both categories

Section 4 Defining Cols: expanded and new example given of an embankment running over a col in the hill to hill direction

Section 5 Defining Cols: revision with updated example

A few grid references and map numbers revised

Version 4: 6 October 2015

Introduction revised and expanded

Version 3: 16 August 2015

Revision of section on artificial hills

Expansion of section on tumuli

Added situation where a cutting promotes a different col to the critical col

New section on cols of islands

Human Activity expanded to cover urban areas

Version 2: 1 March 2013

New summit categories for artificial hills, embankments and dry stone walls

Clarification that principles apply equally to county tops on ridges or slopes

Contributors

The following received a draft of this document and many responded with useful comments that contributed towards its evolution. We thank everyone for their input.

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Summary

This is a brief summary of the protocol presented in this document.

Summit

The Summit of a hill is a single point that is the highest natural ground above sea level (Ordnance Datum Newlyn in mainland Britain or Malin Head for all Ireland) on that hill. Where the highest point is a tree or fallen tree trunk, or built of metal, wood, concrete or other man made material, including stone buildings, covered reservoirs, cairns and walls, the Summit shall be deemed to be the highest other point. Man-made structures of earth or unworked stone, including tumuli or permanent earthen mounds of any era or hill fort structures, are eligible if and only if they cover the natural Summit.

Where the highest point is a rock or boulder that cannot be moved by a typical single adult person without tools, the topmost point of that rock or boulder is deemed the Summit. Where such a rock or boulder can be moved, the Summit is deemed to be the next highest point meeting the criteria above.

The highest point of a Summit covered with heather or other living vegetation is deemed to be the ground immediately below the vegetation. Note that peat is deemed to be part of the hill.

The current summit replaces any summit that previously existed and has been removed, e.g. by quarrying.

Man-made hills, usually formed from waste materials such as slag, are occasionally candidates for a Summit. We accord the artificial hill equivalent status to a natural hill only if construction, stabilisation and landscaping are complete, or if natural stabilisation has occurred and colonisation by herbage, shrubs or trees has taken place. When these criteria are not met we disregard the artificial hill and take the natural Summit, or highest natural ground where the artificial hill covers a Summit.

Some low lying summits, County Tops and Cols lie in urban areas with no identifiable natural ground. While it may be impossible to avoid surveying man-made ground, features such as buildings, walls, flowerbeds and masts should be excluded.

Col

A Col is a pass or saddle situated between two hills. If progressing from one hill to a higher hill, always maintaining the highest possible line between the two hills, the Col is the lowest point through which one is obliged to pass, and the route is called the Critical Hill Traverse (CHT). Similarly, if progressing from one valley to another, always maintaining the lowest possible line between them, the Col is the highest point through which one is obliged to pass, and the route is called the Critical Valley Traverse (CVT). The exact point at which the CHT crosses the CVT is the Col.

As with summits, man-made structures are sometimes encountered in the area of a Col. Where the Col has been in-filled permanently with material or has been deepened by the digging of a cutting, the current base of the Col (be this artificial) shall be the depth (or height) of the Col. Where a Col is traversed by a bridge, the low point of the Col under the bridge is regarded as the Col. Where a man-made cutting near the natural Col creates a lower artificial Col, the artificial col is ignored, provided the original Col is identifiable.

Key concepts used in the document

Critical Hill Traverse

The route or line maintaining the highest possible line between two summits is the Critical Hill Traverse (CHT). This line is unaffected by obstacles and is therefore the theoretical highest possible line irrespective of practical considerations.

Critical Valley Traverse

The route or line maintaining the lowest possible line between two valleys is the Critical Valley Traverse (CVT). This line is unaffected by obstacles and is therefore the theoretical lowest possible line irrespective of practical considerations.

Key Col

Each summit has only one Key Col (sometimes referred to as Critical Col, Relative Col, Prominence Col or more often simply Col) which lies in line between this summit and another higher summit. This second summit is the one that delivers the highest possible route to the subject summit. The Key Col is the lowest point on the CHT between these summits.

Each col can only be the Key Col for one summit. A Key Col can be a long way from a summit. For example, the Key Col for Snowdon (Yr Wyddfa) is in Scotland. To create a picture, if sea level were to rise gradually until the summit just becomes the highest point on a new island, then the Col flooded to create this is the Key Col for that summit.

Relative Height (Drop or Prominence)

This is the difference between the height of the Summit and the height of the Key Col.

Generally, Relative Height is equal to or less than the height of the Summit above sea level. The height of a Col lying beneath the sea is taken as sea level, i.e. 0m. Should a Col exist in low-lying land below sea level, the col height would be negative. In Britain such land is largely restricted to an area SW of The Wash in Lincolnshire.

Defining the summits and cols of hills

Introduction

This document was motivated by the adoption of surveying techniques using tools such as differential GPS and line surveying with automatic level and staff, permitting measurement of absolute height and drop to within a few centimetres. However this increase in accuracy brings with it a new challenge, namely the definition of a summit and a col. Situations arise where the limitation of a measurement depends on definition rather than the equipment used. For example, on 2047 Penycloddiau (SJ127678, LR116) Denbigh council has built a 'tumulus' on top of the hill that completely obliterates the natural summit. This is a permanent feature, so where should someone wishing to measure the height of Penycloddiau place the GPS? Or consider the col of 2872 Milk Hill (SU235632, LR173) which has a railway cutting running through it. Should the surveyor measure to the railway line or some other point?

Such issues have multiplied with the proliferation of publicly available LIDAR data, particularly in low lying areas where alterations by man are commonplace. These datasets provide digital elevation models with a generally high level of accuracy.

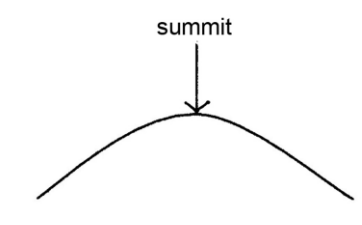
Even when maps provide the only resource, issues can be raised by features such as a spot height on a covered reservoir or a road embankment. While list compilers have tackled such problems in the past, it was done on an ad hoc basis, as and when the need arose. The protocol set out herein underwent an extensive period of consultation with the hillwalking community and has been adopted by the *Database of British and Irish Hills* and by *MountainViews* in Ireland. It enables the positions of summits and cols to be defined for any situation arising in Britain and Ireland, giving surveyors, cartographers and hill-list compilers a clear set of guidelines to follow.

Note: *The number preceding a hill's name is its assignment in the Database of British and Irish Hills.*

Defining Summits

1. Is the natural summit identifiable?

Our first rule is that if the natural summit can be positively identified, irrespective of whether other higher man-made features are present in the vicinity, then this is the point from which absolute height or drop is measured. This will be the case for the majority of hills.



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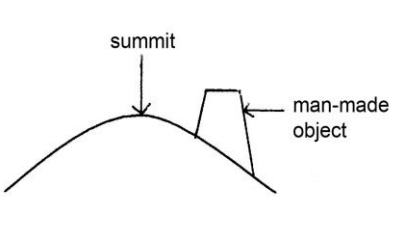


(ii)

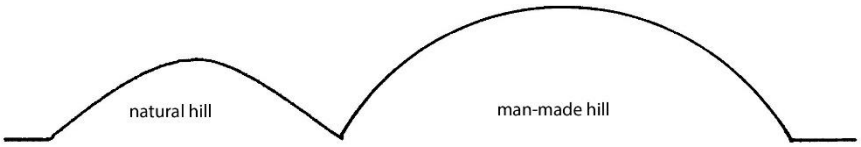
Example: 1239 Sgurr Alasdair (NG450207, LR32)

This rule applies equally to both modern and ancient man-made objects.

2. Is the natural summit covered by or lower than an artificial hill?

These may be put into two categories. In the first the artificial hill is separate from the natural hill and in the second it covers the summit of the natural hill and significantly alters the natural hill's topography.

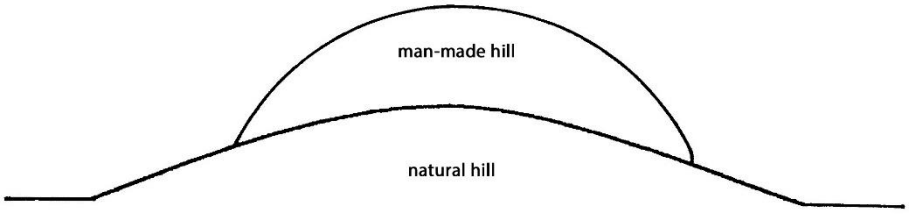
Artificial hill is separate from natural hill



Occasionally a man-made feature (e.g. old spoil heap or bing) is encountered that stands alone in the landscape, or is of similar bulk to and higher than an adjacent hill, is distinct from it and does not obscure the natural summit. We accord the artificial hill equivalent status to a natural hill only if construction, stabilisation and landscaping are complete, or if natural stabilisation has occurred and colonisation by herbage, shrubs or trees has taken place. When these criteria are not met we disregard the artificial hill and take the natural summit. The decision may on occasion be subjective, but the alternative of using the artificial hill for measurement in all cases could lead to the height and drop varying with time as tipping proceeds or the spoil stabilises.

Examples: 19290 Hensbarrow Downs (SX001574, LR200 – see General Comments), 18965 Philipstoun Bing South (NT055767, LR65), 16152 Clints Crags (NY161355, LR89), 16083 Northumberlandia (NZ237771, LR88).

Artificial hill covers natural hill

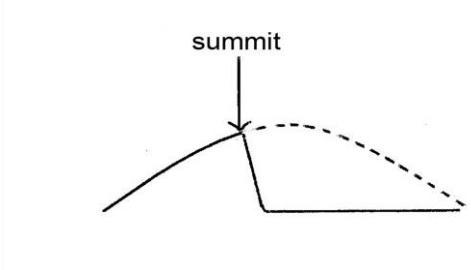


We apply the same principle, but it is the height and drop of the original hill that have changed. While tipping, settlement or landscaping is in progress, the highest natural ground is taken for measurement of height and drop. Note that the data may change if the natural ground is itself later covered by spoil.

Examples: 19254 Penhale Hill (SW917572, LR200), 19100 Canvey Island (TQ819838, LR178). 5273 Mynydd y Grug (ST175907, LR171) does not qualify at present but probably will in the future – see General Comments.

3. Has the natural summit been removed?

This may have happened through quarrying, or through other activities such as levelling of the ground for various purposes. It is impossible to survey the original summit and therefore the highest remaining ground should be surveyed, even though the new summit may have been created through human disturbance.



Examples: 5016 Cairngryffe Hill (NS941411, LR71,72), 14634 Cefn Mawr (SJ200630, LR117), 14120 Duntilland Hill (NS839638, LR65).

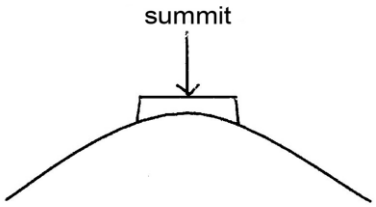
See **Human activity: quarrying** at the end of this document for situations where quarrying profoundly alters the topography.

4. Is the natural summit covered by a man-made feature comprising earth or earth and unworked stone?

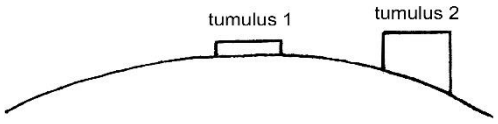
This category covers several types of feature found in the summit area of many of our lower hills and we shall consider some of these in turn.

Tumulus

These usually ancient features comprise stones that have been covered by earth and sometimes they have a central hollow. If the tumulus covers the natural summit, or if the natural summit is not readily identifiable, the highest point of the tumulus becomes the recognised summit.



Examples: 3466 Domen-ddu (SO016782, LR136,147), 2182 Pegwn Mawr (SO023812, LR136), 2181 Bache Hill (SO213636, LR137, 148), 2901 Swyre Head (SY934784, LR195)



Where the natural summit is covered by a tumulus (tumulus 1), but a higher tumulus (tumulus 2) occupies lower ground, the top of tumulus 1 is taken to be the summit of the hill in accordance with rule 1.

Example: 17924 North Molton Ridge (SS778325, LR180)

Embankment

These features are usually constructed of earth, but some may contain unworked stone. If the embankment covers the natural summit, the highest point of the embankment becomes the recognised summit.

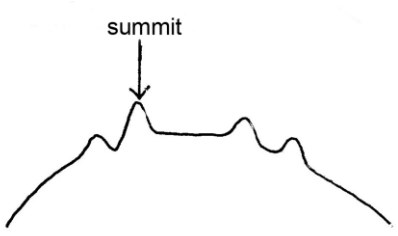
Examples: 5466 Viking Way (SK889236, LR130), 19639 Wat's Dyke (SJ311442, LR117)

Hedgerows are frequently planted on raised banking which is usually a metre or less in height. Where the hedgerow crosses a summit area the banking should be ignored for determination of summit position, even if higher than the surrounding ground, unless it can be proven that the summit lies under the hedgeline.

Example: 17404 Idlicote Hill (SP288433, LR151)

Hill fort

Hill forts are built round the summits of hills and enclose a relatively flat, levelled area upon which dwellings were originally built. The natural summit has usually been removed and the earthen ramparts often form the highest point. In this situation the highest point of the fortification, assuming it to be earthen and not worked stone, is regarded as the summit. If the natural summit can be shown to exist then Rule 1 applies irrespective of whether the ramparts of the hill fort are higher.



Examples: 2846 Burrow (SO381830, LR137), 2858 Wapley Hill (SO347624, LR137,148,149), 14649 Gavel Hill (SJ172248, LR125), 2200 Long Mountain – Beacon Ring (SJ264058, LR126), 18602 Toot Hill (SU381185, LR185)

Modern forts that incorporate concrete or worked stone are treated as buildings and discounted.

Example: Pilgrim Fort (TQ344533, LR187)

Petrified fort

The wall of the fort comprises rocks fused by heat to form a coherent structure encompassing the summit of the hill. The land enclosed by the fortification has usually been levelled and probably contained buildings when the settlement was in use. Usually the natural summit has been obliterated and therefore the highest point of the wall is taken as the summit. Once again, should the natural summit be identifiable Rule 1 applies and should be used.

Examples: 1501 Tap O'Noth (NJ484293, LR37), 19714 Finavon Fort (NO507557, LR54)

Small summit mounds

Many summit cairns and trig pillars are built on small mounds of earth or rock. In most cases it is impossible to ascertain whether the mounds are natural or were constructed prior to the cairn or pillar being built. The top of the mound (or base of the cairn/trig pillar) is defined as the summit.

Example: 1550 Cuilags (HY209033, LR7)

Huge ancient cairns

A few hills have these features. The cairn might be ten metres wide and several metres high. The dilemma is that the cairn comprises loose, mobile stones and therefore the height measurement cannot usefully be made from the top of the cairn. In such cases the positional measurement is made from the top of the cairn or, if the cairn is not symmetrical in profile, the approximate centre of the cairn when viewed from above, and the height measurement is made from the highest ground on the periphery of the cairn (see also General Comments).

Examples: 1678 Tinto (NS953343, LR72), 2747 Grey Nag (NY664476, LR86), 1951 Yr Eifl (SH364447, LR123)

Dry stone walls

A few hills have dry-stone walls passing over their summits. The ground at the base of the structure should be taken as the summit, but refer also to the discussion of cairns in General Comments.

Examples: 177 Drummond Hill (NN749454, LR51,52), 2797 Calf Top (SD664856,7 LR98)

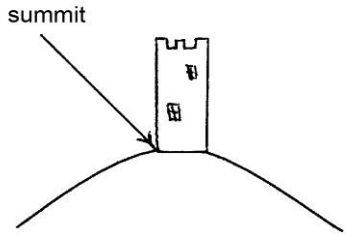
Golf courses

These are often extensively landscaped and the natural summit is frequently not identifiable. In such cases the highest ground should be taken, provided no artificial materials are present in its construction. This is consistent with rule 3 above.

Examples: 2922 Cliffe Hill (TQ434107, LR198), 5106 Airngath Hill (NT004791, LR65), 11737 Torphins Hill (NJ619024, LR37), 17961 Long Hill (ST620467, LR183)

5. Is the summit occupied by a metal mast, wind turbine, stone tower, building, wall of stone and mortar, or covered reservoir?

These features are usually constructed from or contain man-made materials and are often relatively recent in origin. The highest ground adjacent to the structure should be

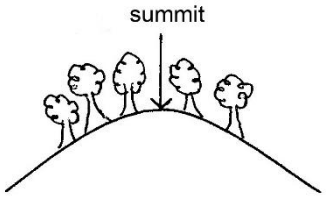


measured for position and height. It is acknowledged that the ground may have been levelled or worked in preparation for the construction of the structure. If the building does not occupy the summit then Rule 1 applies and the natural summit should be taken.

Examples: 2041 Moel Famau (SJ161626, LR116) stone tower, 14856 South Stack (SH202822, LR114) lighthouse, 5339 Pale Heights (SJ543696, LR117) covered reservoir (see General Comments).

6. Is the summit covered by trees?

Few people would disagree with the statement that trees don't count! Consequently the highest natural ground should be identified for measurement.



Examples: 3494 Banc Dolwen (SN792787, LR135,147), 177 Drummond Hill (NN749454, LR51,52), 16 Knock of Crieff (NN873233, LR52,58), 5559 Croes y Forwyn (SJ029210, LR125), 2200 Long Mountain – Beacon Ring (SJ264058, LR126)

General Comments

The following comments apply to most of the above categories.

Firstly, our definition of natural ground does not mean ground that has remained completely untouched by man. Little or no ground in Britain and Ireland has escaped human disturbance at some time or other since the last ice age. It does mean ground where the general contour of the land has not been changed. Thus ploughing, to take one example, may change the appearance of the land, but it does not change the general contour, so ploughed land would count as natural in this context.

Secondly, many summits are marked by a cairn. The cairn should be checked as carefully as possible (we do not advocate its destruction) to ascertain whether it has been built over an embedded rock or boulder. If so, is this rock or boulder higher than any other feature that is a contender for the highest point? If it is, the boulder in the cairn marks the highest point and should be used for the height measurement. An example is 2537 Harter Fell (NY459093, LR90). If there are no hidden fixed rocks or boulders in the cairn, the base of the cairn is the

summit position as stated in Section 4. Occasionally, a summit bears a large well-built cairn which is impossible to probe. There is then no option but to measure from the base of the cairn and report this height with the caveat that there might just be higher ground within the cairn. An example is 2203 Drygarn Fawr (SN862584, LR147).

A similar situation may arise when dense vegetation covers a summit. Again the only option is to measure and report the highest identifiable point with the caveat that the vegetation may hide higher ground. An example is 2918 Brighstone Down (SZ432847, LR196).

Thirdly, many summits are made not of smooth ground, but of ground adorned with embedded rocks. The rocks should be tested to give confidence that they are truly embedded and part of the hill and not just lying loose on the surface. If the rock cannot be removed from its position by reasonable and unaided human effort, it is deemed to be part of the hill and the height measurement is taken from the top of the rock. There are many examples: 392 Geal-charn (NN596782, LR42) is but one. Occasionally, a summit may be crowned by a large boulder sitting on the surface of the ground (e.g. an erratic) which cannot be moved by unaided human effort. In such cases the measurement should be made to the summit of the boulder. An example is 2028 Pen y Castell (SH721688, LR115).

Fourthly, many summits are covered in heather or other thick ground cover. There is a gradation between living plant, plant detritus and the soil underneath. This may only be of the order of 5cm – 10cm, but the technique of differential GPS is capable of resolving these small differences. As far as possible plant matter should be removed before a measurement is taken. The one exception is peat. Our uplands are covered by a few metres of peat in many areas and, although strictly plant detritus, it is both impractical and in our view wrong not to include the peat layer in the measurement. Once again there are many examples, a well-known one being 2807 Kinder Scout (SK084875, LR110).

It should also be mentioned that, if there were ever a case of a British summit with permanent snow, the height would be measured from the underlying ground.

Lastly, many lower hills have covered reservoirs on their summits. These features have been the subject of controversy. We are advised that all are constructions of concrete, some of which are partly or completely covered by grass. Moreover, on a timescale of many decades they may be temporary, being demolished when no longer used. Consequently we have classed them with other structures built of man-made materials (Section 4) and therefore they do not count as part of the hill. The highest ground adjacent to the structure is measured for position and height. If, when demolished the area is landscaped and the earthen remnants of the reservoir remain as a mound, the top of the mound would be used for measurement of position and height. Of course, if the natural summit is identifiable then this should always be taken in precedence.

11737 Torphins Hill (NJ619024, LR37) is an example of a hill where a decommissioned reservoir lies over the summit. It has been converted into a golf tee, but as it has retained its brick retaining walls it is excluded from consideration. A grassy access ramp probably constructed from natural materials leads to the tee, but it does not cover the natural summit and therefore this feature too is discounted.

Note that summit and col heights for a few hills may change by several centimetres with time where they are, for example, on arable land e.g. the summit of 2872 Milk Hill (SU104643, LR173) or where there is an unstable peat layer e.g. 2807 Kinder Scout summit (SK084875, LR110) or the col of 53 Meall Cala (NN500137, LR57). In the case of Meall Cala's col, which contains a network of peat hags, the col height may vary with season as the peat swells and shrinks. In a very few critical cases this could require the summit or col to be re-

measured if there is reason to believe that change has occurred. It is a list author's prerogative to accept or reject a hill for their list. However we recommend that when the height or drop of a candidate hill frequently fluctuates in and out of qualification, such a hill should be deemed not to qualify for that list.

Section 2 may call for judgement as to whether an artificial hill is sufficiently settled and permanent to qualify as a summit, and possibly whether it is of sufficient bulk to be regarded as a hill rather than a smaller feature such as a tumulus. Hensbarrow Downs was given as an example of an artificial hill formed from a reclaimed spoil heap. While landscaping was in progress, the summit was deemed to be hill 2884 Hensbarrow Beacon which was the highest ground before the creation of spoil. In contrast, the spoil on the summit of Mynydd y Grug is still being drained and landscaped, so it does not replace its neighbour Mynydd Machen as the Marilyn although it may well do so in the future.

We would not condone the deliberate addition of material to a summit solely to change the status of the hill.

For many County Tops the highest point lies on a ridge or slope and not a summit. This document applies equally to this situation. The challenge here is not in locating a summit or a col, but being able to transfer the line of the boundary from the map to the ground or to a LIDAR digital elevation model. If it is assumed that a 1:10,000 map can be read accurately to 0.5mm, the accuracy with which the boundary can be mapped on the ground is to within 5m. The procedure we successfully adopted for 2817 Hail Storm Hill was to transfer the grid references of points along the boundary into a hand-held GPS and then, using the GPS, mark out these points on the ground with small flags. Note that a small systematic error is introduced when transferring map grid references to most hand-held GPS instruments and this needs to be taken into account, see http://www.hills-database.co.uk/database_notes.html#GR10.

The highest point was then determined with level and staff and the survey-grade GPS set up on this point. Since the accuracy of the hand-held GPS is about 5m for position and that of a 1:10,000 map also 5m, the overall error in this method of about ±7m for position is the best that is achievable. The height difference between the two points 7m up the ridge and 7m down the ridge then likely determines the uncertainty of the height measurement.

Appendix 4: Flow Chart for Summits summarises the process for determining the summit of a hill.

Defining Cols

LIDAR data, where available, greatly facilitates the identification of cols, particularly in low lying areas where ground has been altered by man. In the commonly encountered situation where a cutting or embankment may have modified the col, the elevation profile will more often than not indicate whether the natural col is extant or has been destroyed.

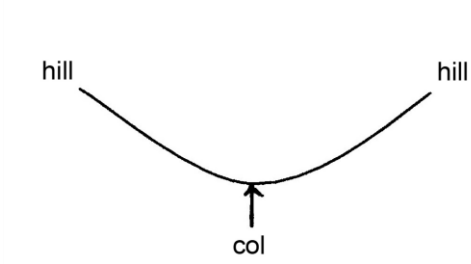
Cols present a greater challenge to surveyors than summits as they are usually of more complex shape than summits and therefore less easy to locate. We will describe the procedure employed by G&J Surveys. The first task is to find its approximate position (say to within 100m of distance), which is fairly easily accomplished with a level and staff. Next a grid of flags is laid out around this point with individual lines being parallel to the hill to hill direction and perpendicular to the valley to valley direction, as shown in Appendix 3: Surveying a col. The spacing chosen depends on how well defined the col is, but it is usually either 5m or 10m. With the level then set up at some convenient point (this may be either inside or outside the grid) the height of each point is measured relative to the level. For the valley to valley direction, the points rise in height to a maximum and then fall again as each line of flags is traversed. The flag with the maximum height in each line is identified and the line of resulting maxima represents the line of the col in the hill to hill direction. The flag with the lowest height in this line then represents the position of the col. If required, a second small grid may be constructed around this point in order to locate the col position more precisely.

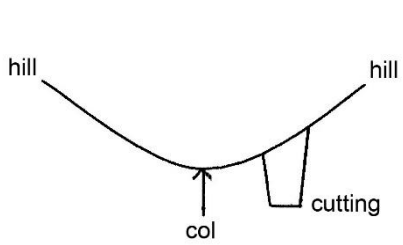
Often cols are of more complicated structure than the classic shape, for example there may be two cols of very similar height (3567 Bell Crags, NY296137 & NY296140, LR89,90) or the col may contain a network of peat hags (53 Meall Cala, NN500137, LR57). In these situations the location of the col may become very time-consuming. For a classic col it takes about two hours to carry out this procedure.

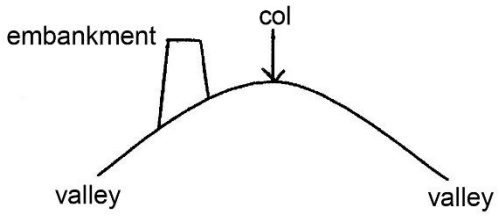
The protocol for defining cols is very similar to that for summits, although the issues arising may be slightly different.

1. **Is the natural col identifiable?**

   If the natural col is identifiable, its height and position are taken even if there is a lower man-made feature such as a road or railway cutting on the hill to hill traverse, or if an embankment or bridge offers a higher traverse. Note that this rule is comparable with the first rule for summits.



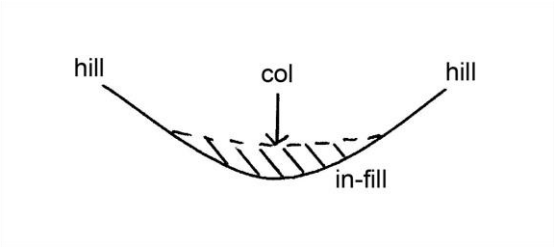




Examples: 1800 Windlestraw Law (col NT039368, LR72), higher col 0.7km E on embankment; 2298 Wentwood (col SO388126, LR 161), lower col at SO441085 in cutting

2. Has the col been covered by debris comprising earth and unworked stone?

In this situation the new surface should be used to locate the position of the col as it is impossible to determine the original position and height of the col.



Example: 3683 Carreg y Foel Gron col (SH745428, LR124)

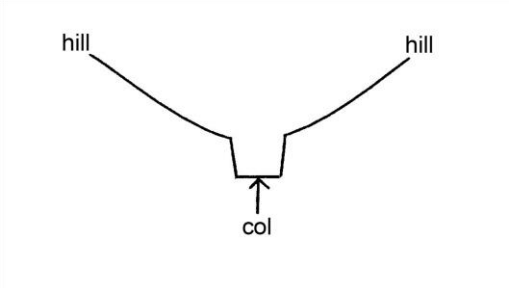
More generally, if the original col has been destroyed, the new col is taken, whether natural or created by human disturbance. This is comparable to destruction of a summit by quarrying.

3. Has the original col been removed by a cutting?

Cutting running in valley to valley direction

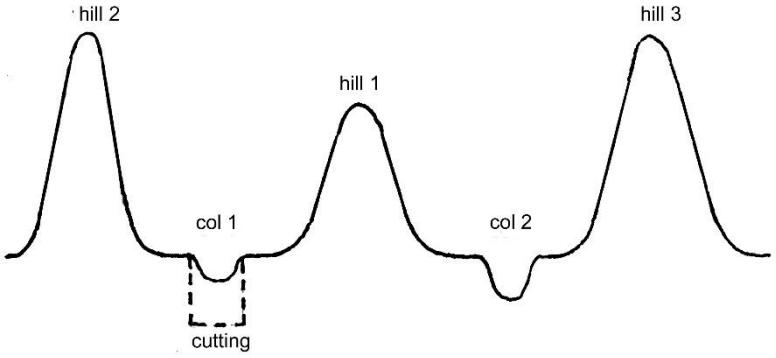
In this situation it is impossible to determine the position and height of the original col and therefore the col position within the cutting should be taken.

Example: 19728 Waterswallows Hill (col SK073770, LR119), railway cutting; 5271 Mynydd Bedwellte (col SO118101, LR 161), road cutting



There are two special cases:

(i) Cutting promotes a different col to the critical col

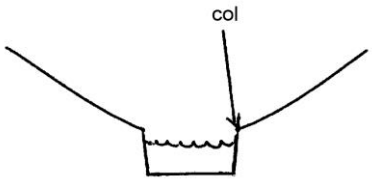


Prior to the construction of the cutting, hill 2 is the parent of hill 1 by virtue of col 1. Once the cutting has been dug, col 1 becomes deeper than col 2 and so col 2 becomes the critical col and hill 3 the new parent.

Example: Pike Law 16627 (SE045173, LR110, col SE040166)

(ii) Cutting is a canal

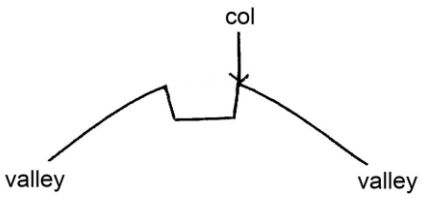
The bank of the canal at the critical hill–hill traverse is chosen as the col and not the water's surface or the bed of the canal. If the two banks are of different height, the lower one is chosen. The alternative of taking the surface of the water is unsatisfactory as water levels may change with season. Where one embankment merges with the water, an attempt will be made to ascertain the water height when the canal is just overflowing (via an overflow point). Only if the canal were permanently drained would the bed become the point of measurement, as the situation would then revert to a conventional cutting as discussed above. Other watercourses, e.g. drainage ditches, are treated similarly.



Examples: 2872 Milk Hill col (SU235632, LR174) railway cutting over canal tunnel; 2828 Raw Head col (SJ528439, LR117) canal; 11722 Carrier's Hill (col NJ626263, LR37) ditch

Cutting running in hill to hill direction

If the cutting runs in the hill to hill direction, the col cannot be at the base of the cutting because in the perpendicular valley to valley direction the position of the col is the highest point of the critical traverse. Consequently the col is located at the top of the embankment on this critical traverse (see survey of col).



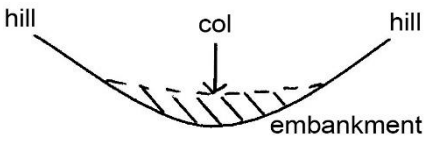
Example: none known

4. Is the natural col covered by an embankment of earth or rubble?

Embankment running in hill to hill direction

If the embankment covers the natural col and it is therefore impossible to determine the col's original height on site, the summit of the embankment should be used for the measurement of col height. This is similar to the case of in-fill discussed above. Roads are treated in the same way, but bridges are excluded.

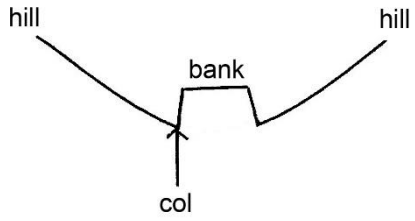
Note that this new height could result in another, lower col on the hill-hill traverse becoming the key col, a situation similar to that discussed in 3(i) for a cutting.



Examples: 3346 Craig Nyth-y-Gigfran (col SH683466, LR115); 2807 Kinder Scout (col SD894486, LR103), 2273 Allt yr Esgair (col SO142225, LR161)

Embankment running in valley to valley direction

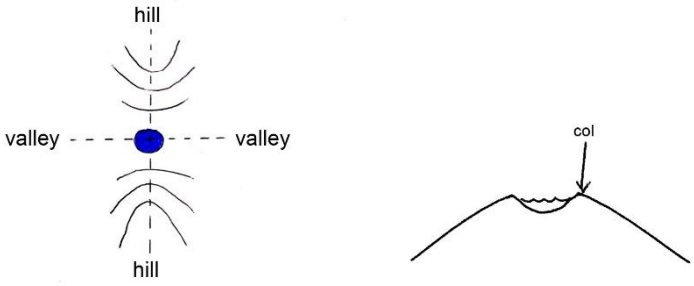
If the embankment runs in the valley to valley direction, the base of the embankment represents the low-point in the hill to hill direction (see survey of col) and therefore this point should be taken as the col.



Example: 16475 The Crews (col NY537588, LR86)

5. Small lakes (lochans, llynnau, tarns) and reservoirs

Although this document concentrates on the treatment of man-made features, pools of water are commonly found in cols and can cause confusion. Reference to the sketches below shows that it is the highest point of the valley–valley traverse that lies on the critical hill–hill traverse that is the col. It is not the water's surface.



Occasionally the pool is the source of two streams each issuing into a separate valley and one has to be crossed in the critical hill–hill traverse. The bed of the shallower of the two streams, where it leaves the pool, is chosen for the position for measurement.

Example: 5622 Pared y Cefn-hir (col SH658144 or SH663144, LR124)

Large reservoirs pose a unique problem as they are usually retained by large concrete dams which, being constructed from man-made materials, are not taken into consideration when determining the height of a col. Most reservoirs are in valleys and do not cover a col, so the natural col can be identified and used. Rarely, a reservoir is constructed over a col with dams retaining the water at both ends. The reservoir can be treated similarly to a canal traversing a col and the height measured on the bank at the water's surface. Water levels in reservoirs can rise and fall. We propose that the maximum water level be used, which can be ascertained from the tide line if the water level is low at the time of survey. It should be noted that the col occupies an area (that of the reservoir) and not a point and so cannot be represented by a unique six-figure grid reference. The grid reference of one or both dams might be used as a convention.

Should the reservoir ever be decommissioned and the original col re-exposed, the natural col would be taken.

Examples: 1659 Stronend (col NS676857 or NS717838, LR57), 730 Sgurr na Ciche (col NM931992. LR33,40), 518 Ben Macdui (col NN632842, LR42, water height raised 8m by hydro dams)

Where a dam has been built over the col itself and comprises a **core of man-made construction**, e.g. concrete, once again the high water mark of the reservoir should be taken for the height of the col; otherwise the top of the dam is taken, as for an earthen embankment covering and crossing a col in the hill to hill direction.

Example: Sheeps Tor West Top (col SX557679, LR202, not in DoBIH)

6. Islands

The col for the highest point of a coastal island is traditionally taken to be the sea. In Britain this is Ordnance Datum Newlyn (ODN) or a local datum if the island is in the Western Isles, Orkney or Shetland. In cases where the island is surrounded by water at high tide but a land bridge is present when the tide is at or above the Datum point, the col height is the low point of the land bridge in the island to mainland direction, as with any other col. If the land bridge appears below the Datum, the Datum is used as the col height, i.e. 0m. For ODN this is the average sea level measured between 1915 and 1921 by a tide-gauge set in the harbour wall at Newlyn in Cornwall.

The datum is Malin Head in the Republic of Ireland, and mean sea level Belfast in Northern Ireland. The Belfast datum is 0.037m below the Malin Head Datum.

Some islands are connected to the mainland or another higher island by a causeway. Causeways may take several forms, e.g. they may comprise concrete, stone blocks in-filled with impermeable or permeable matter along their whole length, or have a bridge at some point to allow for tidal flow. Whatever the construction, ODN or the appropriate local datum is used as the col height for the island. This approach is consistent with the case of a col covered by a reservoir contained by two dams, where the water's surface is taken for height measurement and not the dam.

Example: 12263 Glimps Holm (ND473990, LR7)

An island may find itself connected to the mainland by a substantial area of infill that is higher than the water level at high tide, so that it is no longer an island. In this situation the col is located on the infill. Note that constructions built on this infill, such as causeways comprising man-made materials, should not be considered.

Example: 15918 Barry Island (ST120668, LR171)

Islands are also found in freshwater lakes and rivers where the water's surface may be higher than ODN or the local datum. In such situations the high water line should be taken if this is identifiable, as for reservoirs.

Examples: 12758 Eilean Leathann (NF902618, LR22), island in freshwater loch; 8963 Eilean Aigas (NH466416, LR26), island in river

Appendix 5: Flow Chart for Cols summarises the process for determining the position of a col.

Situations applicable to both Summits and Cols

Human activity: built up areas

Some low lying summits, County Tops, London Borough Tops and cols lie in urban areas where man-made features cover the landscape and natural ground is not identifiable. Where the protocols described in the sections above cannot be followed, the only recourse open to the surveyor is to make measurements at an appropriate location using the best guidance available in this document. This might for example be on a paved area if this were covering the best approximation to the natural contour, but the tops of features such as buildings, walls, raised flower beds or masts should not be used.

Examples: 19019 Church Hill (SO987953, LR139), 5553 Green Walk (Bowdon) Trafford County top (SJ757869, LR109), 18946 Bailey Hill col (SJ233644, LR117)

Cols are generally lower lying than summits and more often suffer from human disturbance. A well-known example is the col of 2863 Abberley Hill (SO701746, LR138). A railway cutting passed through the col in a valley to valley direction which gave Abberley Hill sufficient drop to enter the list of Marilyns. The cutting was crossed by a road bridge at or very near the position of the col. The railway was then closed, several years later the cutting was filled and the road now crosses on an embankment. Abberley Hill is no longer a Marilyn and its history illustrates just how much human disturbance can occur at cols.

Human activity: quarrying

In some areas of the country, quarrying or mining activities have significantly altered the topography. Hilltop removal is covered in Section 3 of ‘Defining Summits’ and in most cases does not change the col of the relocated summit. We are aware of one situation, however, where quarrying has not only changed the height and location of a summit but rerouted the hill–hill traverse and created a new col. It is described in detail in Appendix 2 to illustrate the complexity of changes that can be brought about by quarrying or other engineering activity.

Example: 19370 Penmaen Mawr (SH702757, LR115)

Creation of artificial hills from spoil is covered in Section 2 of ‘Defining Summits’. An artificial hill can also be formed when quarrying has isolated a column of natural ground from its parent hillside. The column is lower than the natural summit of the hill but is separated from it by the floor of the quarry.

Example: 19270 Y Ceiliog Mawr (SH594598, LR115), 19726 Darlton Quarry (SK213758, LR119)

Appendix 1: Alternative treatments

While compiling this document we became aware of alternative approaches to treating the features found on summits and cols. We thought it useful to describe these and explain why we have not adopted them. Our motivation in writing this document was the development of a protocol that can be applied in the field when man-made objects are encountered during a survey. We also aspired to treat summits in the same way as cols. For example, if the natural summit is identifiable, it is used in preference to any man-made object for the height measurement, and if the natural col is identifiable, that too is used in preference to any man-made object for measurement purposes. A summit that has been quarried away is treated in the same way as a col that has been quarried to produce a cutting for a road or railway line. However it is acknowledged that a col is a more complex three-dimensional object than a summit and uniformity of treatment is not always attainable.

Sorting man-made objects by date

One method of treating man-made objects is by date, the rationale being to group these objects into ancient and modern structures. The precise date of transition may be different according to author. Modern structures are then discounted and cannot be used in the determination of summit height and position, but ancient objects are used for this purpose. For example, an ancient tumulus near, but not on, and higher than the natural summit of a hill would count as the summit, even though the natural summit were identifiable. We have not followed this approach for two reasons. Firstly, there is the difficulty of determining the date of construction of a mound (without investigating archaeological archives) when it is encountered during a survey. Secondly, if no written record exists that allows the object to be dated, the summit height and position of the hill cannot be determined. If the tumulus is situated over the natural summit then both approaches are consistent in taking the summit of the tumulus as the summit of the hill. This document tries to be consistent in its treatment of summits and of cols. Recently constructed cuttings would have to be discounted on a date rule even when they destroy the original position and height of a col. In this situation the col can never be determined by survey. The same dilemma would apply to summits that have been quarried away in recent times. The date approach also requires exceptions to be made for some summit objects, in the same way as the protocol described in this document. For example, buildings pre-dating the cut-off have to be treated as exceptions.

Covered reservoirs

The treatment of covered reservoirs is a controversial subject. One alternative treatment allows those that have been landscaped, while we have found proponents of treating all such constructions as part of the hill. Clearly, there is no correct or incorrect treatment of covered reservoirs and we have adopted the stance of not counting them for the reasons given in the General Comments section of Summits. From the correspondence we have received, this is the view adopted by a significant majority of reviewers. However, we recognise that this view is not unanimous.

Canals

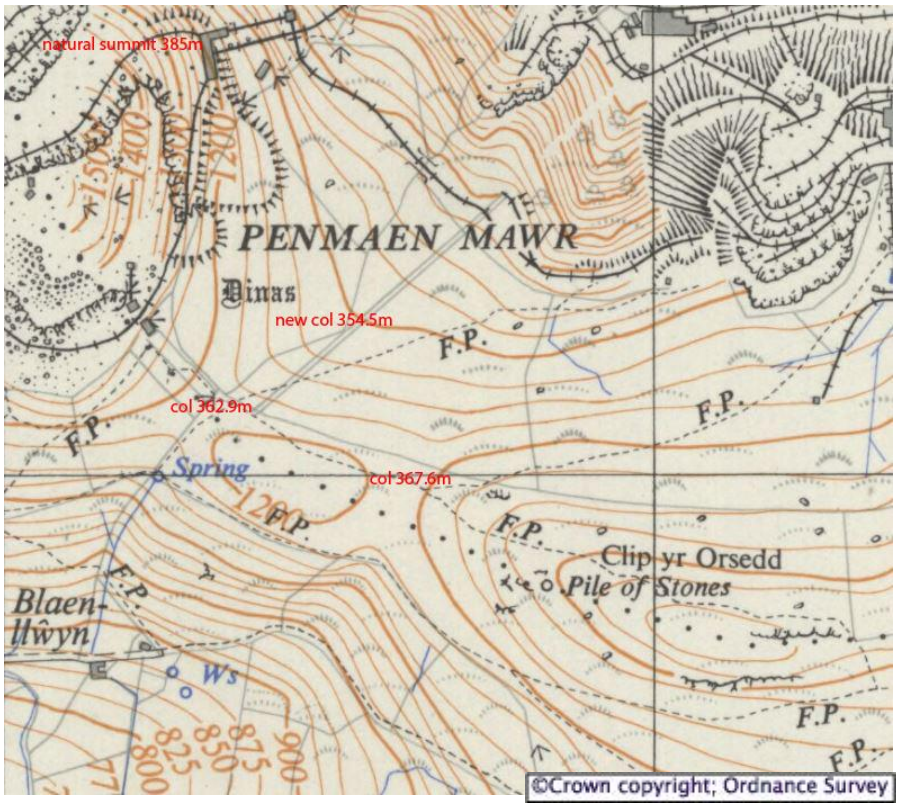
Our treatment of canals that cross a col from valley to valley is not that followed by all, although we believe it to be a majority view. Some authors believe the bottom of the canal should be used for measurement of drop.

Appendix 2: Complex cases

These two examples demonstrate the application of this document to landscapes substantially altered by human activity.

Original hill–hill traverse destroyed by quarrying

19370 Penmaen Mawr (SH702757, LR115) lies on the north Wales coast between Conwy and Bangor and just south of the village of the same name.



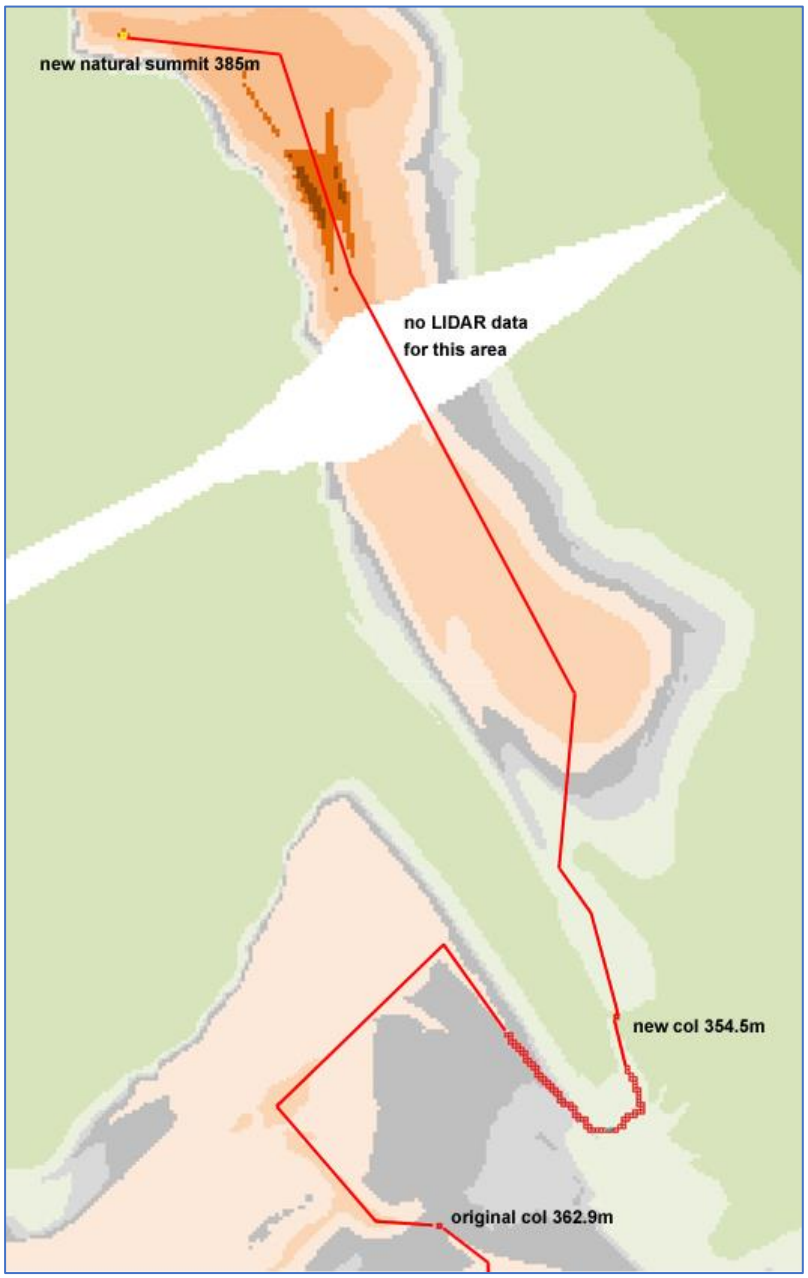
The 1950 1:25000 map shows the original summit in the NW corner of the map, which by that date had already been encroached upon by quarrying. It was 472m (1550ft) high at that time. The Critical Hill Traverse went SE to the col at 362.9m, from there ESE over a slightly higher col at 367.6m, then over Clip yr Orsedd and on to higher ground. With more than 100m of drop it would have been a HuMP in 1950.

Since that map was produced, the topmost 90m of the hill and much of the ground to the south has been quarried away. Two new summits have been created around the northern rim of the quarry, a western top of height 390m and an eastern top of height 385m. The col linking the two tops is at 350m.

The hill–hill traverse from the western summit progresses to the original 362.9m col without passing over lower ground. The eastern summit is shown top left in the elevation map below, derived from LIDAR data with colouring to denote height ranges. Ground 1m higher exists 120m to the SE (coloured dark brown) but this comprises a bank of earth deposited during quarrying, probably to protect vehicles. The slope that once joined the hill to its col has had a section removed by quarrying, which has rerouted the hill–hill traverse via a new col. With so much material removed from the hill, the Critical Hill Traverse now proceeds SSE to a newly created col of natural ground at 354.5m, which being higher than the 350m col mentioned

above, is the Key Col. Its position is also indicated on the 1950 map above. From there it takes a circuitous route around the rim of the quarried area, eventually joining the original traverse at the 362.9m col, which still exists. The route of the Critical Hill Traverse is shown as a red line.

Note that the shortest traverse without further loss of height continues south from the new col, thus missing the original col, before turning ESE at the bottom of the diagram.



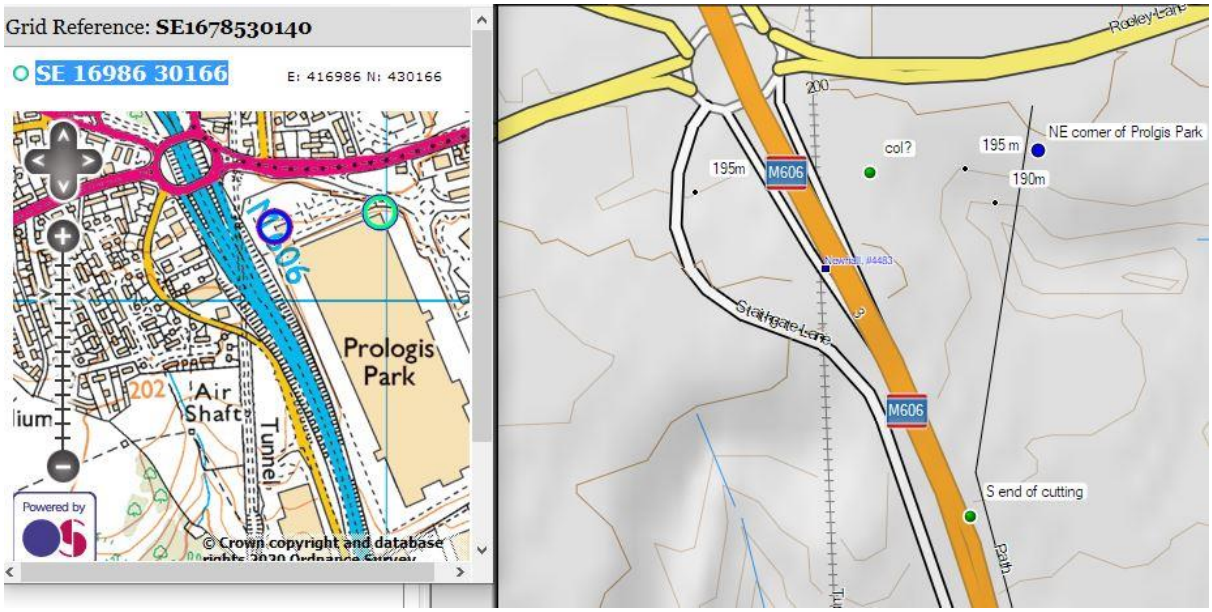
KEY

Brown>deep pink>pale pink>grey>pale green>green

High ground *low ground*

The new col gives the eastern summit a drop of 30.1m, conferring TuMP status, whereas the higher western top has a drop of only 27m.

Natural col destroyed by urban development



The col of 19582 Westgate Hill (SE169297, LR104) lies about 4km south of the centre of Bradford. As shown below in the 1:25000 map this is an urban area that has been extensively altered by the construction of roads (more recently the M606) and more recently still by extensive building work. The larger scale map shows the contouring of the land prior to the construction of Prologis Park. The approximate position of the col, prior to construction of Prologis Park (blue circle in 1:25000 map and green dot marked ‘col?’), may be intact but more probably lies beneath the large building. Even if just outside the building, the col was very probably altered in height during construction and landscaping of the building and vehicle park. Our best estimate for the new position of the col is marked on the large scale map (by the green dot) where the M606 emerges from a cutting.

16306 Syke Whinns Hill (col NY007241, LR89) is an example where human activity has modified the col twice. The original col was below 70m at NY008241 and is not identifiable in the LIDAR. A 19th century railway trackbed, now a cycleway, raised the col to 73.8m. Construction of a new road on an adjacent higher embankment, postdating the LIDAR survey, has since raised the col to c.79m.

Appendix 3: Surveying a col

valley ↑

1	▲ 0	▲ -1	▲ -2	▲ -3	▲ **-4**	▲ -3	▲ -2	▲ -1	▲ 0	▲ 1
2	▲ 1	▲ 0	▲ -1	▲ -2	▲ **-3**	▲ -2	▲ -1	▲ 0	▲ 1	▲ 2
3	▲ 2	▲ 1	▲ 0	▲ -1	▲ **-2**	▲ -1	▲ 0	▲ 1	▲ 2	▲ 3
4	▲ 3	▲ 2	▲ 1	▲ 0	▲ **-1**	▲ 0	▲ 1	▲ 2	▲ 3	▲ 4
5	▲ **4**	▲ **3**	▲ **2**	▲ **1**	▲ **0**	▲ **1**	▲ **2**	▲ **3**	▲ **4**	▲ **5**
6	▲ 3	▲ 2	▲ 1	▲ 0	▲ **-1**	▲ 0	▲ 1	▲ 2	▲ 3	▲ 4
7	▲ 2	▲ 1	▲ 0	▲ -1	▲ **-2**	▲ -1	▲ 0	▲ 1	▲ 2	▲ 3
8	▲ 2	▲ 1	▲ -1	▲ -2	▲ **-3**	▲ -2	▲ -1	▲ 0	▲ 1	▲ 2
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

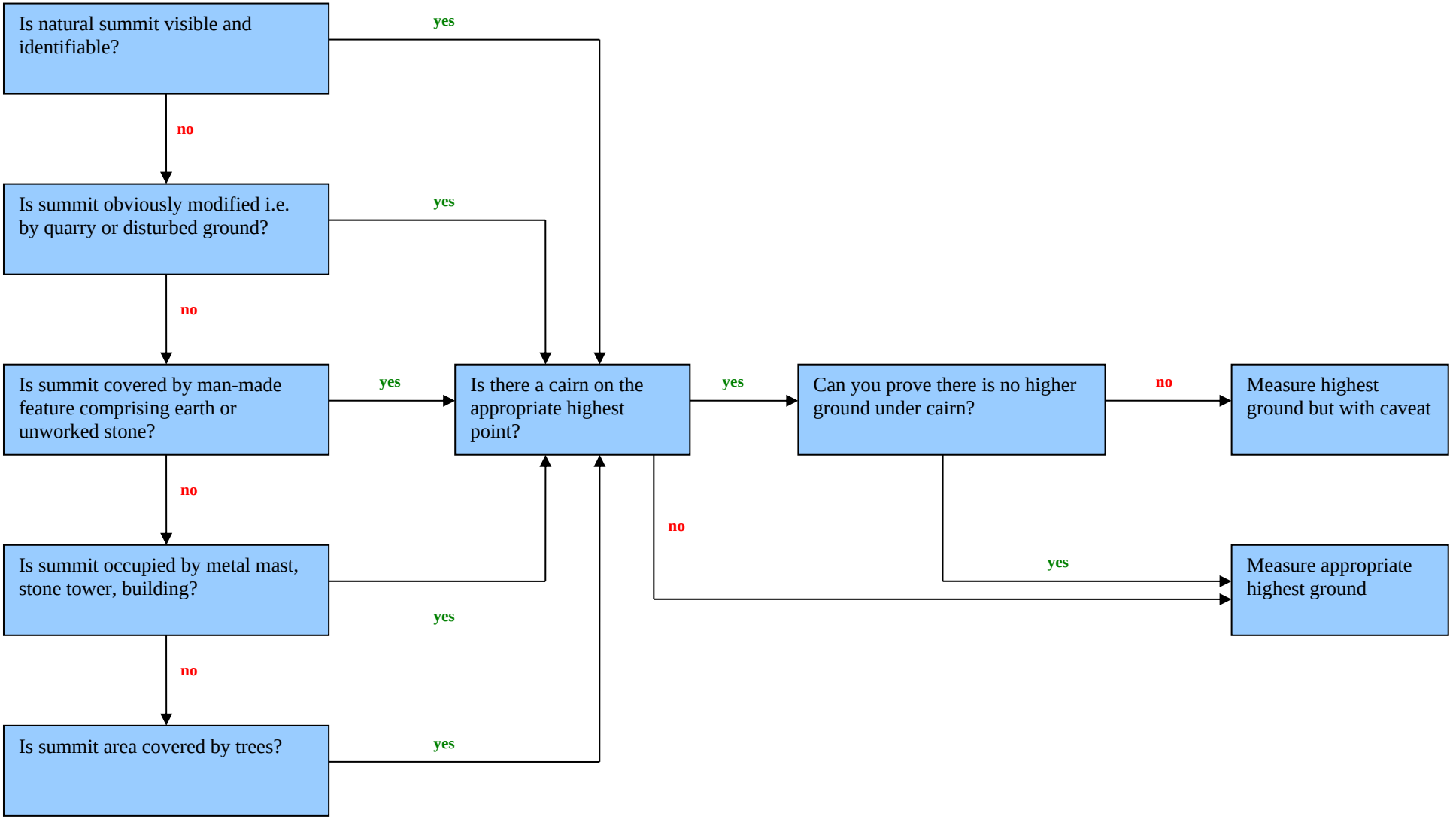
hill ← **Critical hill–hill traverse**

hill →

Critical valley–valley traverse

valley ↓

Appendix 4: Flow Chart for Summits



Appendix 5: Flow Chart for Cols