

# Defining the Summits and Cols of Hills

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*Version 6*

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## Revisions

### 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 any 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. For a Col lying beneath the sea, its height is regarded as sea level i.e. 0m. However, 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

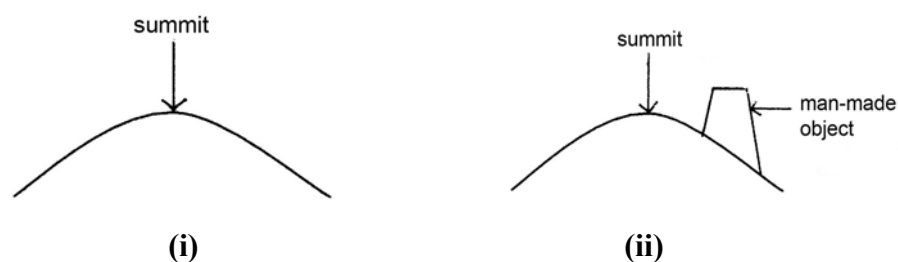
### Introduction

Surveying techniques give hill-list compilers a new dimension in accuracy with 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. Previously the compiler was obliged to rely on map features, e.g. spot heights which are accurate to only 3m and not necessarily positioned at the true summit or col. However this increase in accuracy brings with it a new challenge, namely the definition of a summit and a col. Surveying situations arise where the limitation of a measurement depends on definition rather than the equipment used. For example, on Penycloddiau (Hill Number 2047, 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 Milk Hill (Hill Number 2872, SU235632, LR173) which has a railway cutting running through it. Should the surveyor measure to the railway line or some alternative point? While list compilers have tackled such problems in the past, it has been done on an ad hoc basis, as and when the need has arisen. 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 future hill-list compilers a clear set of guidelines to follow.

### 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.



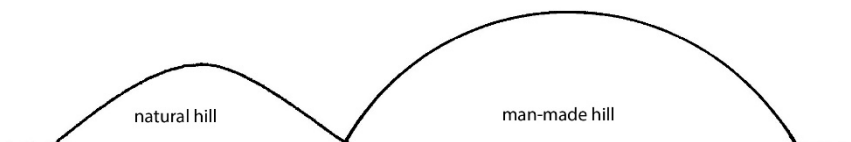
Example: Sgurr Alasdair (Hill Number 1239, NG450207, LR32)

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.

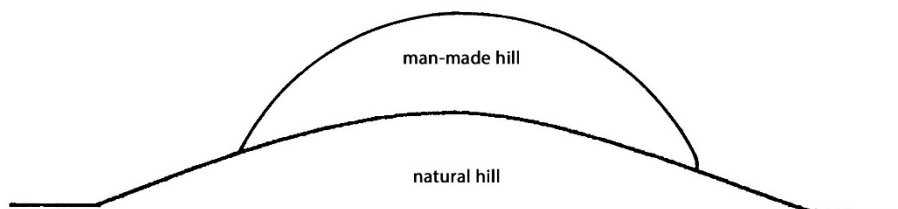
### *Artificial hill is separate from natural hill*



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: Hensbarrow Downs (Hill Number 19290, SX001574, LR200 – see General Comments), Philipstoun Bing South (Hill Number 18965, NT055767, LR65), Northumberlandia (Hill Number 16083, NZ237771, LR88).

### *Artificial hill covers natural hill*



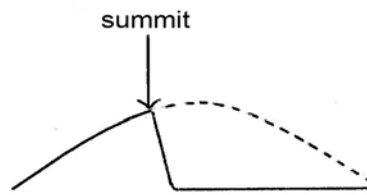
We apply the same principle, but note that it is the height and drop of the original hill that have changed. While tipping, settlement or landscaping is in progress, the highest natural ground is taken for measurement of height and drop. The data may change if the natural ground is itself later covered by spoil, but this is less likely than changes to the summit of the man-made hill.

Example: Penhale Hill (Hill Number 19254, SW917572, LR200). Mynydd y Grug (Hill Number 5273, ST175907, LR171) may qualify 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.





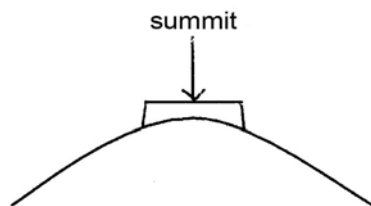
Examples: Cairngryffe Hill (Hill Number 5016, NS941411, LR71,72), Cefn Mawr (Hill Number 14634, SJ200630, LR117)

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

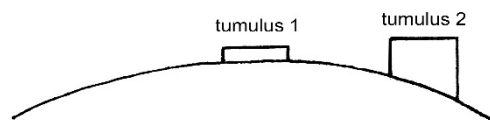
This category covers several types of feature found in the summit area of many of our lower hills and we shall consider some of these in turn.

***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: Domen-ddu (Hill Number 3466, SO016782, LR136,147), Pegwn Mawr (Hill Number 2182, SO023812, LR136), Bache Hill (Hill Number 2181, SO213636, LR137, 148), Swyre Head (Hill Number 2901, 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: North Molton Ridge (Hill Number 17924, SS778325, LR180)

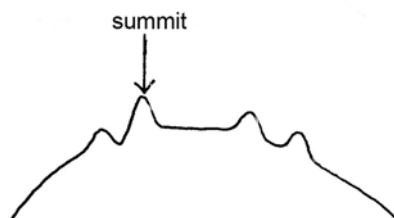
### ***Embankment***

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.

Example: Viking Way (Hill Number 5466, SK889236, LR130)

### ***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: Burrow (Hill Number 2846, SO381830, LR137), Wapley Hill (Hill Number 2858, SO347624, LR137,148,149), Gavel Hill (Hill Number 14649, SJ172248, LR125), Long Mountain – Beacon Ring (Hill Number 2200, SJ264058, LR126)

### ***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.

Example: Tap O'Noth (Hill Number 1501, NJ484293, LR37)

### ***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: Cuilags (Hill Number 1550, 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).

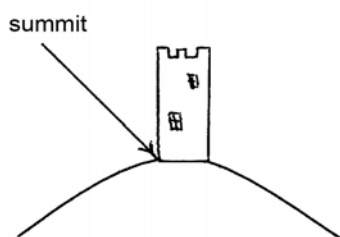
Examples: Tinto (Hill Number 1678, NS953343, LR72), Grey Nag (Hill Number 2747, NY664476, LR86), Yr Eifl (Hill Number 1951, SH364447, LR123)

### ***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: Drummond Hill (Hill Number 177, NN749454, LR51,52), Calf Top (Hill Number 2797, SD664856, LR98)

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

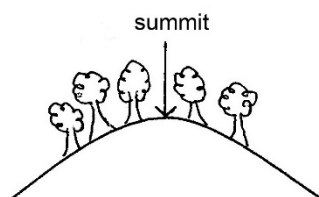


These features are usually constructed from or contain man-made materials and are often relatively recent in origin. The highest ground adjacent to the structure should be measured for position and height. It is acknowledged that the ground may have been levelled or worked in preparation for the construction of the structure. If the building does not occupy the summit then Rule 1 applies and the natural summit should be used.

Examples: Moel Famau (Hill Number 2041, SJ161626, LR116) stone tower, South Stack (Hill Number 14856, SH202822, LR114) lighthouse, Pale Heights (Hill Number 5339, SJ543696, LR117) covered reservoir (but see also 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: Banc Dolwen (Hill Number 3494, SN792787, LR135,147), Drummond Hill (Hill Number 177, NN749454, LR51,52), Knock of Crieff (Hill Number 16, NN873233, LR52,58), Croes y Forwyn (Hill Number 5559, SJ029210, LR125), Long Mountain – Beacon Ring (Hill Number 2200, SJ264058, LR126)

## General Comments

There are a few comments that 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 Harter Fell (Hill Number 2537, 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 contains a very large well-built cairn which is impossible to probe and there is then no option but to measure from the base of the cairn and report this height with the caveat that there may just be higher ground within the cairn. An example is Drygarn Fawr (Hill Number 2203, 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 dense vegetation may just hide higher ground. An example is Brighstone Down (Hill Number 2918, 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: Geal-charn (Hill Number 392, 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 Pen y Castell (Hill Number 2028, 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 Kinder Scout (Hill Number 2807, 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, several hills have covered reservoirs on their summits. These features have been the subject of much 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 are temporary, in that they will be 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.

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. Milk Hill summit, Hill Number 2872, SU104643, LR173) or where there is an unstable peat layer (e.g. Kinder Scout summit, Hill Number 2807, SK084875, LR110 or the col of Meall Cala, Hill Number 53, NN500137, LR57). Indeed 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. If it is assumed that a 1:10k 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 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](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  $\pm 7$ m 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

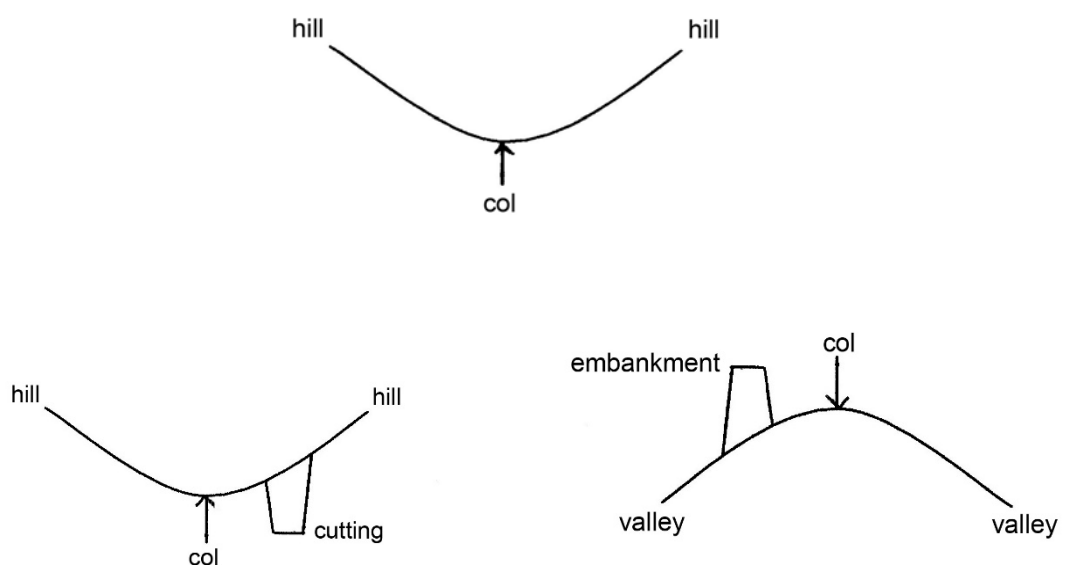
We will first describe how we go about finding the position of a col as these are usually of more complex shape than summits and therefore less easy to locate. The first task is to find its approximate position (say to within 100m of distance), which is fairly easily accomplished with a level and staff. 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 (Bell Crag, Hill Number 3567, NY296137 & NY296140, LR89,90) or the col may contain a network of peat hags (Meall Cala, Hill Number 53, 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?

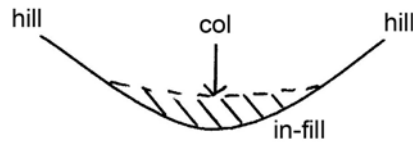
If the col is identifiable, despite there being a man-made feature such as a road or railway cutting close by, the natural position and height of the col is used. Note that this rule is comparable with the first rule for summits.



Example: Most cols fall into this category

**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.

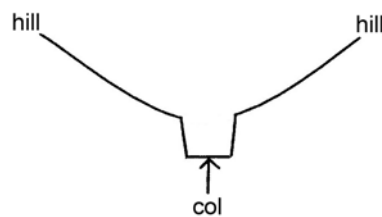


Example: Carreg y Foel Gron col (Hill Number 3683, SH745428, LR124)

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

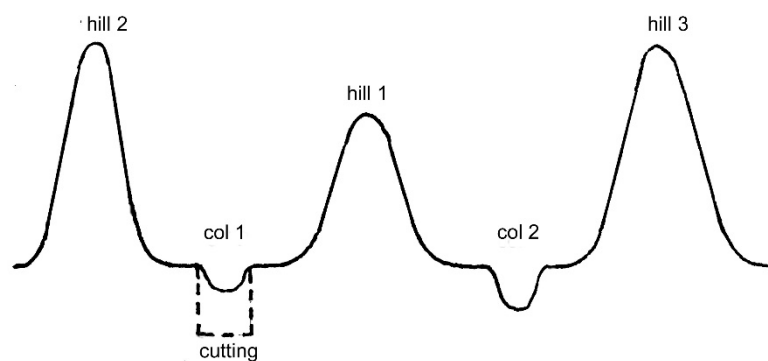
*Cutting running in valley to valley direction*

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 used.



There are two special cases:

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

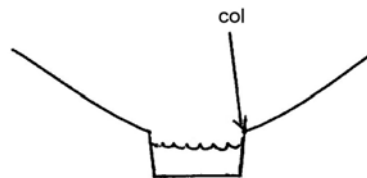


Prior to the construction of the cutting, hill 2 is the parent of hill 1 by virtue of col 1. Once the cutting has been dug, col 1 becomes deeper than col 2 and so col 2 becomes the critical col and hill 3 the new parent.

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

(ii) Cutting is a canal

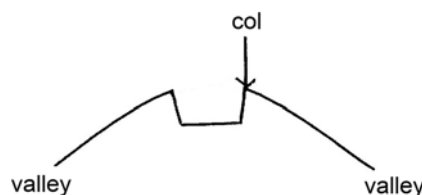
The bank of the canal at the critical hill–hill traverse is chosen as the col and not the water’s surface or the bed of the canal. If the two banks are of different height, the lower one is chosen. The alternative of taking the surface of the water is unsatisfactory as water levels may change with season. 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.



Examples: Milk Hill col (Hill Number 2872, SU235632, LR174) railway cutting over canal tunnel; Raw Head col (Hill Number 2828, SJ528439, LR117) canal

***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

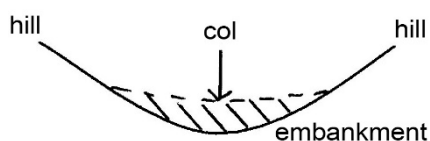
**4. Is the natural col covered by an embankment of earth or rubble?**

***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. Note that



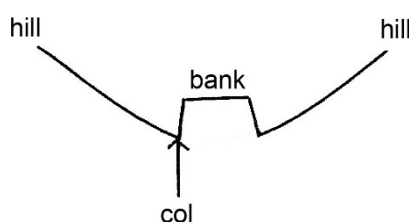
this new height could result in the col replacing another as the critical col for a hill, a situation similar to that discussed in 3(i) for a cutting.



Examples: Y Blaen Llym [Craig Nythygigfran] col (Hill Number 3346, SH683466, LR115); Kinder Scout col (Hill Number 2807, SD894486, LR103), Allt yr Esgair col (Hill Number 2273, SO142225, LR161)

***Embankment running in valley to valley direction***

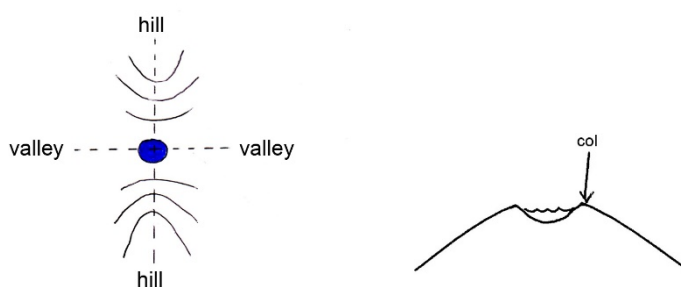
If the embankment runs in the valley to valley direction, the base of the embankment represents the low-point in the hill to hill direction (see survey of col) and therefore this point should be taken as the col.



Example: none known

**5. Small lakes (lochans, llynnau and 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: Pared y Cefn-hir col (Hill Number 5622, 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 used.

Example: Stronend col (Hill Number 1659, NS676857 or NS717838, LR57, 64)

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)

## 6. Islands

The col for the highest point of a coastal island is traditionally taken to be the sea, i.e. 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.

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 infilled 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: Glimps Holm (Hill Number 12263, ND473990, LR7)

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: Eilean Leathann (Hill Number 12758, NF902618, LR22), island in freshwater loch; Eilean Aigas (Hill Number 8963, 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: Church Hill (Hill Number 19019, SO987953, LR139), Green Walk (Bowdon) Trafford County top (Hill Number 5553, SJ757869, LR109), Bailey Hill col (Hill Number 18946, SJ233644, LR117)

Cols are generally lower lying than summits and more often suffer from human disturbance. A well-known example is the col of Abberley Hill (Hill Number 2863, 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: Penmaen Mawr (Hill number 19370, 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: Y Ceiliog Mawr (Hill Number 19270, SH594598, LR115)

## **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 have 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**

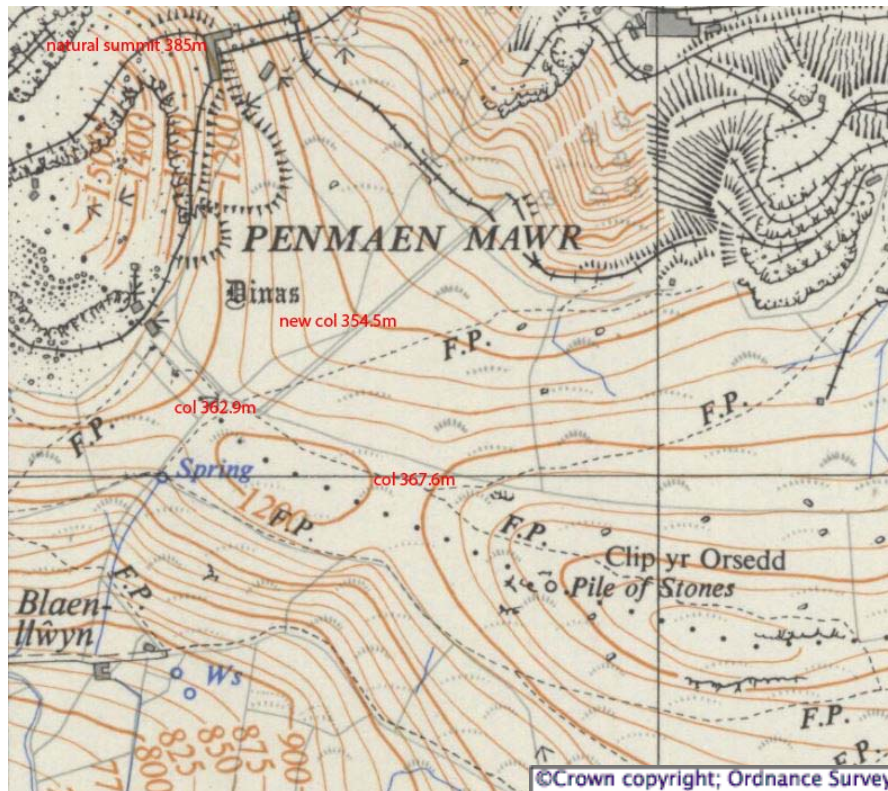
The treatment of covered reservoirs is a controversial subject. One alternative treatment allows those that have been landscaped, while we have found proponents of treating all such constructions as part of the hill. Clearly, there is no correct or incorrect treatment of covered reservoirs and we have 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: Original hill–hill traverse destroyed by quarrying

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

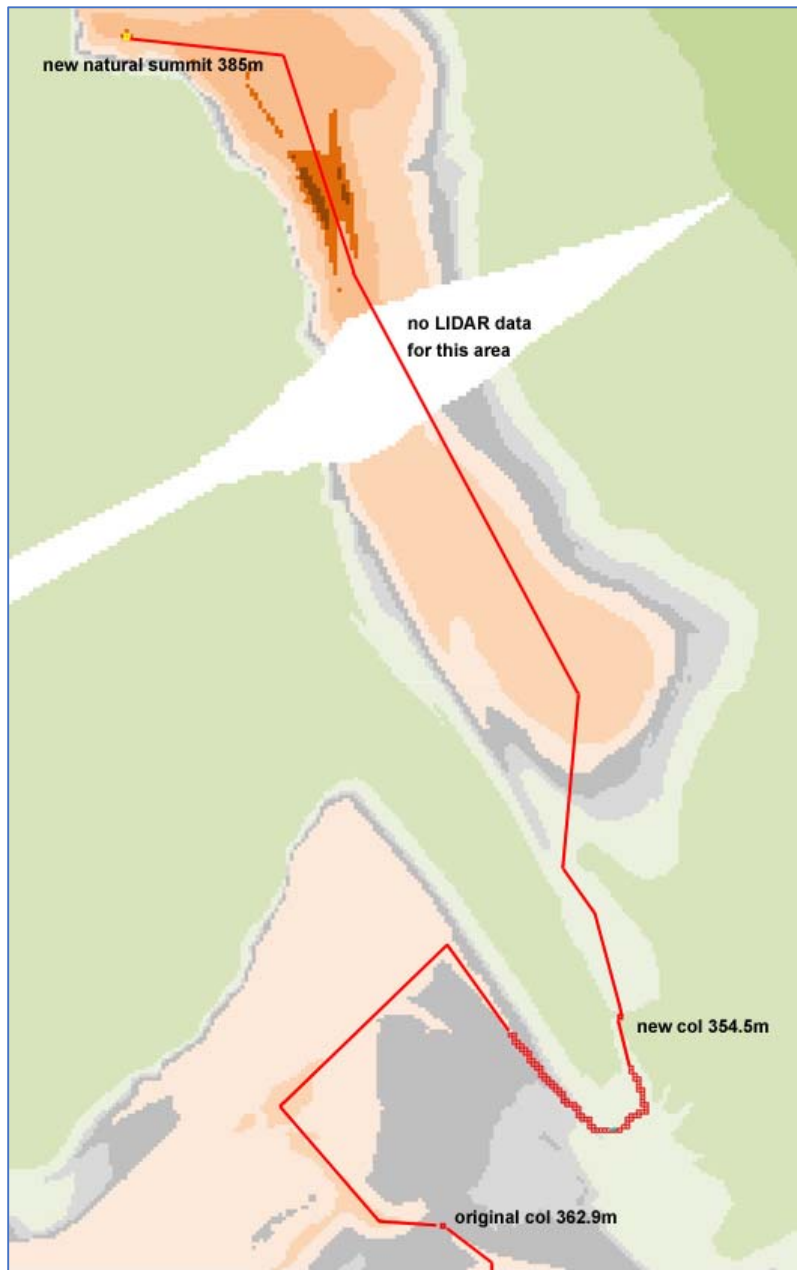


The 1950 1:25000 map shows the original summit in the NW corner of the map, which by that date had already been encroached upon by quarrying. It was 472m (1550ft) high at that time. The Critical Hill Traverse went SE to the col at 362.9m, from there ESE over a slightly higher col at 367.6m, then over 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.

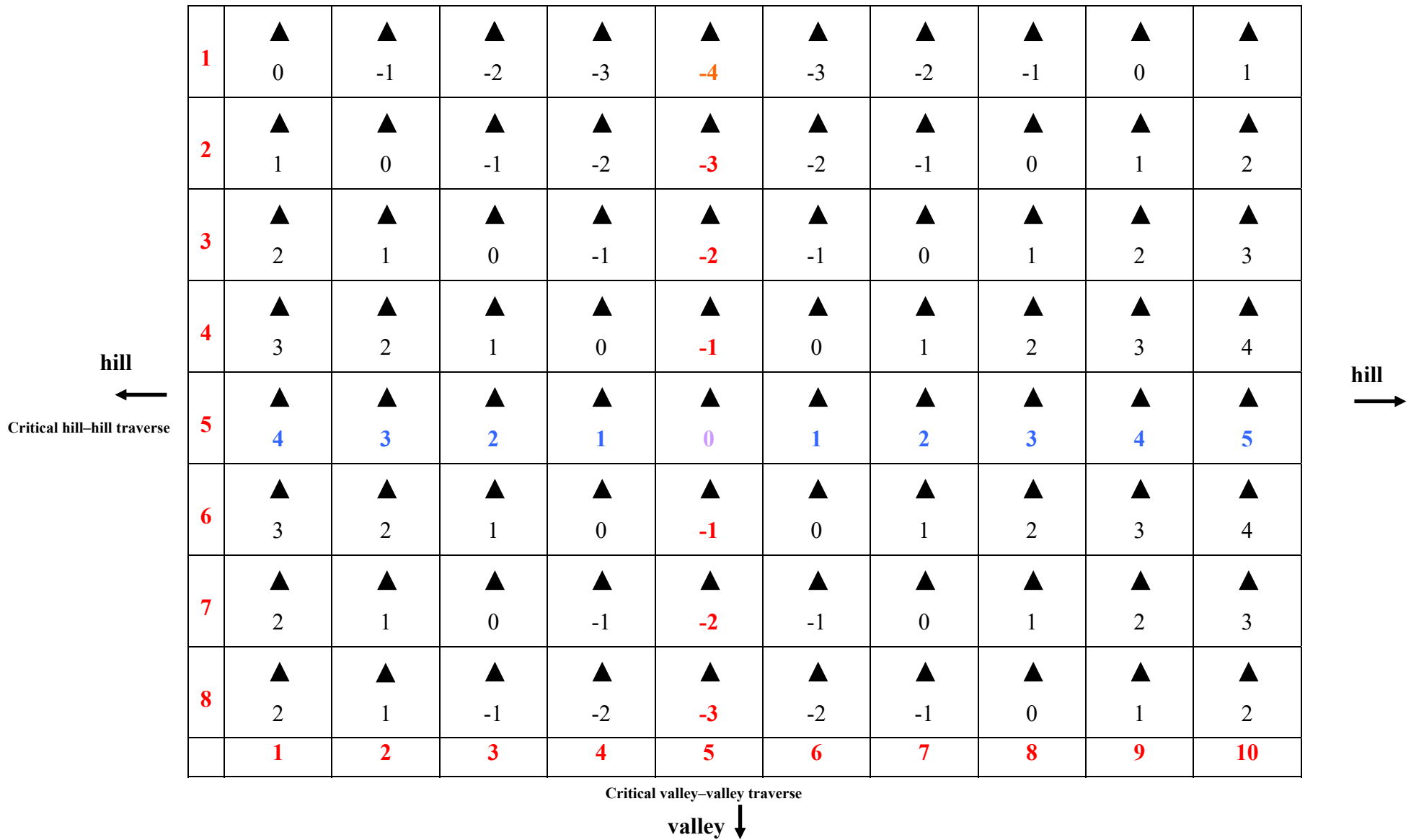


**KEY**  
*Brown>deep pink>pale pink>grey>pale green>green*  
*High ground*                      *low ground*

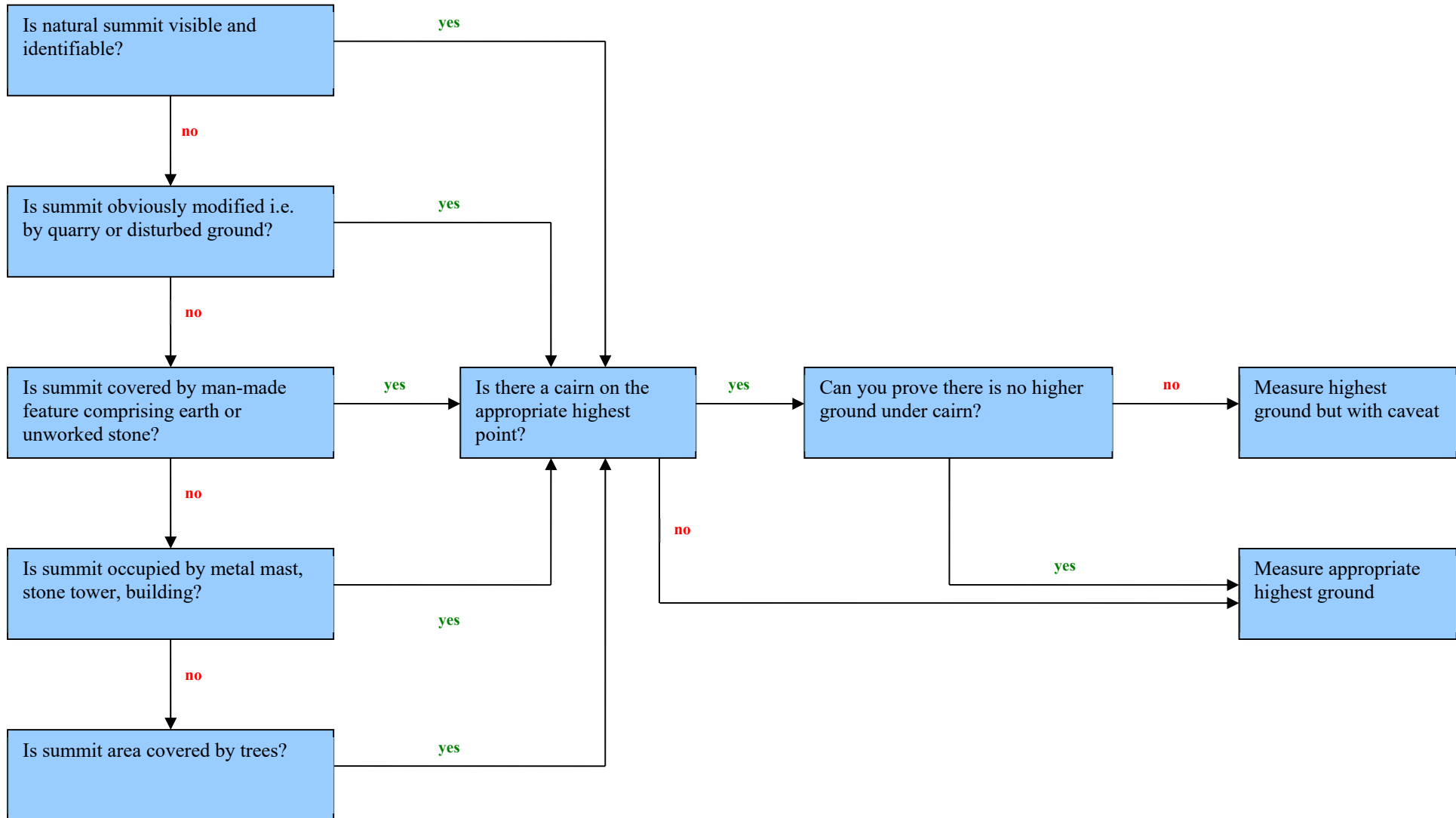
The new col gives the eastern summit a drop of 30.1m, conferring TuMP status, whereas the higher western top has a drop of only 27m.

### Appendix 3: Surveying a col

valley ↑



## Appendix 4: Flow Chart for Summits





## Appendix 5: Flow Chart for Cols

