LANDMAP Methodology Geological Landscape 2016

1 Methodoleg Tirweddau Daearegol LANDMAP

Fel rheol daeareg sydd â rheolaeth neu sydd â'r dylanwad mwyaf ar y dirwedd, gan effeithio'n ddirfawr ar dirwedd, patrwm draeniad, a gorchudd llystyfiant. Hefyd mae'r nodweddion daearegol hyn wedi cael y dylanwad mwyaf ar ddatblygiad hanesyddol aneddiadau, drwy nodi eu potensial amaethyddol a rhwydweithiau cyfathrebu , yn ogystal â mynediad i ddŵr, deunyddiau adeiladu ac adnoddau mwynau eraill. Mae caledwch neu feddalwch wahanol fathau o greigwely, neu eu cyfosodiad, yn creu, yn eu tro, bryniau neu dir isel. Gall ffawtliniau troi'n ganolbwyntiau erydiad a chreu dyffrynnoedd neu ffurfio clogwyni a gall gogwyddiad neu blygiad unedau o graig sy'n cynnwys bandiau bob yn ail o fathau o graig galetach a feddalach, gael eu hystyried yn gefnenau cyfochrog a chonsentrig yn y tirweddau maent wedi cael dylanwad arnynt. Ychwanegwch at hyn y gwynt, dŵr ac iâ yn cerflunio'r creigwely - a'r dyddodion mae'r elfennau hyn yn cynhyrchu - ac mae yna botensial am amrywiaeth mawr ar bob lefel, o'r ogof môr lleiaf i fynydd masiff rhewlifol. Ar un pegwn, gellid gweld moelni daeareg y creigwely'n glir mewn tirwedd ucheldir erydol ac yn y pen arall, tirwedd dyddodiadol megis gorlifdiroedd neu ardaloedd allolchiad rhewlifol, lle mae cynnyrch o'r erydiad hyn wedi cael eu dyddodi gan afonydd neu iâ toddedig, gan orchuddio unrhyw ddylanwad greigwely hynafol.
Mae Agwedd Tirweddau Daearegol LANDMAP yn ystyried dylanwad ffisegol, ac yn bennaf daearegol sydd wedi llunio'r dirwedd gyfoes ac yn nodi'r nodweddion hynny sy'n ymwneud â'r rheolaeth neu ddylanwad a geir gan greigwely, prosesau arwyneb, tirffurfiau a hydroleg. Gellir diffinio a gwerthuso Agweddau Ardaloedd ar gyfer Tirwedd Ddaearegol ar sail eu nodweddion cynhenid, fel arfer naill ai dylanwad topograffig daearegol y creigwely a ffurfiad y tir yn arwynebol ar y brig, neu, yn achos ardaloedd sy'n dyddodiadol yn bennaf,

nodweddion y gwaddodion sy'n bresennol a phrosesau dyddodi fel y mynegwyd gan y tirffurfiau a thopograffeg sy'n cael eu creu gan brosesau o'r fath. Mae prosesau daearegol diweddar, sy'n dyddio'n ôl i ddiwedd Oes yr Iâ, oddeutu 11,000 mlynedd yn ôl, yn aml wedi cael dylanwad mawr ar y modd ffurfiwyd llawer o dirweddau, yn enwedig ardaloedd arfordirol neu lle mae prif systemau afonydd. Fodd bynnag, yn aml dirwedd hŷn sy'n amlwg, ffurfiwyd gan oes yr iâ neu gyfnodau erydol cynharach - mae afonydd, er enghraifft, weithiau yn eistedd mewn tirwedd nad oeddent wedi chwarae rhan yn eu ffurfiad.

Am y rheswm hwn, mae methodoleg Tirweddau Daearegol yn pwysleisio'r elfennau hynny o ddaearegwyneb tir sydd wedi dylanwadu fwyaf ar greu'r dirwedd, yn dilyn erydiad (e.e. yn nyffrynnoedd rhewlifol) neu dyddodiadol (e.e. ar orlifdiroedd afonydd), neu gyfuniad o brosesau o'r fath. Yn aml mae yna ffurfiant creigwely penodol sy'n dylanwadu ar y dirwedd leol - er enghraifft, creu llwyfandir uwchdir, sgarp neu ddyffryndir llydan - a gellid ei adnabod drwy'r fethodoleg Tirweddau Daearegol a'u mapio fel Ardal Agwedd ar wahân. Dylai nodweddion Ardaloedd Agwedd Tirweddau Daearegol yn LANDMAP, felly, cael eu seilio ar ffurfiad ffisegol y ddaearegwaelodol a'r prosesau ffurfiad tir arwynebol, boed yn hynafol ("ffosil") neu'n gyfoes, sy'n rhoi iddo ei gymeriad unigol o fewn tirwedd ehangach. Felly, mae arolygon, yn ystyried y ddaearegwaelodol a'r topograffi wyneb tir, gan gynnwys tirffurfiau penodol, a, lle mae'n bwysig yn lleol, megis prosesau afonol neu arfordirol. Gellid ystyried manylion daearegol, prosesau ar raddfa fach neu nodweddion craig, nad oes ganddynt ffurfiad tir arwynebol penodol neu ychydig iawn o ddylanwad ar y dirwedd ffisegol, yn "elfennau is-dirwedd", ac ni ddefnyddir y rhain yn arferol fel sail ar gyfer dewis Ardaloedd Agwedd ar Lefel 3 yn hierarchaeth y dosbarthiad tirwedd, disgrifir isod. Nid diben methodoleg LANDMAP yw gwneud archwiliad ymhellach neu ddisgrifio'r manylion daearegol mewnol, ar gyfer pob Ardal Agwedd, gan nid arolwg daearegol mohono yn unig, ond yn hytrach modd o nodi'r dylanwadau daearegol yn y dirwedd ehangach. Mae gwybodaeth ddaearegol llawn ar gael mewn mannau eraill, ar ffurf mapiau Arolwg Daearegol Prydain 1:50,000 a chofiannau ategol ac mewn llenyddiaeth wyddonol, ac er hynny nid yw'r wybodaeth a gyflwynir i'r broses LANDMAP yn cael ei ddyblygu.
Felly, mae'r Haen Agwedd Tirweddau Daearegol, yn amlygu dangosiad hanes daearegol yr ardal yn ei dirwedd, gan nodi elfennau penodol o'r diwethaf lle mae'r ddaearegwyneb tir a thopograffi wedi'u cysylltu'n agos. Mae ardaloedd o'r fath yn cael eu gwahaniaethu fel Ardaloedd Agwedd ar wahân.

2 Summary

Geology typically controls or has the strongest of all influences on the landscape, profoundly affecting relief, drainage patterns, and vegetation cover. These geological qualities have also had one of the strongest influences on the historical development of settlements, by determining their agricultural potential and communication networks, as well as access to water, building materials and other mineral resources. The hardness or softness of different types of bedrock, or their juxtaposition, creates, respectively, hills or low ground. Fault lines may become focuses for erosion and create valleys or form cliffs and the tilting or folding of rock units comprising alternating bands of harder and softer rock types may be read as parallel or concentric ridges in the landscapes they have influenced. Add to this the sculpting of the bedrock by wind, water and ice - and the deposits these elements produce - and there is a potential for a great diversity at all scales, from the smallest sea cave to a glaciated mountain massif. At one extreme, the

bare bones of the bedrock geology are displayed for all to see in an erosional upland landscape and at the other, in depositional terrains such as floodplains or glacial outwash areas, the products of this erosion have been deposited by rivers or melting ice, blanketing any older bedrock influence.

The Geological Landscape Aspect of LANDMAP considers the physical, primarily geological, influences that have shaped the contemporary landscape and identifies those landscape qualities which are linked to the control or influence exerted by bedrock, surface processes, landforms and hydrology.

Aspect Areas for Geological Landscape are defined and evaluated on the basis of their intrinsic character, typically either the topographic influence of the bedrock geology and its surface expression at outcrop, or, in the case of primarily depositional areas, the character of the sediments present and the processes of their deposition as expressed by the topography and landforms created by such processes. Geologically recent processes, postdating the end of the last ice age around 11,000 years ago, have often had a major influence in shaping many landscapes, especially in coastal areas or where major river systems are present. Nevertheless, it is often an older landscape that is perceived, formed by ice-age or earlier erosional phases - rivers, for instance, sometimes sit in a landscape in whose formation they played no significant part. For this reason, the Geological Landscapes methodology emphasises those elements of surface geology which have had the strongest influence on landscape generation, following erosion (e.g. in glacial valleys) or deposition (e.g. on river floodplains), or a combination of such processes. There is often a specific bedrock formation that most influences the local landscape - for instance, producing an upland plateau, an escarpment or a wide vale – and this can be recognised through the Geological Landscapes methodology and mapped as a distinct Aspect Area.

Characterisation of the Geological Landscape Aspect Areas for LANDMAP should, therefore, be based on the physical expression of the underlying geology and the surface processes, whether ancient (“fossil”) or contemporary, which give it its individual character within a broader landscape. Surveys, therefore, consider both the underlying geology and the surface topography, including specific landforms, and, where locally important, processes such as fluvial or coastal. Geological details, small-scale processes or rock features, which have no significant surface expression or minimal influence on the physical landscape can be considered as “sub-landscape elements” and are not normally used as a basis for selecting Aspect Areas at Level 3 in the landscape classification hierarchy described below. For each Aspect Area, it is not the intention of the LANDMAP method to investigate further or describe this internal geological detail, as this is not a purely geological survey, but one intended to identify the geological influences in the wider landscape. Purely geological information is available elsewhere, in the form of British Geological Survey 1:50,000 maps and supporting memoirs and in the scientific literature, and although informing the LANDMAP process is not duplicated by it.

The Geological Landscapes Aspect Layer, therefore, demonstrates the expression of an area’s geological history in its landscape, by identifying distinct components of the latter where geology and topography are intimately linked. Such areas are distinguished as separate Aspect Areas.

3 Overview of procedure

The process for carrying out the Geological Landscape aspect is similar to the other evaluated aspects. Initially the study area is classified into different landscape types. These are mapped and survey forms filled out for each. As with all landscape assessments, this is likely to be an iterative process. Desk study derived Aspect Areas will be refined by field assessment which will form the basis for data recording. When the assessment is completed, a technical report is prepared to explain judgements and any deviations from the method. A Quality Assurance procedure is carried out on all assessments to ensure consistency and quality control. In order to maintain the effectiveness and confidence in LANDMAP as the key landscape information resource in Wales, the mapping and survey information is periodically updated. The methodology is described in full in the LANDMAP Guidance for Wales Monitoring Methodology (2016).

The compilation of the LANDMAP Geological Landscape aspect therefore involves six main processes:

1. Classifying and mapping Geological Landscape Aspect Areas
2. Aspect Area data capture
3. Compilation of a Technical Report
4. Quality Assurance
5. Monitoring and updating
6. Quality Assurance of updates

Geological Landscape Aspect Specialists are responsible for 1, 2, 3 and 5 in this process. To maintain nationally consistent standards, LANDMAP datasets are quality assured before they are made available as verified LANDMAP Information. The Quality Assurance assessor is therefore responsible for 4 and 6.

4 Classification and Mapping

The LANDMAP methodology relies on good information sources and so the gathering of relevant data is essential.

4.1 Sources of information

The primary information, which is likely to be used for establishing a Geological Landscapes survey, includes:

- British Geological Survey (BGS) 1: 50,000 geological map sheets (in particular ‘drift’ editions showing surface geology or ‘superficial deposits’
- British Geological Survey Special Sheets1: 25,000 (if available)
- British Geological Survey memoirs (detailed reports to support earlier mapping, now replaced by brief, summary descriptions)

- Soil Survey Maps
- Environment Agency hydrological information
- Mineral Local Plans (typically available from the minerals planning authorities within County Councils)
- 1:25,000 and 1:10,000 Ordnance Survey maps

- Designation maps showing Sites of Special Scientific Interest (SSSIs) with geological interest features and/or formal designation papers
- Regionally Important Geological Site (RIGS) reports and site-specific descriptions (typically available from County or regionally based RIGS groups). Regional (e.g. South Wales coalfields) surveys may also be available.
- Geological Conservation Review volumes - each thematic volume provides a description of all nationally selected geological conservation sites, now mainly formally notified as SSSIs, and their national context. Publication initially by Chapman and Hall, subsequently the Joint Nature Conservation Committee and from 2010, the Geologist's Association.
- MINESCAN reports – Results of the Welsh Metallophyte and Metallogenic Evaluation Project, a joint project of the National Museums and Galleries of Wales and the Countryside Council for Wales (now Natural Resources Wales), includes maps of key mineralogical sites, primarily old mines
- Local Geodiversity Audits and Action Plans (LGAPS) – Area specific reports, for instance for AONBs (Areas of Outstanding Natural Beauty), European Geoparks or Local Authority areas may include elements of site survey (e.g. for RIGS selection) and geodiversity action or management planning.
- Any pre-existing landscape assessments of the study area, for instance applying pre-2003 LANDMAP methodologies
- General geological reports and text books providing an overview of the geological or geomorphological evolution of Wales (e.g. BGS 'British Regional Geology' reports, *The geology of England and* Wales (ed. P. J. Brenchleyly and P.r F. Rawson, Geological Society of London, 2006), etc).
- Any additional geological and technical reports and surveys, scientific publications and field guides that may include information relevant to a landscape-scale survey
- 1:10,000 Aerial Photographs, either non ortho-rectified prints to permit stereo viewing (i.e. facilitating topographic survey) *or* digital and ortho-rectified to allow draping over a digital topographical model (preferably constructed using contour data with a 5m interval (generally available separately).

It is crucial that this data gathering processes as comprehensive as possible and ideally it should be augmented by consultation with other landscape and geological specialists throughout the LANDMAP process, for instance NRW regional geologists and BGS personnel active in Wales. A record of such sources is a standard component of LANDMAP Technical Reports and is likely to be a key factor in any Quality Assurance review.

4.2 Geological Landscape classification

The Geological Landscape aspect is organised according to a hierarchical classification system. This typology allows the recognition of Areas with a similar landscape character or process-related origin, and is based on a hierarchy of four levels.

Level 1	Level 3	Level 2	Level 4
General landscape character	Large-scale terrain or topography	Medium-scale typifying terrain or topography	Small-scale landform

Crucially, this hierarchy is analogous to a conventional methodology for geomorphological mapping at a landscape scale with Level 1 being broadly equivalent to 'Land Region' or 'Landform Region'; Level 2 representing 'Land System', 'Landform System' or 'Recurrent Landscape Pattern'; Level 3 representing 'Facet', 'Facies' or 'Land Unit' and Level 4, 'Site', 'Land Element', 'Slope Unit' or 'Morphological Unit' (for instance as described by R.S. Crofts *in* Goudie 1981, *Geomorphological Techniques* (George Allen & Unwin)). Within the Geological Landscapes Aspect Layer for LANDMAP, these categories have the following general meaning:

Level 1 - General landscape character: This level is designed to categorise the landscape in the most general way and delineate broad topographical zones, within which to group levels 2 and 3. Five categories were selected within the original June 2003 methodology as Level 1 features, three of which fulfil this role, specifically '*Coastal*', '*Lowland hills and valleys*' and '*Mountain and upland valley*': he remaining three being more process related, e.g. '*Mass movement*', '*Karst'*, '*Mass movement*', '*Tectonically controlled topography*' and '*Man-made*'. Full definitions of each of these categories are provided

Level 2 - Large-scale terrain or topography: At Level 2, the landscape is divided into general process or topography-related themes. Within the Level 1 for *Lowland hills and valleys* for instance, these themes relate to processes, both contemporary and ancient (i.e. *Lowland river and drainage systems* and *Lowland glacial and fluvioglacial terrain*) and a general topographical character (i.e. *Undulating lowland hill terrain*, *Lowland scarp and dip-slope dominated terrain* and *Dissected lowland plateau*). A similar principle underlies all other Level 2 features.

Level 3 - Medium-scale typifying terrain or topography: Level 3 is fundamental to the Geological Landscapes methodology, as it is the Level at which Aspect Areas are mapped. Level 3 features have a unifying character related to a specific process or a component of a broader topographical style. Crucially, they can be mapped as facets of a broader landscape, typically being associations of landforms characteristic of a particular processes or topographic style, rather than individual small-scale landforms. The interpretation of each Level is summarised and their relationship to levels 2 and 1 categories tabulated below.

All Aspect Areas are characterised and mapped at Level 3 according to this classification, the category selected to describe its *dominant* character. Certain Aspect Areas, however, may include a range of features representing more than one Level 3 category, which although may not be the dominant character, do make a significant contribution to the character of the Aspect Area as a whole. Such features can be recorded as subsidiary Level 3 features within the supporting electronic data recording system, (see below). In addition, if a surveyed area does not meaningfully conform to any pre-existing Level 3 categories, new Level 3 features can be created, subject to approval by NRW (including through the Quality Assurance Process), and are recorded in the database under '*Other'*.

Careful collation and storage by Aspect Specialists of all research information is required. This is because the Aspect Specialist's reasoning in reaching classification decisions and

the evidence leading to those decisions, may be required to be submitted to, or challenged at, a Public Inquiry.

Categories added during the course of surveys after June 2003 when the Geological Landscapes methodology was first established are indicated by *. These features are typically recorded under 'Other' within the database.

Level 1	Level 2	Level 3
General landscape character	**Large-scale terrain or topography**	**Medium-scale typifying terrain**
Coastal	Erosional coastline	Rock-cliff and shore
		Soft-sediment cliff and shore
		Island*
	Depositional coastline	Sand dune
		Spits, bars and ridges
		Saltmarsh
		Soft sediment foreshore*
	Estuary	Estuary
		Saltmarsh*
		Reclaimed saltmarsh/mudflat*
		Ria*
		Creek/inlet*
	Ancient coastline	Coastal slope
		Coastal flat
		Coastal platform*
		Submerged forest*
Lowland hills and valleys	Lowland river and drainage systems	Active lowland river-flood plain system
		Ancient lowland river-flood plain system
		Lowland river gorge
		Incised river / stream valley / ravine*
		Alluvial basin / former lake*
		Lowland vale*
		Lake/wetland*
	Undulating lowland hill terrain	Undulating lowland hill terrain
		Lowland ridge*
		Lowland hill / knoll*
		Rock platform / outcrop*
	Lowland scarp and dip-slope dominated terrain	Lowland escarpment
		Lowland dip slope
	Dissected lowland plateau	Lowland plateau
		Lowland valley slope / escarpment
	Lowland glacial and fluvioglacial terrain	Lowland glacial outwash plain / field
		Lowland till plain / field

		Glacio-depositional topography / veneer*
		Glacial/ fluvioglacial valley deposits*
Mountain and upland valley	Undulating upland terrain and dissected plateau	Undulating upland terrain
		Upland escarpment
		Upland valley slope
		Upland plateau
		Upland hill/ mountain*
		Upland dip slope*
		Upland ridge*
		Periglacial uplands and slopes*
		Rock platform/ outcrop*
	Upland and mountain river and stream	Active upland river or stream channel system
		Ancient upland river/ stream systems
		Upland gorge
		Incised rive r/ stream valley / ravine*
		Upland wetland or other depositional basin*
		Lake / wetland*
		Upland vale*
	Glaciated mountain terrain	Mountain glacial erosion terrain
		Glacial mountain valley
		Rock platform/ outcrop*
	Upland glacial and fluvioglacial depositional terrain	Upland glacial outwash plain/ field
		Upland till plain/ field
		Glacial/ fluvioglacial valley deposits*
Mass movement	Mass movement	Mass movement
Karst	Karst	Lowland karst
		Upland karst
Tectonically controlled topography	Tectonically controlled topography	Tectonically controlled valleys
		Tectonically controlled hills and escarpments*
Man-made	Man-made	Mineral workings
		Artificial water bodies and channels*
		Artificial channel / canal*
		Engineered features and reclaimed/infilled land

4.3 Definitions of classification categories

Definitions of these classes to Level 3 of the hierarchical classification system are shown in the table below. This ensures compatibility between adjacent surveys and consistency across Wales. These definitions are used unless there is a particular local circumstance that necessitates an alternative definition, in which case these are defined in full in the Technical Report.

At levels 1 (General landscape character) and 2 (Large-scale terrain or topography) such categories have a set meaning and although some Aspects Areas may conceptually be assignable to more than one – for instance Karst and Lowland hills and valleys at Level 1 – ultimately a decision must be made by the Aspect Specialist as to which is most appropriate. Categories at these levels have been selected to cover all potential landscape types in Wales, and no additions are permitted.

At Level 3 (Medium-scale typifying terrain or topography), however, circumstances have arisen in which none of the landscape categories listed in the original June 2003 methodology were appropriate, and definition of a new category became necessary. Such categories are typically reviewed during the Quality Assurance process (see below) to confirm their suitability within a Geological Landscapes hierarchy before being formally adopted. As a result, at least 29 additional Level 3 categories were created during the initial survey programme, as the original June 2003 was applied across Wales (see Table above) - although a few of these additions were a consequence of certain Level 3 categories being relevant to more than one Level 2 category (for instance the Level 3 category 'Saltmarsh' was originally assigned only to the Level 2 category 'Depositional coastlines', but is also relevant to the Level 2 category 'Estuary'). As the recognition of these categories postdates the establishment of the 2003 methodology for Geological Landscapes, they may not have been evenly applied across the whole of the Geological Landscapes Aspect Layer for Wales, and are consequently recorded under 'Other' in the appropriate fields of the database. Such potential inconsistencies can be considered as part of the monitoring process when an area survey is reviewed and updated.

At Level 4 (Small-scale Landform), due to the great diversity of possible landscape features and the difficulty in recognising many without ground-survey, lists of features cited for each Aspect Area will not be complete and are at most no more than 'representative'. The recognition of Level 4 features, nevertheless, provides an insight into the nature of the individual landforms that characterise the Aspect Area. As many Level 4 features can be found in a great range of landscape settings, they are not, in general, explicitly linked to any one Level 3 category. In addition, the recognition of 'new' Level 4 features does not require a formal process, as may be considered necessary when additional Level 3 features are proposed. As the form does not include provision to record 'new' Level 4 features under 'Other', as with additional Level 3 features, the former are often record within Field 37, 'Additional Comments'.

A definition of the Level 1 to 3 categories, which form part of the Geological Landscapes hierarchy, is provided below to aid or help interpret its application.

Level 1: Coastal definition
Regions affected by coastal processes within the most recent geological past, mainly the Pleistocene and Holocene epochs of the Quaternary Period (essentially the last 1.8

million years), but locally may include older Pliocene Epoch (topmost Neogene Period) features representing significantly higher sea-levels than at present (dating back to around 5 million years ago). Coastal regions show the effects of comparatively recent climate and sea-level change, as well as current coastal processes, including erosion and deposition. Includes the following Level 2 and 3 features:	
Level 2 definition	**Level 3 definition**
Erosional coastline. Any coastal area where marine erosion is the dominant process. Such areas typically include a cliff line and commonly areas of bedrock geology exposed at beach level, for instance in a wave-cut platform. Smaller areas of sediment accumulation may also be present, although the materials present may be in continual movement, for instance due to longshore drift. Includes the following Level 3 features:	*Rock-cliff and shore*: Cliffs exposing bedrock geology and linked rocky foreshore characteristic.
	Soft-sediment cliff and shore: Cliffs developed in superficial deposits (i.e. Quaternary soft sediments), including glacial clays, sands and gravels. Foreshore areas often include typical beach deposits, especially sands and gravels, although local areas of exposure of superficial deposits or even bedrock may be present.
	Island: Category reserved for areas of small to medium size, which are permanently or periodically isolated (e.g. by high tides) from a mainland. In practice features recorded at Level 3 in this category are likely to be larger than 500m in length but smaller than 2km, as any smaller islands would be considered to be Level 4 features and any larger could be meaningfully separated into more than one Level 3 (for instance *Rock-cliff and shore* and *Coastal platform* (Level 3 feature added after June 2003).
Depositional coastline. Coastlines with a net input of material are typically characterised by a range of soft-sediment landforms and depositional features such as sand dunes, spits and mudflats. Includes the following Level 3 features:	*Sand dune*: Areas of active or stabilised coastal sand dune without significant and permanent modification by human activity (such as by engineering works). N.B. Areas of artificially stabilised sand dune can be included here only if the Aspect Area has not been extensively landscaped and the restoration of natural processes is hypothetically possible, e.g. by removing forestry cover.
	Spits, bars and ridges: Coastal depositional features, typically comprising shingle ridges or occasionally sand dominated features. Can include both natural, unmodified features or features constrained, for instance, by coastal defence works (but providing that the morphology of the landform has not been significant changed by such work)s.
	Saltmarsh: Typically high intertidal or supra-tidal areas of mud deposition, the latter only flooded during the highest tides of the year, which develop a succession of characteristic plant communities. Highly sinuous, branching channel systems typical. Can include both areas of current deposition and degraded areas where erosion is now taking place. Excludes saltmarsh areas developed within estuary systems (see below).

	Soft sediment foreshore: Extensive areas of sand or mud dominated foreshore, for instance adjacent to sand dune systems or saltmarsh. (Level 3 feature added after June 2003)
Estuary. Geomorphological systems developed where rivers enter the sea. Most estuaries contain both depositional and erosional features, the former being emphasised within this Category. Where erosional features such as rock cliff and foreshore exposures are present, classification within the Level 2 category '*Erosional coastline*' is typical. Includes the following Level 3 features:	*Estuary*: General Level 3 category, typically applied to smaller estuary systems where separation of, for instance, cliff and saltmarsh areas would be more appropriate at Level 4, or to parts of an overall estuary system where similar marginal features, are best considered at the latter level.
	Saltmarsh: High intertidal or supra-tidal areas of mud deposition, the latter only flooded during the highest tides of the year, which develop a succession of characteristic plant communities. Highly sinuous, branching channel systems typical. Can included both areas of current deposition and degraded areas where erosion is now taking place. Includes only those areas of saltmarsh developed within estuary systems. (Level 3 feature added after June 2003)
	Reclaimed saltmarsh/mudflat: Areas of former saltmarsh reclaimed for primarily agricultural purposes and therefore not extensively modified, excepting through drainage. Traces of former channel systems often remain. Many such areas could hypothetically, therefore, be restored as active saltmarsh following removal or breach of coastal defence works. More extensively modified areas are more appropriately classified with the Level 1, '*Man-made'*. (Level 3 feature added after June 2003)
	Ria: River valley system 'drowned' by sea level rise after the end of the last Ice Age. Rias typically include a range of geomorphological processes characteristic of an estuary system, including saltmarsh and cliffs which may be classified separately at Level 3 if the ria is large enough. This Level 3 category is, therefore, typically applied to smaller systems in their entirety and to areas below mean high water *or* mean low water in larger systems (depending on whether marginal features such as saltmarsh and cliff can be meaningfully separated at the same level). (Level 3 feature added after June 2003)
	Creek/inlet: Relatively smaller scale features associated with estuaries and especially rias. Category typically used for marginal, tributary valleys areas with mudflat and/or saltmarsh development where the main channel of the system is separated within a different Level 3 feature.

	Usually includes only areas below mean high water mark. (Level 3 feature added after June 2003)
Ancient coastline. Changes in sea-level during the Quaternary and late Neogene, in particular due to sea-level fall after periods of high-levels (for instance during warm interglacial intervals) can leave evidence of a former coastline at a higher level than that developed today. Such features can include former cliff lines, raised beaches and other elevated marine platforms and coastal slopes, all now isolated form coastal processes and typically vegetated. This Level 2 category also includes extensive areas of flat, low-lying coastal land underlain by Holocene deposits representing sea-level fall from a post-glacial maximum (which may, in part, have been reclaimed by human activities but not otherwise significantly modified) and features submerged by more recent sea-level *rise*, such as submerged forests, where extensive. Includes the following Level 3 features:	*Coastal slope*: Coastal areas with a seaward slope clearly related to the development of the present coastline, and formed, for instance, due to ice-age periglacial, slope processes, including the degradation of a former, raised, interglacial cliff line. (e.g. includes '*slope-over-wall'* coastlines). In many cases, however, coastal areas with slopes above active cliff line area are not separated from an adjacent terrestrial Level 3 category, for instance within the Level 1, *Lowland hills and valleys* category.
	Coastal flat: Extensive areas of flat, low-lying coastal land underlain by Holocene deposits, typically formed due to sea-level fall from a post-glacial maximum. Some areas included within this category may also, at least in part, have been reclaimed by human activities but are not otherwise significantly modified, for instance by engineering works. Typically, however, this category would exclude areas of reclaimed saltmarsh, for instance within estuary systems.
	Coastal platform: Relatively high level platforms, sometimes several 10s of metres above modern sea-level, developed adjacent to coastal areas and clearly related to marine erosion during periods of high sea-level stand (e.g. interglacial or pre-Quaternary). (Level 3 feature added after June 2003)
	Submerged forest: Intertidal features representing former coastal marsh and woodland, now preserved below mean high water due to post-glacial sea-level rise. Most such areas are normally recorded at Level 4, although locally they may be extensive enough to warrant recognition at Level 3. (Level 3 feature added after June 2003)

Level 1: Lowland hills and valleys
Distinguishing "lowland" from "upland" areas is a key theme in UK environmental and land use studies, and is also highly relevant to physical geology. In the latter case the nature of the landscape present can be quite different, with colder and wetter, *upland* areas having developed, for instance, a range of distinctive landforms related to the past presence of ice or the erosive power of relatively juvenile drainage systems with their steep valleys and fast flowing channels. Low-lying *lowland* topography, however,

is typically dominated by more mature rounded landforms and relatively slow-flowing mature river systems – often with well-developed flood plains and meander systems – are typical features of lowland areas. Lowland areas are typically cultivated and include most of the larger settlements - the consequences being that many natural features and landforms may have been significantly modified and may now be difficult to recognise. Distinguishing lowland and upland areas within the Geological Landscapes processes therefore, becomes as much an issue of contemporary land use patterns, as it does altitude, and in practice a distinctive upland character is not usually developed below around 250m above present sea level. In subdividing Level 1, *Lowland Hills and valleys* at Level 2, the emphasis is on processes past and present and the overall structure or morphology of the lowland landscape, the following Level 2 and 3 features being included:

Level 2 definition	Level 3 definition
Lowland river and drainage systems. Most major river systems flow from upland to lowland areas and can, therefore, be regarded as a single system. In each region, however, their characters are usually quite distinctive and are consequently classified differently within the Geological Landscapes methodology. In addition, as many LANDMAP studies are focussed on relatively limited areas, geopolitically defined, only a restricted section of the whole river system may be represented, so any overview or more comprehensive classification may not be possible. In lowland areas, mature river systems are typical, with well-developed floodplains, meandering courses and, commonly, terrace systems. Such river systems may also dissect and thereby separate sections of geologically or geomorphologically	*Active lowland river-flood plain system*: Includes typical contemporary lowland river systems, including the active channel and floodplain. The development of a wide floodplain is typical in many, with extensive alluvial deposits and well-developed meander belts and, commonly, traces of former channels, occasionally preserved as 'ox-bow lakes' within the floodplain. Typically lowland rivers occupy relatively wide valleys, with less steep sides than those of upland areas. Sections of some, however, where they pass through bedrock massifs can assume a more upland character as the valley narrows and steepens and a floodplain is virtually lost. Under such circumstances classification at Level 3 as an *Active upland river or stream channel system* may be more appropriate. The Aspect Area, however, is typically mapped to include only level floodplain areas and the active river channel or channels; valley sides above being included within adjacent Aspect Areas. Due to the resolution of the various survey methods employed, however, mapped floodplains are also likely to include the lowest river terraces developed, as these may be less than 1m above active areas and difficult to distinguish using aerial photographs, even where stereo pairs or imaging is available. In addition, the development of flood plains along smaller river and stream systems may be discontinuous and several Aspect Areas may, therefore, be necessary to represent the disjunctive sections of active floodplain of a single system. Alternatively, under a '1 km' rule (see discussion below), some floodplain features may be too small to be meaningfully classified at Level 3 and under such circumstances will only be recorded at Level 4 within a broader lowland Level 3 category.
	Ancient lowland river-flood plain system: As river systems evolve and valleys deepen they leave behind former floodplain areas as *terraces*. Where extensive these can

related terrains belonging to other Level 3 categories.	be recognised at Level 3. The boundaries of the Aspect Area will typically be the base of any valley side above and the base of the terrace feature below, where it rises above the modern, active river-flood plain system. Terrace systems have, by definition, been dissected by later fluvial erosion and several Aspect Areas may therefore be required to describe now separated sections of a single river terrace system.
	Lowland river gorge: Very steep to sub-vertical sided sections of lowland river, for instance crossing ridges of hard geological units such as limestones, may have a gorge-like character and can be classified as such where sufficiently extensive. In such cases the boundaries of the Aspect Area will correspond to the top of the steep valleys sides and may, therefore, also include the river channel and any associated narrow floodplain. Alternatively, the steep valley sides on either side of the river or stream may be classified as separate Aspects Areas with a section of an *Active lowland river-flood plain system* Aspect Area separating them. Gorge sides typically include extensive areas of natural rock exposure, which distinguishes them from *Incised river/ stream valley/ ravine* features, as defined below.
	Incised river/ stream valley/ ravine: Steep sided and often narrow stream or river valleys, typically with a sharp break of slope at the top of their sides. Many of these features relate to rapid, fluvial down-cutting through soft glacial deposits during the Holocene and are typical of stream valleys developed on relatively steep slopes with a blanket of glacial clays and gravels. Boundaries of the feature usually correspond to the top of the steep valley sides and include the stream or river channel itself. Where significant areas of floodplain alluvium are present, however, these may be places in an *Active lowland river-flood plain system* Aspect Area, thereby separating the two sides of the valley feature. Can also include steep valley sides and river-cliff features associated with large river systems where they cut through more extensive terraces of glacial deposits. Bedrock exposure in the bed of the river or stream is also frequent. (Level 3 feature added after June 2003)
	Alluvial basin/ former lake: Includes a range of alluvium-dominated depositional basins or depressions, many of which are likely to have been late-glacial or post-glacial lakes. (Level 3 feature added after June 2003)
	Lowland vale: Wide valley-like features with broad, level to gently undulating floors, often with a number of stream

	systems rather than a single major river channel. Typically developed in areas of outcrop of relatively soft geological units such as mudrocks and within extensive areas of superficial deposits, including glacial deposits and/ or alluvium. (Level 3 feature added after June 2003)
	Lake/wetland: Natural freshwater lakes and wetland areas – the latter often represent partially silted up developments of the former or marginal areas to natural water bodies. (Level 3 feature added after June 2003)
Undulating lowland hill terrain. A general category for lowland landscapes in which the topography has no well-developed grain or distinctive platforms, plateaux or escarpments. Includes the following Level 3 features:	*Undulating lowland hill terrain*: Lowland terrain comprising hills and valleys and typically with mature rounded slopes and no well-developed grain, distinctive platforms, plateaux or escarpments. Although such areas will contain drainage systems, including streams, all significant river-flood plain systems are excluded and placed in the Level 3 category for *Active lowland river-flood plain system* systems.
	Lowland ridge: Elongated hill or ridge, with lowland character and altitude and without well-developed scarp and dip slope morphology. (Level 3 feature added after June 2003)
	Lowland hill/knoll: Isolated hill or knoll or a small, distinctive group of adjacent hills – all with a lowland character and altitude. (Level 3 feature added after June 2003)
	Rock platform/ outcrop: Significant areas of natural rock outcrop in a lowland context. Usually excludes limestone pavement and other outcrops, which are classified as *Karst* at levels 1 and 2. (Level 3 feature added after June 2003)
Lowland scarp and dip-slope dominated terrain. Classic bedrock-controlled topography in which one or more relative thick units of hard rocks (e.g. sandstone or limestone) are bounded above and below or alternate with softer materials (typically mudrocks). The result is a prominent steep escarpment where the harder unit outcrops, with	*Lowland escarpment*: Typically represents the steep escarpment developed where a dipping geological unit of relatively hard rock (limestone, sandstone, volcanic deposits, etc) outcrops.
	Lowland dip slope: Usually represents the gentler sloping counterpart of an escarpment. The inclination of the surface is equivalent to the natural inclination, or dip' of the geological unit forming the feature.

a more gentle 'dip-slope' behind, representing the natural inclination (or 'dip') of the harder unit – as now exhumed by weathering and erosion. Such topography often creates a landscape with a distinctive grain, which is controlled by the geological orientation (or 'strike') of the harder rock unit. Includes the following Level 3 features:	
Dissected lowland plateau. Where geological units are sub-horizontal, the presence of a resistant geological unit such as a sandstone can, after erosion, leave a distinct elevated plateau in the landscape, which is often surrounded by relatively steep escarpments. Dissection by river systems will produce a characteristic 'tabular' landscape with flat-topped hills with valleys between which are often steep sided. Includes the following Level 3 features:	*Lowland plateau*: Aspect Areas with flat-topped hills, typically representing part of a larger dissected plateau feature. Surrounding escarpments or valley slopes are frequently included within the Aspect Area, although may be separately mapped if sufficient prominent (see below).
	Lowland valley slope/ escarpment: Typically used for major valley slopes only, where the slope is more distinctive in the survey area than the plateau feature alone.
Lowland glacial and fluvioglacial depositional terrain. Although Pleistocene ice sheets typically had their origins in upland regions, or encroached on Wales across the Irish Sea, the deposits they left behind on melting are typically most extensive in the lowland areas into which they flowed. These deposits include extensive blankets of stony glacial clay (till) or sheets of	*Lowland glacial outwash plain / field*: Aspect Areas assigned to this category are typically dominated by fluvioglacial sands and gravels and form broad, level to irregularly surfaced terrace like features. Where least disturbed, characteristic landforms such as kettle holes may be preserved – now represented by depressions with small lakes or peat deposits.
	Lowland till plain / field: Aspects Areas dominated by glacial clay (or 'till') deposits, often low-lying with gently undulating surfaces and boggy or wet grassland areas and including small ponds and rhos pasture. In some areas '*drumlins'* may be preserved – low rounded mounds of glacial clay which formed *beneath* an ice sheet as it melted.

fluvioglacial sands and gravel, both types often smothering pre-existing topography. Where human disturbance has been limited, these areas can retain a range of typical glacial landforms such as drumlins, kettle holes and outwash terrace features. Includes the following Level 3 features:	*Glacio-depositional topography/ veneer*: Where glacial clay covers are thinner, they may be draped over a pre-existing topography, features of which, such as slopes and escarpments, can still be identified in the modern landscape. In such areas, the typical surface deposit is glacial clay, however, although small areas of bedrock exposure may locally emerge through this cover. (Level 3 feature added after June 2003)
	Glacial/ fluvioglacial valley deposits: Melting ice in river valleys, including from valley glaciers, typically deposited a range of glacial deposits, including clays (till) and sands and gravels. Although typically dissected by post-glacial river systems, these older deposits commonly remain as marginal aprons and sloping terrace like features along valley sides. This dissection often means that several Aspect Areas in a valley complex may represent sections of a once contiguous feature, now isolated by recent fluvial erosion. (Level 3 feature added after June 2003)

Level 1: Mountain and upland valley	
The higher upland areas are readily recognisable in terms of their topography, which includes high ground, steep slopes, common and often extensive rocky outcrops, juvenile drainage systems, well-developed erosive glacial landforms and, in some areas, mountainous peaks. Vegetation and land use is also distinctive and human influence often limited, excepting areas of large scale afforestation. The transition from 'lowland' to 'upland' commonly takes place between 250 and 300m in altitude, as 'rough' grassland and moorland take over from enclosed agricultural land. Although these land use changes are not primary features of the natural landscape, they do coincide with changes in the nature of the topography, such as steepening slopes, increased presence of rock exposure and surface rock scatter and changes in drainage systems including the development of peat bogs in higher wetter areas. Crucially, however, the limited human interference means that geomorphological features may be relatively well preserved as they have not been removed by agricultural improvements.	
Level 2 definition	**Level 3 definition**
Undulating upland terrain and dissected plateau. This broad category includes a wide range of hilly topographies, which may be closely associated in upland areas. They include undulating hilly terrains, plateaux and escarpments, but distinguished from their lowland counterparts by	*Undulating upland terrain*: Undulating areas of upland hill terrain, without distinctive escarpments or flat plateau features. Such areas typically include a range of stream systems which are too small to separate as Aspect Areas within the Level 3 category *Active upland river or stream channel system* (see below).
	Upland escarpment: Distinct escarpment feature in an upland context, often mapped to include an associated dip slope area.
	Upland valley slope: As for *Lowland valley slope/ escarpment* Aspect Areas (see above), this category is

features such as steeper and higher slopes, the frequent presence of significant areas of natural rock outcrops and relatively juvenile drainage systems. Crucially, however, it *excludes* all mountainous terrains with well-developed glacial erosion features which are included within the Level 2, *Glaciated mountain terrain*. Includes the following Level 3 features:	typically used for major valley slopes only, where the slope is more distinctive in the survey area than any associated hill or mountain features.
	Upland plateau: In a similar manner to *Lowland plateau* Aspect Areas (see above), flat-topped hills in upland areas can represent part of a larger dissected plateau feature related to relatively flat lying and resistant geological units.. Surrounding escarpments or valley slopes are frequently included with the Aspect Area, although may be separately mapped if sufficient prominent (see above). Dissected plateau morphologies can also form where the bedrock comprises steeply dipping and folded slaty mudrocks and sandstones. In such circumstances, the plateau feature could have several possible origins, including as a result of pre-Quaternary peneplanation. In both cases, the high-level plateau has been subsequently dissected by river and glacial valleys.
	Upland hill/ mountain: Discrete upland-character hill or mountain, separated from other similar features (including by valley systems). (Level 3 feature added after June 2003).
	Upland dip slope: Typically only used where the associated upland escarpment is not well developed or is largely absent in the Survey area (Level 3 feature added after June 2003)
	Upland ridge: Elongated ridge within an upland area or of upland character. Often virtually symmetrical and without a well-developed escarpment/ dip-slope morphology. (Level 3 feature added after June 2003)
	Periglacial uplands and slopes: Category used for undulating upland areas or ridges and associated slopes with well-developed periglacial features, including tors, block fields and stone-stripes. Although most upland areas in Wales are likely to have late glacial periglacial features modifying earlier glacial landforms and deposits, only very locally are typical periglacial landforms well developed (mainly in upland areas of south Wales which were not glaciated during the last, or Devensian glaciation, hence allowing sufficient time for such landforms to fully develop). (Level 3 feature added after June 2003)
	Rock platform/ outcrop: Category used for extensive areas of horizontal to gently dipping natural rock exposure or other major outcrop features. (Level 3 feature added after June 2003)

Upland and mountain river and stream. Typical upland drainage systems comprise small, juvenile stream and river systems, often with steep, rocky courses and with erosion as a dominating process. Where slopes are less steep and such streams combine to form larger systems and rivers in the larger valleys, a range of depositional features can develop, such as floodplains, meander belts and terrace features. Unlike lowland systems, however, the river system occupying the floor of the upland valley tends to remain narrow and relatively fast flowing, with the sides above being high and steep with fast flowing juvenile-character streams flowing directly into the main course. This Level 2 feature also includes a range of other features, which are typical of upland areas with high rainfall, for instance valley mire and other extensive wetland areas including natural lakes. Includes the following Level 3 features:	*Active upland river or stream channel system*: In the larger upland valleys, stream and river systems with significant and continuous areas of floodplain and lowest terrace can be mapped separately at Level 3 within this category. As for all other Aspect Areas, however, the size of the features is relevant and in practice, floodplain systems less than 1km in length are unlikely to be mapped separately from the surrounding terrain. In addition, as areas of significant floodplain development may not be continuous, more than one Aspect Area may represent segments of the same river system. Many modern upland stream systems are also 'misfit', being considerably smaller than would be required to create the valley they now occupy. In most cases this is due to the valley shape having had a significant glacial input in its evolution, having either been deepened and widened by ice flow during glaciation or cut during times of high volume flow by glacial meltwaters as ice sheets melted. Occasionally a river system may alternate between lowland and upland-style reaches as it passes from lowland-style areas through hard ridges of solid geology, with upland-style landscapes and back to a lowland hinterland again. These different sections can be mapped separately, as the river changes from a more typically lowland style (with relatively broader floodplain-terrace systems, well developed meanders and less steep or lower valley side above), to a more upland style with a much narrower and often straighter, steep sided valley and very limited floodplain-terrace development. In the latter areas the bed of the river also commonly shows bedrock exposure, sometimes manifesting itself as reefs and low waterfalls/ 'rapids'. As for lowland river systems, the lateral boundary of the Aspect Area is usually drawn at the edge of a flat floodplain-low terrace feature, with the valley sides above being included with adjacent Aspect Areas.
	Ancient upland river/ stream systems: As for lowland areas, the evolution of an upland river system may involve phases of down-cutting leading to the abandonment of earlier floodplains as river terrace features. Although the general narrowness of upland rivers means that such features are typically relatively small, occasionally they are large enough to be mapped separately at Level 3. Similarly, terrace systems have, by definition, been dissected by later fluvial erosion and several Aspect Areas may therefore be required to describe now separated sections of a single upland river terrace system.
	Upland gorge: Where down-cutting of a valley has been particularly rapid or pronounced, steep to sub-vertical sided

	gorge features may be developed. In upland areas rock cliffs and significant areas of scree are often typical. Gorges are typically mapped from the top of their sides to include the river or stream course below. Occasionally, however, the latter may be separated with the *Active upland river or stream channel system* Level 3 category and opposite sides of the same gorge feature may be included within two or more separate Aspect Areas.
	Incised river/ stream valley/ ravine: As for lowland areas, these are steep sided and often narrow stream or river valleys, typically with a sharp break of slope at the top of their sides. Many of these features relate to rapid, fluvial down cutting through soft glacial deposits during the Holocene and are typical of stream valleys developed on relatively steep slopes with a blanket of glacial clays and gravels. They may also, however, have cut down into bedrock geology. Boundaries of the feature usually correspond to the top of the steep valley sides and include the stream or river channel itself. In upland areas significant areas of floodplain alluvium are rarely present in these narrow valleys, although Aspect Areas grouped within this category can also include steep valley sides and river-cliff features associated marginal to larger upland valleys with active floodplain systems. Bedrock exposure in the bed of the river or stream is typical. (Level 3 feature added after June 2003)
	Upland wetland or other depositional basin: Broad valley features, depressions and low-angle slopes between higher upland ridges and mountains often developing areas of mire and blanket bog with extensive peat deposition. Such features are commonly associated with extensive areas of glacial clay deposition, which has created the poor drainage necessary to create the characteristic habitat, often leading to peat formation. Some level floored depressions, however, are clearly evidence of the former presence of lakes, now largely or entirely filled with alluvium and / or peat. Aspect Areas included within this Level 3 features are typically mapped to include only the depression or lower lying area itself, as indicated by a marginal break or change of slope at the base of the surrounding slopes. Note: As blanket bog may cover higher and steeper slopes as well, it may not be mapped in its entirety within this category, the topographic feature represented by the depression being paramount to the this methodology. (Level 3 feature added after June 2003)

	Lake/wetland: Natural lakes of medium to large size, both occupying valley floors and higher level depressions in upland areas can be mapped within this category. Smaller features, i.e. less than 1km in length, are typically recorded only at Level 4, however, and included as part of a broader upland Level 3 category. (Level 3 feature added after June 2003)
	Upland vale: Wide valley-like features with broad, level to gently undulating floors, and typically developed in areas of outcrop of relatively soft geological units such as slaty mudrocks can be included within this Level 3 category. Commonly, however, such areas have an extensive cover of glacial deposits and the presence of numerous streams can create mires and lead to peat deposition in upland areas. These areas may be more appropriate grouped with the *Upland wetland or other depositional basin* Level 3 category and the *Upland vale* category hence restricted to less wet but still broad upland valleys. (Level 3 feature added after June 2003)
Glaciated mountain terrain. High mountain areas in Wales can preserve a range of well-developed glacial-erosive landforms, such as cirques, U-shaped valleys, arêtes and glacial hanging valleys. Very steep to sub-vertical slopes with extensive areas of natural rock-outcrop are also typical' as are a number of depositional landforms, including moraines. Most of the individual landforms are best characterised at Level 4, but together form a very distinctive mountain landscape which is quite different from the more rounded and moorland vegetation-cloaked landscapes typical of the upland areas grouped within *Undulating upland terrain and dissected plateau* at	*Mountain glacial erosion terrain*: High mountain areas, typically dominated by rocky peaks and cliffs with well-developed cirques, arêtes and scree slopes.
	Glacial mountain valley: Broad valleys with a classic glacier-produced U-shaped cross-section. Also a glacial erosion feature, but typically with smoother lower slopes and only with rock exposure and screes towards the top of the steepening upwards sides. Glacial deposits are typical of the lower parts of these slopes, however, and valley floors may include extensive areas of glacial clay (till), sand and gravel, sometimes including moraine, formed during the final stages of retreat at the end of the last ice age. The latter areas, if extensive, may be separately mapped at Level 3 (see below) as can be any significant active river system (see above).
	Rock platform/ outcrop: Extensive areas of rock exposure can be mapped separately at Level 3. Such areas are commonly smoothed by the passage of ice and may locally possess striations. Excludes most cliff-like areas of rock exposure which would normally be included within either *Mountain glacial erosion terrain* or *Glacial mountain valley* at level 3. (Level 3 feature added after June 2003)

Level 2. Includes the following Level 3 features:	
Upland glacial and fluvioglacial depositional terrain. Upland valleys commonly contain deposits left behind as the glaciers which once occupied them melted. In addition, some broader, undulating upland hill areas may also retain local covers of glacial deposits, where they were once buried beneath thick ice sheets. In contrast to lowland areas, however, areas of glacial and fluvioglacial *deposition* are typically much smaller and commonly not individually mapped at Level 3. Includes the following Level 3 features:	*Upland glacial outwash plain/ field*: In some of the larger valleys which dissect upland areas, significant areas of deposition of glacial and fluvioglacial sand and gravel may be present and can be mapped at Level 3. Normally, however, such deposits have been dissected by later fluvial erosion and, therefore, are best mapped within the *Glacial/ fluvioglacial valley deposits* category, below, as they do not have the extensive sheet or terrace-like form characteristic of lowland areas.
	Upland till plain/ field: Although typical of some lowland regions, level to undulating areas of thick glacial clay (or till) deposition in upland areas are generally not so extensive. In some upland depressions and large glacial valleys, however, some developments may be sufficiently extensive to be mapped at Level 3, although the *Glacio-depositional topography/ veneer* or *Glacial/ fluvioglacial valley deposits* categories may be more appropriate.
	Glacio-depositional topography/ veneer: Where glacial clay cover is relatively thin, it forms no more than a veneer across a pre-existing topography, and features such as slopes and escarpments can still be identified in the modern landscape. Such a phenomenon is frequent in undulating upland areas and can be mapped separately at Level 3. In such areas, the typical surface deposit is glacial clay (till), although small areas of bedrock exposure may locally emerge through this cover. (Level 3 feature added after June 2003)
	Glacial/ fluvioglacial valley deposits: Melting ice in river valleys, including from valley glaciers, typically deposited a range of glacial deposits, including clays (till) and sands and gravels. Although now dissected by post-glacial river systems, these older deposits commonly remain as marginal aprons and sloping terrace-like features along valley sides. This dissection often means that several Aspect Areas in a valley complex may represent sections of a once contiguous feature, now isolated by recent fluvial erosion. This category is very similar to that used for glacial deposits in lowland valley systems, although in an upland context, the valley sides above are typically higher and steeper. In addition, due to the general absence of large plains or depressions in hilly or mountainous upland areas within which such deposits can accumulate, this is a major Level 3 category within which most glacial and fluvioglacial deposits of upland areas can be grouped. (Level 3 feature added after June 2003)

Level 1: Mass movement	
Mass movement was established as a Level 1 category by the June 2003 Geological Landscapes methodology as the processes involved occur across all landscape regions, from coast to mountain and at all scales (from major landslip systems to small-scale mud-flows and cambering). As with other categories, mapping of areas of Mass Movement would be carried out at Level 3, through the recognition of mass movement systems that were sufficiently large enough to significantly affect the character of a landscape. In practice, however, few systems have operated at this scale, and most mass movement features have therefore been recorded at Level 4.	
Level 2 definition	**Level 3 definition**
Mass movement. Includes all types of mass movement feature, such as landslips, mudflows, rockslides and cambering. Includes only the following Level 3 feature, as no further subdivision is necessary:	*Mass movement*: The nature of the mass movement process or landform can be recorded at Level 4 on the form. Where such processes can be meaningfully mapped at Level 3, the Aspect Area boundary would correspond to the limits of the disturbed on active area. Where smaller systems exist, they are included within a more general Level 3 category, and recorded only at Level 4.

Level 1: Karst	
Karstic landscapes typically develop over outcrops of major limestone units and as they are consequently substrate rather than altitude controlled, they can be found at all levels from coastal to mountain, - and hence they were recognised at Level 1 by the June 2003 Geological Landscapes methodology. Karst, however, is a system rather than purely a landscape feature, and includes both characteristic surface landforms and sub-surface structures and processes, such as caves. The former, however, are typically formed due an inter-reaction with the latter as the continual, slow dissolution of the relatively soluble limestone very slowly lowers the overall landscape causing it to cut into or breach underground passages and shafts. Characteristic features of such landscapes, therefore, are depressions representing dolines or sink holes, rock pavements and other natural outcrops (including gorges) and an absence of surface water, meaning that valleys are typically dry (at least for most of the year, as most of the drainage is via underground joint and cave systems). In addition, as limestone is a valuable economic commodity and many Carboniferous limestone areas in Wales include metalliferous mineral deposits, quarries and, more locally, old mine workings are also very characteristic.	
Level 2 definition	**Level 3 definition**

Karst: A single Level 2 category is appropriate to cover typical karstic landscapes, as developed in Wales, the only subdivision necessary being at Level 3 to separate the different characteristics of landscape features in lowland and upland areas. Limestone gorges, however, being key landscape features related to drainage, may be separately described at Level 3 as either *Lowland river gorge* or *Upland gorge* within the relevant Level 1 and 2 categories for lowland and upland areas respectively. Most individual karst landforms would are described at Level 4, however. Not all areas of limestone outcrop, however, develop typical karstic features, in part due to the purity of the limestone itself (i.e. its mud-content) – and the presence of interbedded mudrocks which will inhibit the development of extensive karstic drainage systems. Other areas may be too small to map separately at Level 3, but any typical features present can still be recorded at Level 4.	*Lowland karst*: Lowland karst is commonly extensively cultivated or wooded. Occasionally surface features may be discernible, however, including gorges and other natural rock outcrops including cliffs and occasional dolines. Due to human activity, however, the latter have commonly been infilled or may be obscured by woodland. In addition, some areas of lowland karst have been extensively removed by quarrying and small quarries, commonly for building stone or lime production are always characteristic of limestone outcrops. An absence of surface water, including streams in valleys is also typical, however. In some areas, rather than forming the escarpments that might be expected for relative resistant rock units, outcrops occupy flat to very gently dipping depressions. Such areas are probably related to fluctuating ground water levels, leading to intensive corrosion and the dissolution of most such irregularities. Such processes are typical of poljes where seasonal fluctuations in the water table create seasonal flooding of the depression. Limestone gorges are typically separated as *Lowland river gorge* at Level 3, however (see above). *Upland karst*: Upland karst commonly displays a greater density of typical surface features, such as cliffs and crags, dolines / sink holes and limestone pavement, than do lowland areas –(largely due to a general absence of obscuring vegetation and much more limited human interference). Some quarries may be present, however, but they tend to be less extensive than in lowland areas, in part due to greater distances from markets. Upland limestone gorges are typically separated as *Upland gorge* at Level 3, however (see above).

Level 1: Tectonically controlled topography
Occasionally, evidence of ancient tectonic processes are displayed in the landscape in such a way as to create topographic features which can be usefully distinguished at Level 3 within a more generalised landscape style. Such features include fault scarps, fault-delimited valleys and gorges, isolated massifs of ‘exotic’ rock types emplaced

along major fault systems and landscapes with multiple parallel ridges, - the latter often associated with fault lines and exhumed folds, their shape picked out by erosion.	
Level 2 definition	**Level 3 definition**
Tectonically controlled topography. Key and distinctive tectonically created features of the landscape can be described at Level 3 if sufficiently large enough. Smaller features may be recorded at Level 4 within broader Level 3 categories, although in practice most structural geological features will be at a sub-landscape scale and not, therefore, relevant to the LANDMAP process. Most features in the geological landscape have some element of tectonic influence, however, including the orientation of escarpments, river valleys and coastlines. Within the *Tectonically controlled topography* categories, however, only those Aspect Areas where the tectonic influence has exerted an exceptional level of control on the shape of the landscape – despite later glacial and fluvial processes - should be included. In practice, however, in many cases there will be another more general Level 3 category that can also be applied, and this should be recorded as a subsidiary Level 3 feature on the relevant form. Includes the following two Level 3 features:	*Tectonically controlled valleys*: Some valley systems show a distinct orientation related to regional tectonic 'grain' and have been eroded along geological weakness such as faults or relatively soft geological units. Such features are often remarkably straight, and may deflect their contained river from its general overall course. Although occasionally mapped at Level 3 within this category, many such valleys may be included as part of general fluvial Aspect Area categories (e.g. *Active lowland river-flood plain system* or *Active upland river or stream channel system*) and should therefore be recorded in as either a subsidiary Level 3 feature, or at Level 4 or in a text description.
	Tectonically controlled hills and escarpments: Although potentially recordable as 'hills', 'mountains', 'escarpments' or 'ridges' within lowland and upland Level 3 categories, some landscape features are sufficiently distinctive or unusual to warrant inclusion in this category. Examples include isolated knolls of ancient Precambrian rocks emplaced along major fault zones, areas of multiple parallel ridges also developed along such zones and sharply curved or v-shaped ridges representing the outcrop of folded geological units. Other tectonic influences in the landscape, such as surface striations in upland areas, may be more appropriate recorded at Level 4 or in text descriptions. (Level 3 feature added after June 2003)

Level 1: Man-made
Most of the landscape of Britain has been artificially modified in some way, if only through deforestation. This Level 1 category, however, covers only the most significant modifications of the natural landscape, such as dams, quarries and urban and industrially developed areas, where its natural structure and character has been significantly changed. For *Man-made* features, a broad subdivision is appropriate at Level 3, within which most human influences can be classified. Crucially, it the scale of the change which is significant, and as with other categories, developed or engineered areas less than 1 km in length would not normally be mapped separately from a surrounding, more natural landscape. Again, as with other categories, most individual features of engineered landscapes will only be recorded on the forms at Level 4within a broader landscape category at Level 3.

Level 2 definition	Level 3 definition
Man-made	*Mineral workings*: Includes all significant areas of mineral working including quarries, mines and their associated waste tips and processing areas.
	Artificial water bodies and channels / *Artificial channel/ canal*: A broad category to include all medium to large sized reservoirs and artificial lakes as well as significant stretches of canalised river courses, typically with marginal flood banks. (Level 3 feature added after June 2003)
	Engineered features and reclaimed/in filled land: Can include a very wide range of features, from urban, purely residential settlements to large-scale industrial developments, dockyards and significant areas of engineered topography or 'made ground'.

Level 4 definition	Small-scale landforms and features
For each Aspect Area classified at Level 3, a representative range of Level 4 features can be selected from a prescribed list to aid description. These features are typically at the level of individual site and provide a valuable insight into the range of landforms present, or characteristic of the Aspect Area, such as 'River cliff', 'Lake', 'Moraine', 'Active sand dune', etc. Nevertheless, the selection made should not be taken as being a concise categorisation of the Aspect Area, as published maps and aerial photographs do not always facilitate the accurate identification of some types of feature and ground survey would, therefore, be necessary. Crucially, Level 4 features are not rigidly tied to any Level 3 or higher category in the LANDMAP hierarchy, and the full range of prescribed Level 4 features is available for selection, irrespective of the Level 3 category selected. Most can, however, be readily grouped within process related categories, as detailed in the table below, although a few could relate to several categories, the latter are indicated in italics below. When recording Level 4 features not recognised in the original methodology, however, it is necessary to use field 37 ('Additional Comments') as no equivalent category of 'Other' for Level 3 categories is available.	

As with Level 3 features, several Level 4 features have been added during the course of post-June 2003 surveys and these are indicated by *. As noted previously, the latter features may be recorded in field 37 ('Additional Comments'). Features highlighted in *italics* may be recorded in a range of Level 1-3 categories landscapes.

Coastal features (including estuarine)	Cliff Island Active sand dune Sand Beach Tombolo Marsh/ salt marsh Creek *Shingle/ gravel* 'Fossil' cliff line Former salt mash/ marsh Wave-cut platform	Boulder Sand/ shingle foreshore Stabilised Sand Dune Spit Gravel/ shingle ridge Lower salt marsh/ mudflat Rock platform Sea-cave/cave *Scree/ talus* Mud- dominated foreshore Sandbank	Dune slack Bar Beach Upper salt marsh/ grazing marsh Coastal Slope Sand Raised beach/platform Hanging coastal valleys *Lagoon/ lake/ pool (natural)*
Fluvial and wetland features	Gorge/ Gully/ Ravine *Shingle/ gravel* Abandoned channel/ Ox Bow lake River channel (natural) *Lagoon/ Lake/ Pool (natural)* River terrace	Braided channel system Alluvial fan (active) Hanging (fluvial) valley Former lake (e.g. silted up) Alluvial fan (ancient) *Spring* Stream* Peat bog	River cliff* Marsh/bog/fen* Tufa* Marsh/wetland* Incised meander* Meander* Waterfall/ rapids etc Flood plain
Glacial / periglacial features	*Scree/ talus* Moraine Esker Kettle hole Drumlin/ drumlin field Tor	Arête Cwm/Corrie Roche moutonnée Nunatak Glacial U-shaped valley *Rock Pavement*	Glacial hanging valley Patterned ground Block slopes/ surface stone* Scree slopes* *Natural crags and inland outcrops**
Karstic features	*Dry valley* *Rock Pavement* Polje	*Spring* Limestone gorge Doline	Cave* Limestone pavement* *Natural crags and inland outcrops**
Mass movement	Landslip (active) Mudslide/mudflow	Landslip (ancient) Rockslide (ancient)	Rockslide (active)

Other topographical features	*Dry valley* Slope Hill top Scarp Slope	Dip slope etc Plateau Ridge *Rock Pavement*	Stepped topography Scarp *Natural crags and inland outcrops**
Artificial features	Lake/reservoir (artificial) River Channel/canal (artificial) Opencast mine, gravel or sand pit Coal/ Mineral spoil tips	Made Ground Landfill Reclaimed land Urban/Industrial development Coastal defence works	Engineered topography etc Flood defence bank/works* Disused quarry* Mine shaft/ adit* Road/railway cutting*

Although Sub-Level 4 features are only normally relevant to site specific surveys, for instance where conservation condition monitoring may require the recording of individual geological units or specific mineral-rich deposits within a larger geological site, for instance a quarry (a Level 4 feature), they may be still important to the overall characterisation of the Aspect Area. In particular, a review of the stratigraphical units and rocks types present is a key part of the characterisation of an Aspect Area and details are recorded in the Description fields in the database. Other Level 5 features could include structural geology features, soil types and hydrological characteristics.

The Geological Landscapes classification is a guide to mapping the expression of geology in the landscape – that is, of topography expressing geology. Crucially, it is not intended to be prescriptive and 'new' categories may be added at Level 3 to adapt the scheme as different terrain types are identified as area surveys progress – examples of these are indicated on Table 1, above. Because the physical (i.e. geological) landscape consists of a rock substrate (the 'solid' or 'bedrock' geology) modified by past and present processes with varying amounts of relatively recent surface deposits ('superficial' or 'drift' geology') this classification is inevitably a hybrid, a blend of elements of bedrock expression and surface processes. The identification of smaller and smaller components in the landscape is not the desired end of this process and can actually mask the overall significance of an area: for instance mapping of an individual landform such as an rock pavement (i.e. a Level 4 feature) does not necessarily provide an insight into the processes that have created the landscape, whereas mapping it within a landscape which includes dolines and dry valleys clearly demonstrates that karstic processes are or have been at work and a Level 3 category is therefore easy to assign. Scale is an important consideration, however, and a rock pavement approaching a kilometre or more in length becomes a major landscape feature and should therefore be mapped at such at Level 3. Streams are particularly good example of the importance of scale: many are simply features of Level 3 landscape, i.e. they are most appropriately identified at Level 4, but larger systems become rivers and hence are likely to become Level 3 features. For this reason, many Level 3 categories have a smaller scale counterpart at Level 4 in the Geological Landscapes hierarchy.

The objective of LANDMAP, in the context of the geological or physical landscape, is to define areas with a commonality of topography or geological structure and to define these in a mapped form. Crucially, it is topographic expression that is mapped, not directly the rock types beneath (which are usually concealed) or processes that worked upon that substrate (which may have ceased around 10,000 years ago when the last ice age finished). Aspect specialists derive a refined but practical characterisation of real terrains, using appropriate characters such as slope characteristics, surface features including small-scale landforms, drainage patterns and geological parameters (e.g. rock or deposit type and tectonic structure), to distinguish an Aspect Area from adjacent areas. This data is recorded in appropriate fields with the Description section of the data form with key features being summarised by the short text description, which is required for each defined Aspect Area.

As stated previously, it is the *dominant* character of the Aspect Area that guides the selection of the most appropriate Level 3 category. In some cases, selecting such a category may not be a straightforward process, for instance in hill country, which may include local escarpments, dip slopes, tectonically controlled valleys and plateau-like features all in intimate association. In addition, a wide range of processes may have combined to create these landforms, including fluvial, glacial and karstic, the effects of each superimposed on the landscape and landforms created by those that they post-date. Selecting the most appropriate Level 3 feature therefore becomes a process of pragmatically identifying those elements that significantly contribute to the character of the landscape as preserved today - but in doing so it is also necessary to identify generations of 'overprinting' by other modifying processes. Any such subsidiary processes and features can be recorded at Level 3 or Level 4, to provide a more complete view of the Aspect Area being described.

4.4 Mapping Aspect Areas

Having reached a judgement on the Geological Landscape character and qualities of an area maps are prepared defining the area, extent and boundary of each Aspect Area. The boundaries must be justified in the survey form for each Aspect Area. Aspect Area boundaries are digitised in a GIS using OS digital topographical base map. Each Aspect Area requires an appropriate geographical name and unique identifier. Mapping of areas is an iterative process. Generally, the best method is as follows:

Desk study

An initial stage in this process is the establishment of a geological base map of the study area – typically a local government administrative district – using published geological maps supported by other sources, such as scientific publications. Published geological maps, such as those produced by the national British Geological Survey (BGS) at 1:50,000 scale, are crucial for the establishment of baseline information on bedrock geology and the more significant areas of Quaternary deposits ('drift'). Coverage of Wales has until recently has been poor with mapping for areas of central Wales, in particular, being limited to 1:250,000 regional maps. For these areas, a compilation mapping from scientific papers and other sources has been necessary to provide the necessary geological detail. This situation has changed rapidly over the last few years for coverage at 1:50,000. Geological mapping at this scale is quite adequate for Aspect Area mapping, as the general geological identity of the main formations present (i.e. named rock units) is what is

important for Aspect Area characterisation, rather than the small-scale detail of minor components.

Compilation of geological information from such maps and other sources at 1:10,000 or 1:25,000 provides the necessary base map for Aspect Area mapping when overlain on an appropriate Ordnance Survey (OS) topographical map. It is essential that the base map includes topographical contours – ideally at 5m intervals – which, in the case of digital mapping, may only be available separately from the OS 1:10,000 base mapping.

Mapping

From this compilation the major geological units with an influence on topography and major geomorphological features, such as river and estuarine systems, can be identified. To confirm the significance of these geological features in the broader landscape, but also to identify or resolve features which are not readily discerned from OS maps alone, examination of aerial photography is essential as well as the use of an appropriate tool to facilitate viewing of the nature of the physical structure of the landscape. The latter can either be carried out by digital terrain mapping, which drapes orthorectified aerial photographs and/or geological mapping over a digital terrain model, or by viewing successive frames in an aerial transect as stereo pairs (using either printed copies or a digital viewing system).

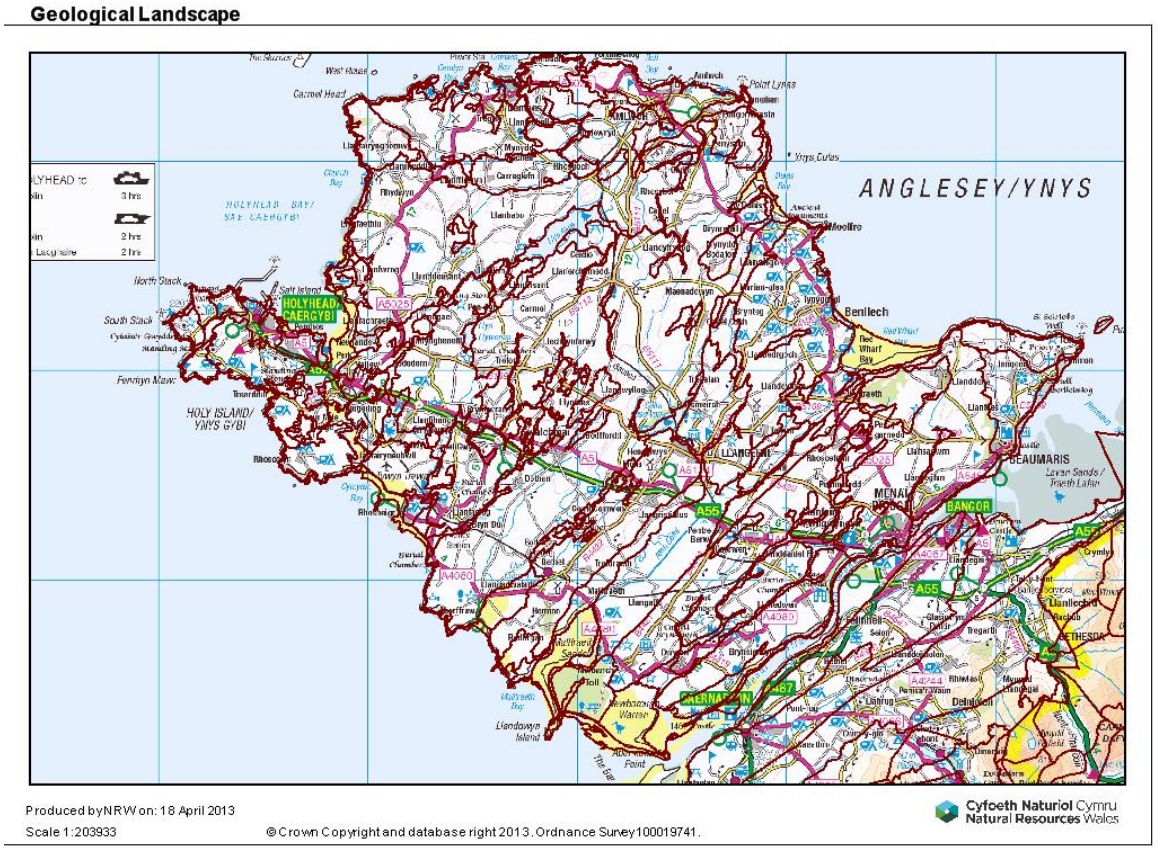
Although the former has the advantage of enabling large landscape blocks to be viewed from various angles, the latter, a well-established geomorphological mapping method, can provided additional detail as it allows more subtle features of less than 2m height to be recognised in a way which is currently impossible with most commercially available digital topography, with a resolution of no more than 5m. It also avoids the problem of artefacts, which can result from the processing of digital contour data and which can, for instance, make some relatively smooth hill sides look like stepped features. Where recent 1:50,000 geological mapping is lacking, the use of this technique to map topographic features such as breaks of slope, ridges, cliffs and natural water courses can even produce a provisional geological map, by identifying features such as the margins of floodplains, geological lineaments, discontinuous escarpments and characteristic landforms such as drumlins. The geological significance and interpretation of these mapped features can then be determined by comparison with areas where the geology is known and a similar topographical expression is apparent to provide a provisional identification of the nature of the geology present in the unmapped area.

Where the boundaries of significant geological units or tectonic features, such as faults, clearly coincide with topographic features such as breaks-of-slope, Aspect Area boundaries can be clearly mapped to a high resolution. Where the coincidence of geological boundaries and features is less clear, however, Aspect Area boundaries can be drawn to a topographical change which can be reasonably considered as being a consequence of the proximity of a geological change – for instance the base of an escarpment formed by a hard unit rather than the mapped boundary of the unit which may only cap the feature. Only in cases where the geology is of high scientific value - and conservation priorities may therefore be distinct from adjacent areas - or where geological formations or deposits have a significant affect on land use - such as by determining soils rather than distinctive landforms - should the Aspect Area boundaries be more geological than topographical.

Finalising boundaries

Finalise and digitise boundaries using a GIS and a 1:10,000 or 1:25,000 OS digital topographical base map, forming a separate polygon for each Aspect Area.

Geological Landscape Aspect Area map for Ynys Mon (Anglesey)



5 Surveys

The survey form provides a structured summary of the key characteristics of each identified Aspect Area, together with an evaluation of its significance and a summary of its management requirements.

Classification is the first stage of assembling the Geological Landscape Aspect information. Once this process has been completed and the selection of Aspect Areas finalised, the completion of data-capture forms for each area is required. In practice, however, the compilation of the information necessary to describe each Aspect Area is carried out as part of the initial survey process and will inform the classification of each Area at Level 3. A summary of the Survey to be completed for each Aspect Area is provided below.

5.1 Geological Landscape Survey

Survey Number:	Generate
Aspect Area Name:	Insert
Unitary Authority or NPA:	Select

Aspect:	Select
Date Survey Conducted:	Insert

Classification

Level 1	General Landscape Character	Select
Level 2	Large Scale Terrain or Topography	Select
Level 3	Medium Scale Typifying Terrain or Topography	Select
Level 4	Small Scale Landform or Feature	Select

Survey

Monitoring

1. Date of monitoring?	

1a. Monitoring undertaken by	

1b. Has this record been updated following monitoring work?
This record has been updated following monitoring work as more up to date information is available
This record has been updated following monitoring work, there was a real change in the Aspect Area
This record remains unchanged following monitoring work

1c. Change indicated by		
OS Data, Aerial Photographs	Satellite Imagery Interpretation	Phase 1 Habitat Survey & Seasonal Change Maps
Policies, plans & information resources	Fieldwork	

1d. What has changed?		
Classification	Description	Evaluation
Condition & Trend	Recommendations	Boundaries

1e. Has the information been verified in the field? [if yes] At what scale has this been verified?	

2. Does this area have a special or functional link with an adjacent area? [if yes] Which area and what is the nature of the link?	

Description

3. If classification Level 4 is 'Other', specify here	

4. What is the geographical and topographical character of this area?	

4a. Where bedrock dominated, what is the dominant bedrock type?		
Sedimentary	Igneous intrusive	Igneous extrusive
Metamorphic		

4b. Where bedrock dominated, what is the age that characterises the Aspect Area?		
Precambrian	Cambrian	Ordovician
Silurian	Devonian	Carboniferous
Permian	Triassic	Jurassic
Cretaceous	Paleocene	Eocene
Oligocene	Miocene	Pliocene

c. Where bedrock dominated, what is the major rock lithology (-ies)?		
Sandstone	Siltstone	Mudstone
Conglomerate	Limestone	Marls
Coal	Granite	Basalt
Andesite	Rhyolite	Tuff
Slate	Other	

4d. Where drift dominated, what is the dominant drift deposit?		
Fluvial	Alluvial	Coastal
Glacial	Fluvioglacial	

4e. Where drift dominated, what is the major sediment that characterises the area?		
Sand and gravel	Silt	Boulder clay/till
Head	Other	

5. What is the characteristic Level 3 component of the area? (Select only one)		
Rock cliff and shore	Lowland dip slope	Upland gorge
Soft- sediment cliff and shore	Lowland plateau	Mountain glacial erosion terrain
Sand Dune	Lowland valley slope/ escarpment	Glacial mountain valley
Spits, bars and ridges	Lowland glacial outwash plain/ field	Upland glacial outwash plain/ field
Saltmarsh	Lowland till plain/ field	Lowland escarpment
Upland till plain/ field	Ancient upland river/stream systems	Estuary
Coastal Slope	Undulating upland terrain	Mass movement
Coastal Flat	Upland escarpment	Upland Karst
Active lowland river floodplain	Lowland Karst	Mineral workings

Ancient lowland river flood plain system	Upland valley slope	Artificial water bodies and channels
Lowland river gorge	Upland Plateau	Engineered features and reclaimed/ infilled land
Undulating lowland hill terrain	Active upland river or stream channel system	Other, please specify *if other*

6. Which of the following is a significant contributor to the geological character of the area? Specify for each category		
Stratigraphic formation(s)	Superficial deposits	Active Processes
Structural features	Past Processes	Other

7. What additional Subsidiary Level 3 components are notable?		
Rock cliff and shore	Lowland dip slope	Upland gorge
Soft- sediment cliff and shore	Lowland plateau	Mountain glacial erosion terrain
Sand Dune	Lowland valley slope/ escarpment	Glacial mountain valley
Spits, bars and ridges	Lowland glacial outwash plain/ field	Upland glacial outwash plain/ field
Saltmarsh	Lowland till plain/ field	Lowland escarpment
Upland till plain/ field	Ancient upland river/stream systems	Estuary
Coastal Slope	Undulating upland terrain	Mass movement
Coastal Flat	Upland escarpment	Upland Karst
Active lowland river flood plain system	Lowland Karst	Mineral workings
Ancient lowland river flood plain	Upland valley slope	Artificial water bodies and channels
Lowland river gorge	Upland Plateau	Engineered features and reclaimed/ infilled land
Undulating lowland hill terrain	Active upland river or stream channel system	Other, please specify *if other*

8. What Level 4 components are notable in this area?		
Cliff	Hanging coastal valleys	Former lake (e.g. silted up)
Wave- cut platform	Lagoon / Lake / Pool (natural)	Alluvial fan (Ancient)
Sea-cave / cave	Lake / reservoir (artificial)	Arête
Gorge / gully / ravine	River Channel / canal (artificial)	Cwm/Corrie
Boulder	River channel (natural)	Roche moutonnée
Scree / talus	Former salt mash / marsh	Nunatak
Island	Waterfall / rapids	Glacial U-Shaped valley
Sand/ shingle foreshore	Ley	Flood plain
Patterned ground	Mud- dominated foreshore	Abandoned channel / Ox Bow Lake
Landslip (Active)	Active sand dune	River Terrace

Landslip (Ancient)	Stabilised sand dune	Dry Valley
Glacial hanging valley	Dune Slack	Slope
Rockslide (Active)	Sand Beach	Hill Top
Spit	Scarp Slope	Mudslide / mudflow
Rockslide (Ancient)	Dip slope	Bar
Tombolo	Plateau	Polje
Spring	Gravel / shingle ridge	Ridge
Beach	Moraine	Limestone gorge
Marsh / salt marsh	Esker	Doline
Lower salt marsh / mudflat	Kettle hole	Scarp
Opencast mine, gravel or sand pit	Upper salt marsh / grazing marsh	Drumlin/ Drumlin Field
Coal / Mineral spoil tips	Creek	Tor
Coastal defence works	Rock platform	Rock Pavement
Sand	Stepped Topography	Made Ground
Shingle / gravel	Peat bog	Landfill
Coastal slope	Braided channel system	Reclaimed land
Urban /Industrial development	Raised beach /platform	Engineered topography
Alluvial fan (active)	Hanging (fluvial) valley	'Fossil' cliff line

9. What Active geological and geomorphological processes are significant in this area? Insert up to 5 named processes	

10. Are there components of significant hydrological importance? If yes, which?	

11. Are there any pedological processes that are significant in the area or have had a landscape forming effect? If yes, which?	

12. Is there current mineral extraction? If yes, what for?	

13. Has there been mineral extraction in the past? If yes, what for?	

14. Are there SSSI / GCR sites here? If yes, which?	

15. Are there geological SINC, 2nd tier or RIGS sites in the area? If yes, which?	

Evaluation

16. Value		
Outstanding	High	Moderate
Low	Unassesed	Details…

17. Condition		
Good	Fair	Poor
Unassessed		Details…

18. Trend		
Improving	Constant	Declining
Unassessed	Details…	

Recommendations

19 Existing management		
Generally appropriate	Generally inappropriate	Unassessed
20 Existing management remarks:		
21 Explain the management that is appropriate or inappropriate		
22 Principal management recommendations		
23 Guidelines (up to 10) and indicate timescale		
Immediate	Medium Term	Long Term

Tolerance to Change [optional]

23. Are there any significant threats to the current integrity and condition of the Earth Heritage features of the area? [*if yes* identify threat(s) and define an acceptability threshold for any resultant change]	

Aspect Area Boundary

20. To what level was this information site-surveyed?		
Level 1	Level 2	Level 3
Level 4	Individual Site	None

21. At 1:10,000, how much of the Aspect Area boundary is precise?		
All	Some	Most
None	Explain	

22. What baseline information source was used for Aspect Area boundary mapping?		
OS Raster	Aerial photographs	OS Landline
Other, specify		

27. If OS Data was used, what was the scale?		
1:10,000	1:25,000	1:10,000 and 1:25,000

28. What is the justification for the Aspect Area Boundaries?	

Evaluation Matrix

		Outstanding	High	Moderate	Low	Unassessed	Details
29 [a]	Evaluation criteria: Research Value.						
29 [b]	Evaluation criteria: Educational Value.						
30	Evaluation criteria: Historical Value.						
31	Evaluation criteria: Rarity / Uniqueness						
32	Evaluation criteria: Classic Example.						
33	Evaluation criteria: Overall Evaluation Give details						
34	Justification of Overall Evaluation.						

Bibliography

35. List the key sources used for this assessment.	

Assessment

36. Additional Assessments.	

37. Additional Comments	

A full description of the geological and topographical character of the identified Aspect Areas is required including a brief summary of the overall character of the Aspect Area. Closely related Aspect Areas, for instance segments of the same geomorphological feature or system, can also be listed. Key geological information is provided, including a list of the characteristic stratigraphical units or other rock types present, significant superficial deposits and structural features and processes - both active and past. Sources used can be listed in the Field 35 and also in the Technical Report.

Significant active geological and geomorphological processes are also be recorded in the database and features of surface hydrological significance can also be recorded, including river systems, springs and karst. Pedological processes, present or past, and ground water hydrological issues can also be recorded, although these fields can be considered as optional as assessment is not possible from aerial photographs and digital terrain mapping and only in exception circumstances do either category represent features or processes affecting the visible landscape, as is being described through the Geological landscapes methodology. Two exceptions to this general rule, however, are areas of peat formation – relevant in a pedological context - or the presence of karstic features and hence processes which are clearly related to a very specific type of ground water hydrological system.

The presence of quarries or mines, both active and disused is also recorded**,** although in many cases, confirmation of the exact nature of the materials worked would only be possible with a systematic ground survey. Information regarding the presence of geological conservations sites such as SSSIs (Sites of Special Scientific Interest) and 'RIGS' (Regionally Important Geological Sites) is also recorded. There is currently no comprehensive national coverage of RIGS sites in Wales, however, meaning that potential RIGS sites can be identified during the course of the Geological Landscapes survey, especially geomorphological features identified following an aerial photograph based survey. This information can be recorded for instance in fields 36 or 37 or in the Evaluation fields, as the presence of such sites may be relevant to any assessment.

6 Evaluating Aspect Areas

The Aspect Specialist aims to establish an evaluation of intrinsic value based on a professional understanding of the Geological Landscape character of the landscape. Pre-defined assessment criteria are provided in a matrix. The matrix is completed within the survey form for each Aspect Area after collecting all information on which the evaluation is to be based. The evaluation is then summarised with an overall evaluation and justification. The summary needs to be carefully worded as it may be used for secondary products such as designation or in development management and decisions.

For each evaluation criteria the importance of the qualities within the Aspect Area are scored on the following scale with the suggested interpretation of each category in the second table.

Outstanding	The importance of the qualities within the Aspect Area are of international or national importance to the Geological Landscape Aspect
High	The importance of the qualities within the Aspect Area are of regional or county importance to the Geological Landscape Aspect
Moderate	The importance of the qualities within the Aspect Area are of local importance to the Geological Landscape Aspect
Low	The importance of the qualities within the Aspect Area are of little or no importance to the Geological Landscape Aspect

Outstanding	Aspect Area contains features (including sites) of outstanding Earth heritage importance, including for national and international geological science. Generally, such areas also have a high actual or potential educational value and many will also be of historical importance and contain rare or unique features. As geological science is continually developing, however, an area rated as '*Outstanding'* may not always feature significantly in historical studies, or be suitable for general teaching purposes – evaluation of these criteria may occasionally be relatively low within the Evaluation Matrix. Although not necessarily including '*Outstanding*' representatives of '*Classic examples'*, it would be expected that some of the sites present in the Aspect Area would show good exposures or developments of geological and geomorphological phenomenon and therefore merit at least a '*High*' rating for this criteria.
High	The Aspect Area contains features (including sites) of high regional significance for scientific studies, typically linked to a high educational potential. Some of these sites may also have some historical value or demonstrate well-developed geological or geomorphological features. Other Aspect Areas evaluated as '*High'*, form the major landscape features in a district, such as prominent escarpments and upland tracts.
Moderate	An overall rating of '*Moderate'* is appropriate where the Aspect Area concerned is not known to include any exceptional or notable features, although it may still be 'representative' of its underlying geology or surface geomorphology
Low	Aspect Areas assessed as having an overall rating of '*Low'* have been damaged by development, or other human activities to such an extent that the majority of features of geological or geomorphological significance have been destroyed, buried or otherwise obliterated.

The evaluation matrix takes which into account: Research value, Educational value, Historical value, Rarity/Uniqueness and Classic example status**.** A typical interpretation of each category is demonstrated in the table below.

Evaluation matrix for Geological Landscapes Aspect Areas

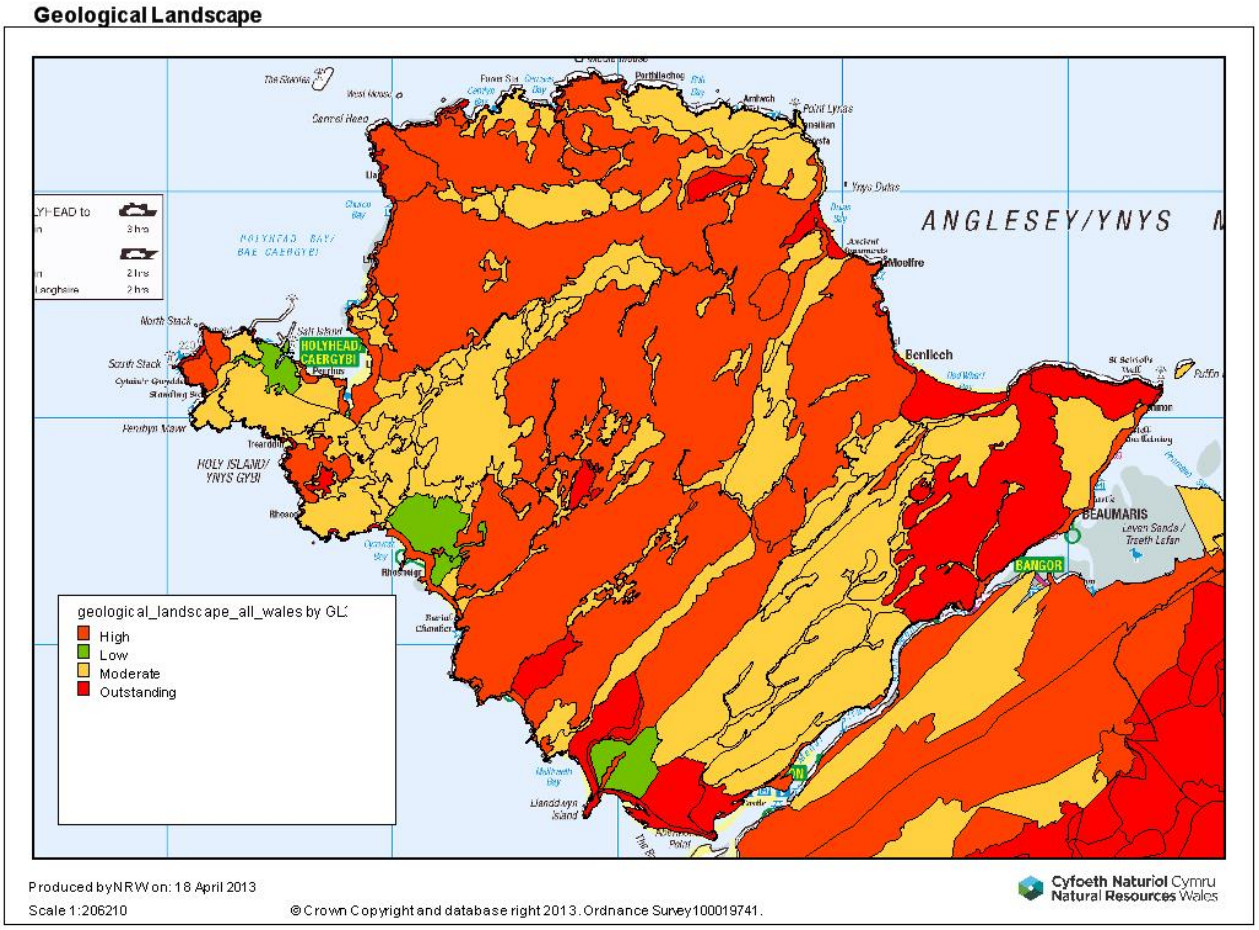
Evaluation criteria	Outstanding	High	Moderate	Low
Research value	Includes features or sites of outstanding importance to the national and international	Includes features or sites of significant scientific potential or importance, including to regional	Features present have some scientific potential but may be better developed or exposed elsewhere.	Geological heritage of the area is damaged, concealed or better seen elsewhere and therefore is of limited *current*

	geoscience community.	geological studies.		scientific significance.
Educational value	Includes features or sites of exceptional value for education – primarily at university level but also potentially at school level.	Includes features or sites with a high potential for educational use, primarily at university, but also at school level.	Includes features which although having some local potential, e.g. at school level, may be better developed or exposed elsewhere.	Geological heritage of the area is damaged, concealed or better seen elsewhere and, therefore, is of little or no educational value.
Historical value	Includes features or sites which have significantly contributed to the historical development of geology as a science.	Includes features or sites which have made a significant contribution to the development of knowledge of local or regional geology.	Includes features or sites which have been noted in literature but have not in themselves significantly contributed to the understanding of local and regional geology.	Includes no described sites or sites present have no particular historical significance in published literature.
Rarity/ Uniqueness	Includes features of exceptional scientific importance which are nationally or internationally rare or unique	Includes features which are scientifically rare or exceptional in a regional context.	Includes features which although being widely distributed regionally, may still be of local interest.	Features present are widely distributed regionally and better developed or exposed elsewhere.
Classic example	Includes features or sites which constitute an actual or potential ‘text book’ example of a geological or	Includes features or sites which clearly demonstrate key geological or geomorphologi cal features.	Includes features or sites which although demonstrating geological and geomorphologi cal features, are not well	Features or sites present are too badly exposed or developed to demonstrate key geological processes or features.

	geomorphological phenomenon.		exposed or developed.	

Each evaluation entered requires a short explanation and an overall valuation is made based on the general balance of responses to each part of the matrix. Occasionally, however, the overall valuation may differ from the balance of individual ratings, as Research value is considered to be the most significant category, as it directly reflects the global geological significance of the geology and/or geomorphology of the Aspect Area concerned. In such cases, a '*High'* or '*Outstanding'*, Research value rating would serve to raise the overall valuation, even if the Historical, Classical and Educational values are relatively low.

Geological Landscapes Aspect Area Evaluations for Ynys Mon (Anglesey)



A key part of the LANDMAP process is the assessment of the current condition of the identified Aspect Area and the provision of outline advice for future management of the area. This information is recorded in the database and responses are made according to the following general scheme:

Condition: This field records the current condition of the Aspect Area and can be interpreted as follows:

Good	The Aspect Area shows no significant potentially damaging activities such as large-scale industrial development, urbanisation or reservoir construction and there is no significant threat to the integrity of individual sites by virtue of SSSI or RIGS designation
Fair	Despite the presence of potentially damaging activities, the character of the Aspect Area generally remains in a favourable condition, although key sites of geological heritage importance may still lack formal protection.
Poor	Significant sections of the Aspect Area have been damaged or lost as a result of large scale activities, such as industrial development, urbanisation or mineral extraction (including subsequent site restoration without the conservation of geological features) and key sites of geological heritage importance lack formal protection.

Although most rural Aspect Areas can be reported to be in a favourable conservation condition, areas significantly modified by urban or industrial development are by definition in a '*Poor'* condition in a purely geomorphological sense and should be recorded as such. Nevertheless, some of these areas may still retain an intrinsic geological or geomorphological importance and this is reported accordingly with management guidelines. This assessment, however, should be balanced against any cultural or ecological value that such areas may have in terms of other Evaluated Aspects within LANDMAP.

Trend: Any observable changes in the conditions of Aspect Areas, including both improvements and deterioration, can be recorded within this field in the database. In dominantly rural areas, an assessment of '*Constant'* is appropriate in this context. For industrial and urban areas, an assessment of '*Constant'*, however, may mean that although the area is already significantly damaged in a landscape sense, no further works are known to be taking place and hence there is no change to its status. Where such activities are continuing, however, or future development is to be expected, the Aspect Area may be assessed as '*Declining'*.

Recommendations – Existing management: An assessment of whether existing management of the Aspect Area is '*Generally appropriate'* or '*Generally inappropriate'* is required. In assessing management in a Geological Landscapes context, an emphasis should be made on the landscape scale, as assessing the condition of individual sites is generally beyond the scope of LANDMAP. As for other management categories, in rural areas where potential threats are expected to be limited, an assessment of '*Generally appropriate*' may be appropriate. Where there is significant development, however, an assessment of '*Generally inappropriate*' in a strict geological and geomorphological sense is usually unavoidable. Explanation of any such assessment should be provided in the database.

Recommendations – Principal management recommendations and Guidelines: This field allows for recommendations to be made to improve the current management of the Aspect Area for Geological Landscapes as a series of guidelines. In general, in rural areas, where new large-scale industrial or urban developments are unlikely, few general recommendations are usually necessary. Key landscape scale issues; however, may

include forestry, mineral extraction and flood or coastal defence works. Developments such as these can obscure geological and geomorphological features or damage natural systems. In most urban and industrial areas, however, the removal or covering of geological and geomorphological features may mean that management recommendations are no longer relevant and are not, therefore, always provided.

Recommendations concerning geological site management are generally only significant at a sub-landscape scale but as such sites can provide a window into the geology and structures which characterise the Aspect Area, some comment may still be relevant within LANDMAP. Where an Aspect Area is underlain by geological formations of high scientific value, the recording of temporary excavations to ensure that no information of geological importance is lost may be recommended – the opportunity for such activities can be established through planning conditions attached to such developments. Similarly, where geological Sites of Special Scientific Interest (SSSIs) or Regionally Important Geological Sites (RIGS) have been identified, guidelines concerning management and protection may also be appropriate. A number of other management objectives may also be stated, to reflect possible local issues and provide a framework, if required, for maintaining the condition of the Aspect Area in a '*Good'* condition.

Tolerance to Change: Within this field, activities which could potentially have significant adverse effects on the condition of the Aspect Area can be recorded, including an assessment of a threshold for any changes - beyond which the Aspect Area must be considered as having been damaged. In rural areas, where development pressure is limited, identified threats are likely to be at the level of an individual site, rather than being potentially destructive in the context of the Aspect Area as a whole. Such threats can include the infill and consequent loss of important quarry exposures by agricultural operations and irresponsible collecting of geological specimens at sensitive, scientifically important sites. In certain areas, however, forestry remains a significant potential threat, especially to sensitive glacial and periglacial features in upland areas, as it can not only obscure their form and distribution, it can also cause extensive damage due to the deep furrowing normally employed during planting. In developed areas and especially areas adjacent to developed areas, the geological and geomorphological characters of an Aspect Area may be threatened through future industrial or urban expansion. Although creating geological exposures, mineral working can also be a very significant threat, especially where rare landforms and sensitive features such as glacial kettle holes or cave systems are present.

The identification of a potential threat, however, does not mean it is an *actual* threat, but the information provided is intended to offer some guidelines for future management of the Aspect Area. In addition, these lists should not be considered to form a concise assessment of potential issues and reference to the Nature Conservancy Council's strategy and guide to site management (1990)* can be made for a more general review of potential threats to a wider range of site types and to NRW for site-specific observations [*NATURE CONSERVANCY COUNCIL 1990. *Earth Science Conservation – A Strategy* (including *Appendices* 1-6 – *A handbook of Earth Science conservation techniques*), Nature Conservancy Council, Peterborough, Appendices 1-6].

7 Technical Report

To support the Geological Landscape survey the Aspect Specialist submits a Technical Report for the Geological Landscape aspect so that the justification and explanation of key decisions is made transparent.

Format and content of Technical Reports

Executive Summary (500 words) in Welsh and English

Contents page

Methodology: If the prescribed LANDMAP guidance was followed then the Aspect Specialist does not need to reproduce the methodological description.

Overview: A summary description of the Geological Landscape aspect for the whole study area bringing out the most important characteristics and key issues.

Information sources and data sets used including full details of consultations, date, personnel involved and outcomes

References

Justifications and judgements of any decision that may cause confusion. Areas where such texts are likely to be needed include:

- Justification of approved additions to, or departures from, the prescribed hierarchical classification system, although such deviations are generally not permitted.
- Explanation of potentially contentious decisions about individual Aspect Areas.
- Elaboration on the justifications of evaluations for any potentially contentious decisions about individual Aspect Areas.

8 Monitoring

A robust, repeatable and standardised monitoring methodology has been developed to facilitate the process of identifying Aspect Areas where significant change has occurred. This methodology is described in full in the LANDMAP Monitoring Methodology (2016) and uses a range of mapped data, including processed information derived from remote sensing, to identify areas of potentially significant landscape change.

The following may provide useful insights in interpreting the materials available during monitoring.

- **Change in Segment Density (complexity)**

Changes in Segment Density (i.e. complexity) can be useful for indicating changes to some types of Geological Landscape feature, in particular the development of vegetation on, or ‘restoration’ of, former mineral workings. Such changes can lower the geological usefulness of such features leading to a deterioration of, or decline in, quality. An increase in complexity can also result from the conversion of agricultural land to housing, or the development of scrub across upland heathland. A decrease may represent the conversion of the latter to grassland or the removal of woodland.

- **Normalised Difference Vegetation Index (NDVI)**

These maps can, for instance, help resolve if the identified changes relate to afforestation, which can be a major damaging issue for some Geological Landscapes features, especially geomorphological. Some apparently significant changes identified, however, may be related solely to vegetation evolution, with no consequences for Geological Landscapes features.

- **Ordnance Survey MasterMap**

Major roadworks, however, have the potential to both create new geological features and damage existing features or geomorphological systems. However, as the resolution of aerial photography is generally not high enough to adequately assess such changes, a field visit may be required to assess their significance. Note: Although most accurate in urban areas, Ordnance Survey digital mapping does not always record significant changes in rural areas, and as a consequence may not be reliable as an indicator of change in such areas. In addition, mineral workings, mineral and waste disposal areas and some natural features such as sand dunes are also commonly not fully mapped, for instance lacking contours or water bodies. As a result Ordnance Survey mapping is not suitable for assessing such areas and referral must be made to aerial photographs.

- **Aerial photographs** (ortho-rectified layers) as original set corresponding to the base line survey date and later set corresponding to the monitoring interval.

Aerial photographs can be extremely useful for investigating the significance of changes identified through other mapped data resources although in some cases assessment of any identified changes may remain inconclusive. In such cases, a site visit to assess the significance of any change may be necessary. However, the use of 'flat' digital photographs for assessing the types of changes in surface texture and topography that may be relevant for geological and geomorphological features is limited. Although digital terrain models can provide some 3-dimensional information, these generally do not have sufficient vertical resolution and in practice, only stereo-pairs of aerial photographs, ideally at 1:10,000 scale, viewed though a suitable optical stereoscope can currently provide sufficient topographical resolution to allow the fuller assessment of changes to features such as river systems, quarry sites and coastlines. If such imagery is available, a field visit may not be unnecessary, as subtle topographic changes such as the limits of active river channel-flood plain systems are often recognisable and development which does not affect such systems can be more clearly separated from that which has.

9 Quality Assurance

To ensure national consistency and high standards, LANDMAP information is Quality Assured before any datasets are approved and made available. The methodology is described in full in the LANDMAP Quality Assurance Methodology.

Aspect Specialists submissions for quality assurance should be comprehensive and include:

- A single GIS layer defining Aspect Areas
- Aspect Area surveys
- A comprehensive Technical Report/Monitoring Table
- Supplementary information as required. Documentation, including correspondence, survey maps and field data sheets should be retained, in the event that they are required.